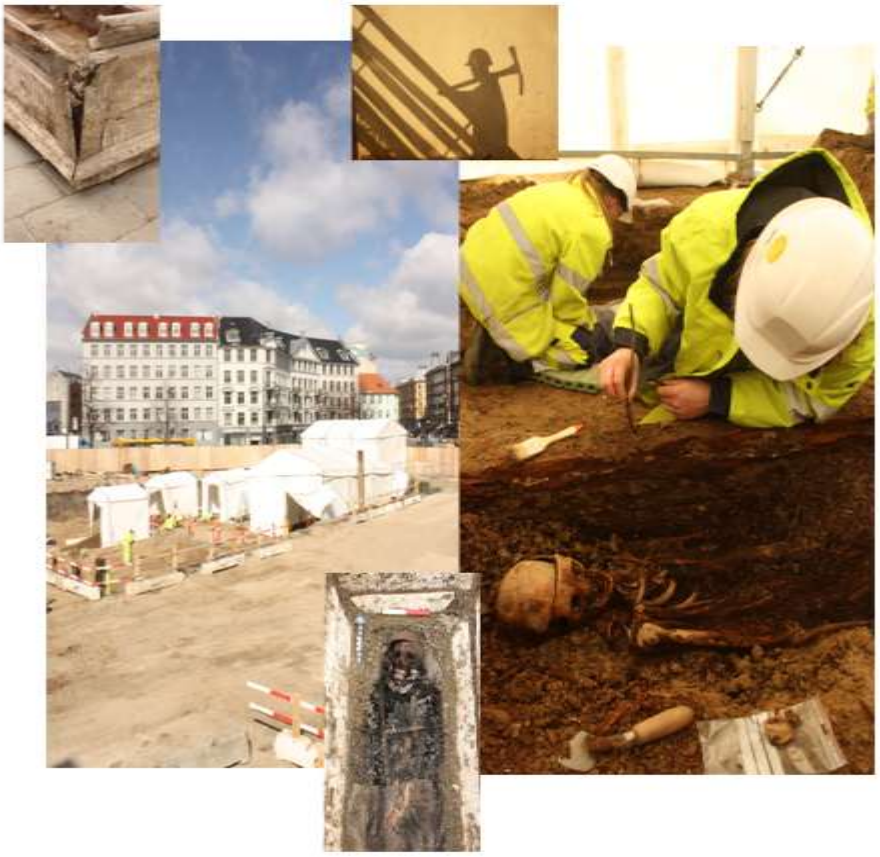
KØBENHAVNS MUSEUM MUSEUM OF **COPENHAGEN** / ARCHAEOLOGICAL REPORT

Assistens Kirkegård

Nørrebros Runddel, Metro Cityring Project

KBM 3830, Nørrebro, Trinitatis Sogn
Sokkelund Herred, Københavns Amt

Kulturstyrelsen j.nr.: 2010-7.24.02/KBM-0015



Sian Anthony, Jens Winther Johannsen,
Marie Louise S. Jørkov & Samuel Keenan.

KØBENHAVNS MUSEUM
MUSEUM OF COPENHAGEN

Københavns Museum
Vesterbrogade 59
1620 København V
Telefon: +45 33 21 07 72
Fax: +45 33 25 07 72
E-mail: museum@kff.kk.dk
www.copenhagen.dk

Front cover: Excavation in Area 4 looking north to Nørrebros Runddel; Archaeologists at work in April 2010; Elaborated coffin (G799); Elaborated coffin and skeleton with many personal gifts (G518). Forside: Udgravning i område 4 set fra syd med Nørrebros Runddel i baggrunden; Arkæologer igang med udgravningsarbejde, April 2010; udsnit af rigt forsiret kiste (G799); skelet og gravgaver i rigt forsigt kiste (G518)

Contents

Abstract

The development of a new Metro line in the city of Copenhagen prompted archaeological investigations by the Copenhagen Museum throughout the city and its environs. One of the four major excavations resulting from this project was at Assistens cemetery, 1km north-west of the city centre. The creation of a new Metro station at Nørrebros Runddel resulted in an excavation in Area G in the north-easternmost corner of the cemetery. The excavation took place between December 2009 and February 2011.

Assistens cemetery remains a site of great cultural and historical importance for Copenhagen and is still a working cemetery. Opened in 1760 it was created to remove the cemeteries away from the increasingly crowded city, thus the new cemetery encapsulates contemporary ideals of urban planning, health concerns and social reactions to the new and demanding environments of the 19th and 20th centuries. The excavated area was incorporated into the cemetery in 1806 and was reserved for parishioners from Trinitatis Church in the city centre. Cemetery protocols record that coffin burials took place in the area until 1984 and cremation burials until 1988.

The research aims of the project were designed to enable the integration of all the evidence from the graves: archaeological, anthropological and documentary to allow future research into burial traditions in the 19th and 20th centuries. The methods used have aimed to gain the full potential out of the stratigraphic, archaeological information. The project has also maintained a balance between scientific enquiry and an inherent respect for the ethics of investigating modern graves.

In total 854 *in situ* inhumations (burials within coffins) and 81 cremation burials were excavated. In addition to this, information was found relating to the active life of the cemetery, such as landscaping features. Stratigraphical data from the grave cuts and coffins provide evidence for the spatial management of the cemetery in relation to the placing of new graves and the removal of earlier graves. The excavation has provided direct evidence about how the cemetery was organised and the professionalization of the gravediggers. The coffins and accompanying material culture have provided insights into the interaction between the mourners and the funeral industry. In this process the societal attitudes to death and disposal of the dead are revealed. The skeletal assemblage investigated in cooperation with the archaeological information has given invaluable information on demography, families and lifestyles.

The potential of this investigation is vast; it is the first in Denmark to systematically excavate a large cemetery from this period. Within the local context it aids an overall study of the chronological aspect of burial traditions and attitudes to death in the post-Reformation period. The large osteological sample size from Assistens cemetery will allow creation of statistically significant data sets that can be compared with documentary data and thus contribute to ongoing debates concerning the effects of urbanisation and industrialisation on the health of individuals and populations. The results also have an international significance, being comparable to other contemporary cemeteries in Europe and America. This investigation opens up new archaeological perspectives onto the historical period, our recent past, reflecting both the world of the dead and that of the living.

Resumé

I forbindelse med Metroens udvidelse foretog Københavns Museum en række arkæologiske undersøgelser i København både inden og uden for voldene. Den ene af fire større udgravninger foregik på Assistens Kirkegård, der ligger cirka en kilometer nordvest for Københavns bymidte. Ved etableringen af metrostationen ved Nørrebros Runddel blev en del af Afdeling G i kirkegårdens nordøstligste hjørne undersøgt. Undersøgelsen foregik mellem september 2009 og februar 2011.

Assistens Kirkegård er af væsentlig kulturel og historisk betydning for København og fungerer endnu som kirkegård. Den blev etableret i 1760, da man ønskede at rykke kirkegårdene ud af den stadig tættere befolkede bymidte. Kirkegården er således udtryk for samtidens byplanlægning, sundhedshensyn og befolkningens tilpasning til de nye krævende livsbetingelser i det 19. og 20. århundrede. Det undersøgte område blev indlemmet i kirkegården i 1806 og var forbeholdt indbyggere i Trinitatis Sogn. Den sidste begravelse i området blev foretaget i 1984, mens den sidste urnenedsættelse skete i 1988.

Projektets målsætning var at integrere gravenes arkæologiske, antropologiske og historiske data i undersøgelsen, for således bedst muligt at kunne facilitere fremtidtigt forskningsarbejde. Målet med de anvendte udgravningsmetoder har bl.a. været at få det fulde udbytte ud af de stratigrafiske data. Der har samtidigt skulle opretholdes en balance mellem den videnskabelige målsætning og de etiske hensyn i forbindelse med undersøgelsen af grave fra en så sen historisk periode.

I alt blev 854 jordfæstegrave (begravelser i kister) og 81 urnegrave undersøgt. Dertil kommer en række andre vidnesbyrd om menneskelig aktivitet på kirkegården, herunder gravernes arbejdsmetoder. Gravenes stratigrafi vidner om kirkegårdens rumlige organisering, og hvordan gamle gravsteder blev nedlagt og søndergravet når nye gravsteder skulle etableres. Kisterne og de tilhørende genstandsfund har givet indsigt i sammenspillet mellem de afdødes efterladte og begravelsesindustrien og er dermed med til at kaste lys over periodens generelle indstilling til døden såvel som samfundets håndtering af afdøde. Sammenholdt med de arkæologiske data har undersøgelsen af skeletmaterialet givet væsentlige oplysninger om periodens demografi og livsførelse.

Undersøgelsen har stort forskningsmæssigt potentiale. Det er den første danske udgravning af en kirkegård fra dette tidsafsnit og muliggør således et overordnet studie af den kronologiske udvikling i begravelsesskikke og indstillingen til døden i den efterreformatoriske periode i Danmark. Det store osteologiske materiale muliggør statistiske undersøgelser, som kan sammenlignes med historisk og arkæologisk data og derved bidrage til den fortløbende debat omkring urbaniseringens og industrialiseringens betydning for sundhedstilstand for det enkelte individ såvel som den samlede befolkning. Undersøgelsen har ligeledes betydning for den internationale forskning, idet den vil give sammenligningsgrundlag for andre kirkegårdsudgravninger i den vestlige verden. Idet resultaterne afspejler både de levende og de dødes verden, åbner undersøgelsen samlet set op for nye arkæologiske perspektiver for denne sene historiske periode - vores nære fortid.

Archaeological periods:

Late Bronze Age, Early Iron Age, Late Post-medieval, 20th century

Feature types:

Graves, coffins, brick vaults, rubbish pits, gravestones, prehistoric house/settlement?

Key words:

Cemetery, inhumations, coffins, coffin furniture, grave decorations, gravediggers, family plots, single graves, cremations, prehistoric, industrialisation, skeletons, osteology, burial, grave goods, Post-medieval, Modern

1 Introduction and administrative data

Metro Project and Københavns Museum

The excavation on the Assistens Kirkegård was undertaken as part of the new Metro Cityring project which will provide a new transportation system to the surrounding outskirts of the city. The site at Assistens cemetery was designated as a station location - Nørrebros Runddel, where there would be significant archaeological material and sensitive remains that required archaeological excavations. The work was conducted by the Museum of Copenhagen (KBM) which is responsible for archaeological work within the municipalities of Copenhagen and Frederiksberg.

Site location

The cemetery is located in the Nørrebro area, to the north west of the main city centre ofCopenhagenonZealand (Fig 1). Therefore it lies outside of the main focus of urban medieval and early historical activity. The cemetery is bounded by Nørrebrogade to the north-east, Jagtvej to the north-west, Hans Tavsens Park to the south-east and Kapelvej to the south-west. The cemetery was initially founded in 1760 as a small section next to Kapelvej but was extended to the north and west throughout the 19th century; it is still in use as a cemetery. The excavation was limited to a small section in the northern corner of the cemetery, formed by the junction of Nørrebrogade and Jagtvej. This part of the cemetery was opened in 1806 and continued as a working cemetery until the excavation started. The area is centred on the proposed entrance to the station which would face to the north, to the Nørrebros Runddel and around an historic building – the Sexton's or gravediggers' house (*graverbolig*). This section of the cemetery was reserved for residents of the Trinitatis Parish which is within the city centre of Copenhagen and centred on the parish church of Trinitatis Kirke, famous for the Rundetaarn.

Scope of the project

The construction of the new station and related ancillary works such as service trenches required the removal and documentation of a number of burials within the site. The remit of this project required only that appropriate recording and documentation of the archaeological material should take place. The development involved the demolition of workshop buildings on the site with the exception of a single protected building (the gravediggers' house, *graverboligen*). This was moved to enable the station to be constructed and will be replaced in the same position after the completion of the Metro station. This work and protection of the building did not fall under the remit of this project.

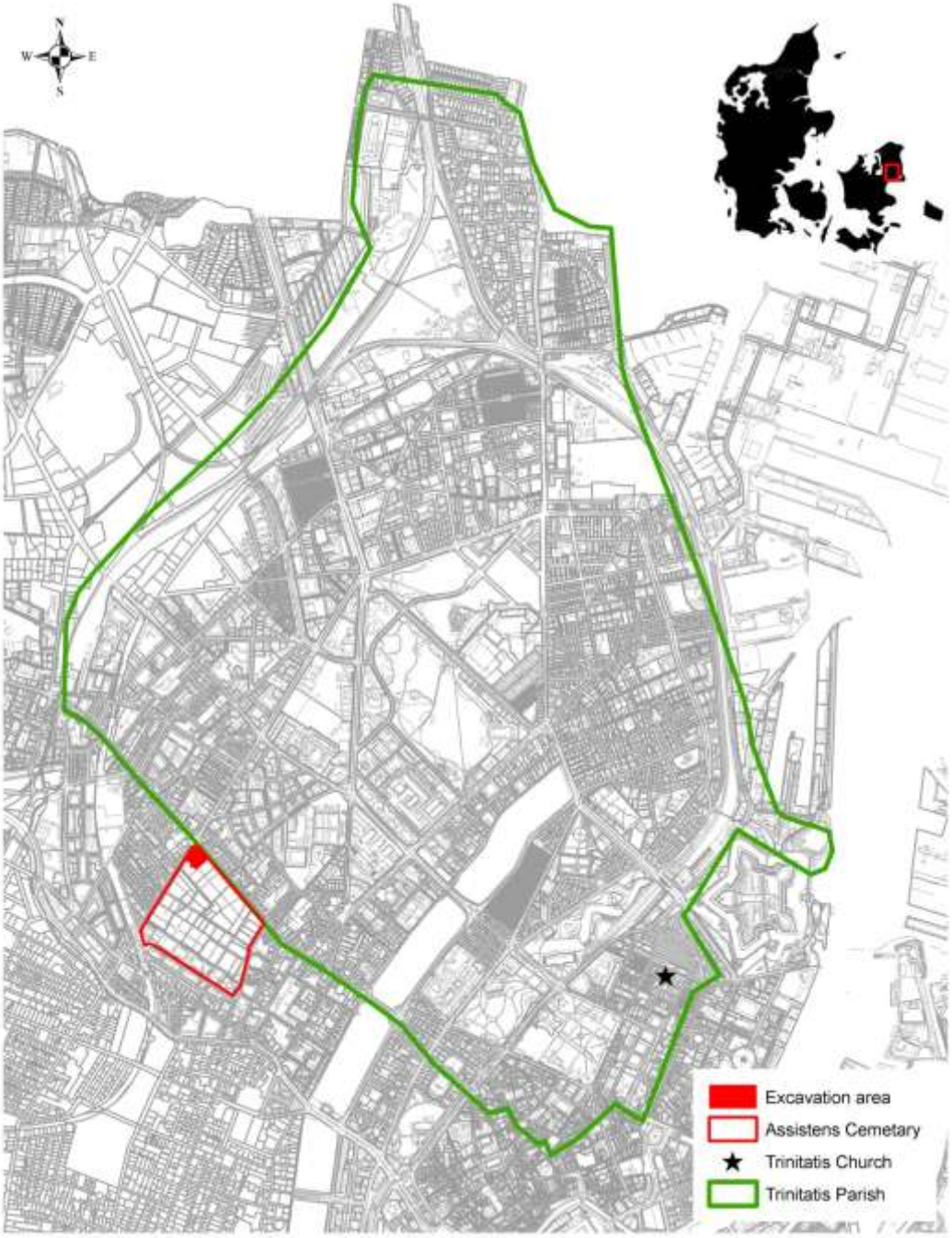


Fig 1 Location of site within Denmark and Copenhagen (Kirkegårdens placering i Danmark og København)

The aim of this project was to create a complete, thorough and accurate set of data that can be used for future research. This is stated within the document covering the overall archaeological design aspects of the Metro Cityring project which was approved by the Danish Agency for Culture, (Kulturstyrelsen, KUST) in the autumn of 2009 (Thomasson 2009). The excavations are designed to allow this future research to be undertaken to enhance the archaeological and historical knowledge that can be gained from the site and related to the development of Copenhagen.

However the excavation was not carried out under jurisdiction of the Danish Museum law (Bekendtgørelse af museumsloven nr. 1505), since the area was property of the Church. Instead it was carried out as an 'ethical clearance' on the wish of the Metro company andtherefore under a separate agreement between the Museum of Copenhagen and the Metro company (Metroselskabet). Despite this, the work carried out did conform to KUST standards and guidelines, in many ways exceeding the work that would have been allowed under the Museum law.

A significant issue in the project was the ethical requirements inherent in a cemetery excavation of such a modern period. All the coffins, skeletons and their associated artefacts were retained on site, recorded and reburied in a new location within the cemetery during the fieldwork phase of the excavation. This decision was made by the Museum of Copenhagen in 2009 (Københavns Bymuseum 2009). This rapid registration and reburial of the archaeological features and finds required that the recording and documentation at the site was of the highest quality as there would be no further opportunity to re-document the material.

Project staff

The excavation was led by Sian Anthony as Excavation Leader and Field Leaders Hanna Dahlström, Anna Dunphy (until August 2010) and Stine Damsbo Winther (from August 2010). Marie Louise S. Jørkov was responsible for the osteological documentation. Archaeologists included: Brendan Fagan, Fredrik Grehn, Terje Stafseth who were responsible for specialised roles on the excavation. Archaeologists on the project included: Michael Alrø Jensen, Stine Damsbo Winther, Signe Føg Morgensen, Karen Green Therkelsen (who registered prehistoric finds and created some of the figures in this report), Kirstine Haase (who registered some of the finds), Lars Haugesten, osteologist Lise Harvig, John Howorth, Samuel Keenan, Mette Kjelstrup, Jacob Mosekilde, Rachel Morgan, Charlotte Rimstad (who was responsible for processing skeletal material and also registered textiles), Claus Rohden Olsen, Karin Roug, osteologist Helene Wilhelmsson. Students included: Anja Borch-Nielsen, Lise Christensen, Jens Hansen, Mie Pedersen, Ingeborg Sæhle, Maria Louise Tvede, Louise Melchior Rasmussen, Zenon Topagic. Further assistance was given by Hannah Butterfield during the fieldwork and Amalie Møller Højbjerre during the post-excavation process. Petter Linde and Kennet Stark assisted with IT and IntraSiS support. Stuart Whatley gave advice and assistance with finds material. Work on historical sources was undertaken by Inger Wiene, and students Pelle Skrubbeltrang and Katharina Zander. Additional research was undertaken by Lise Christensen.

The post-excavation work and report editing was led by Sian Anthony and the principal authors are Sian Anthony, Samuel Keenan, Jens Winther Johannsen and Marie Louise S. Jørkov. Additional contributions were by Hanna Dahlström, Charlotte Rimstad (textiles), Lars Haugesten (wedding rings) and Kirstine Haase (cemetery-era ceramics, clay pipes and glass). Joakim Thomasson as the leader of the Antiquarian section at KBM guided the project throughout its stages and created the initial report framework. Lene Høst-Madsen was the overall project leader for the Metro Cityring project. Grateful thanks and acknowledgements are made to all the people who worked on the excavation in

sometimes difficult environments who provided interpretations and created the foundation for the report writing through their work.

Consultants and contractors

Thanks are also made to Professor Dr Niels Lynnerup for initial advice when planning for the project; Matthew Law, doctoral student at Cardiff University, for information concerning the conch shells; Per Agner Bach Stougaard, consultant with the Danish Police Criminal Technology Centre, for forensics help; Adrian Miles, Senior Archaeologist from Museum of London Archaeology, for information and discussion concerning London excavations and historic cemeteries in general; Mette Marie Hald for botanical analysis; Irene Skals for assistance with textile analysis; Rachel Ives and AOC Archaeology Group London for generously providing the osteology database; Niels Albertsen from Santax Medico for help and guidance with the x-ray machine; Dr. Pia Bennike, Dr. Niels Dyrgaard Jensen and Dr. Steen Holger Hansen for help, academic advice and fruitful discussions; Tom Olsen from the Center for Kirkegårde for patience in organising the reburials along with the staff from the cemetery for their good humoured strength and assistance with the burials and Carsten Hansen and staff from NCC for generous assistance and patience throughout the excavation. Beredskabsstyrrelsen kindly provided stretchers.

Organisation of the report

The report is designed to provide a full statement concerning not just the results and archaeological interpretation of the work but also to describe in detail the methods undertaken and some of the theoretical basis. It also examines and assesses the processes and procedures created to deal with the archaeology. This provides a baseline - and a discussion point for similar future excavations. The aim of the report is to provide three main points of information: a guide to the data and documentation material, especially for the IntraSiS database which will provide access for interested users, an assessment of the results and a basic cultural historical interpretation.

Administrative data

Case number KUAS	2010-7.24.02/KBM-0015 (Metro Cityring)
Case number KBM	KBM3830
SB-number	020306-664
County	København
Municipality/City	København
Area	Nørrebro
Parish	Trinitatis
Street/block	Assistens Kirkegård, corner of Jagtvej and Nørrebrogade
Duration field phase	December 2009-February 2011
Excavation management	Sian Anthony (Udgravningsleder), Hanna Dahlström (Feltleder), Anna Dunphy (Felt Leder) and Stine Damsbo Winther (Feltleder)
Investigated area (m^2) and % of total	7194.5 m^2, 100% investigated
Investigated volume (m^3) and % of total	Full excavation 10954.8 m^3 Targeted excavation 435.2 m^3 1m excavation 4238.1 m^3 Total excavated 15628.1 m^3, 100% investigated
Coordination system	DKTM zon 3
X-coordinate	1174607
Y-coordinate	650237
Height system	DVR 90
Metres above sea level	*c* 9.4m
Contractor/Client	Metroselskabet I/S
Archive material	Paper archive including osteological documentation. Digital archive including IntraSiS database and osteological Access database
Finds material	Prehistoric finds (flint, ceramics);historic finds (textile, ceramics, coffin decorations, jewellery, toys, glass items)

2 Cultural historical background and topography

The site before the cemetery

The location of the cemetery is far beyond the medieval city limits of Copenhagen, in what was once open land. There are references to a medieval village or hamlet, Serridslev, in the area, although the exact location of the village is unknown. It was recorded as being destroyed in 1523 by order of Fredrik I and the land belonging to the village was taken over by the city of Copenhagen (Dahl 2010: 17). Historic maps suggest use of the area as grazing. However, a main road, Nørre Landevej, was established leading out of the town from Nørreport which is today's Nørrebrogade. This forms the eastern boundary of the cemetery. Jagtvej, which forms the northern boundary of the cemetery, was originally the Royal hunting road of the court, but it is uncertain when it was established. Historical accounts concerning owners of properties from the end of the 16th century describe several properties along Nørre Landevej and up to Jagtvej. However, there does not seem to have been any substantial settlements.

During the 16th century Copenhagen was threatened by war on several occasions. Therefore, temporary fortifications were built north of the city in Nørrebro and all settlement in the suburbs was later destroyed during the siege of Copenhagen by the Swedes in 1658-60 (Dahl 2010: 18). In response to this, in 1661 all settlement between the lakes (north of the city) and the outer fortifications was banned to stop future enemies using them as cover. The area became a demarcation zone and in 1682 this zone was extended up to the present-day Møllegade/Solitudevej (Dahl 2010: 19) which lies south of Assistens cemetery.

Prior to the establishment of the cemetery historic sources show that the site had been marked out as tobacco fields (Dahl 2010).

Establishment and development of the cemetery

From the 18th century there was an increasing lack of burial space in urban areas and allied with scientific theories and ideas of the enlightenment, there began a movement to sanitise the old cities. Part of this movement, which is common to western European countries and America, was to encourage burial outside of urban areas (Rugg 1997). Copenhagen's solution was to establish various cemeteries lying just outside the city walls and the lakes. The oldest of these (also called Assistens cemetery) was situated in the area between the rampart and Sortedamssøen. This was established as an additional cemetery for Vor Frue Kirke, Helliggeist Kirke and Skt Nicolai Kirke, but gradually became a cemetery for paupers and plague victims (Dahl 2010: 30). Holmens cemetery was opened in 1666 and Garnison cemetery in 1671 and they were intended for poorer members of the navy and army and their families. Another larger cemetery, Assistens cemetery was originally proposed to be located within the area between the city rampart and the surrounding lakes, and it is uncertain why it was not (Nielsen 1939: 98). One reason given for the current location was due to its situation on a slight rise in the ground level, away from the marshy wet environments nearer to the lakes (Dahl

2010: 32). However, it is likely due to many other reasons – cheapness of land and willingness of local landowners to have a cemetery placed near their lands being practical reasons; however, there are hints of other social reasons for the location. Placing the cemetery on a slight rise overlooking the city but not part of it, it would have dominated the landscape and been a visible symbol of new organisation of dealing with the dead and the people who dealt with the dead.

The city authorities also intended a wall to be built around the new cemetery instead of the more common ditch or fence. This was ostensibly to prevent grave robbing and create a secure place (Lindberg 2010: 76) but it also made it more of a defined place in the landscape.

Origins and expansion

Assistens Cemetery was created in 1760. It consisted of what is today Area A, the most southern part of the cemetery. The original cemetery was divided into sections, one for each of the church parishes in the city – Vor Frue, Trinitatis, Helliggeist, Skt. Nicolai and Skt. Petri, and also the poor houses of Vartov Hospital and Vaisenhuset (Nielsen 1939: 107). The cemetery sections were administered separately by each parish and there was little overall management or control of burials and prices (Nielsen 1939: 129). Just as in the old urban churchyards, selling the grave plots and burial fees became a considerable source of income for the parishes.

One of the first historic maps showing the site is by Christian Geddes (Fig 2). This is an elevated map of Copenhagen and its suburbs from 1761; the time of the establishment of Assistens cemetery. The wall around the cemetery is depicted on the map. By Kapelvej, on the south-east corner of the cemetery is a small building, which is likely to be the first gravediggers' house.

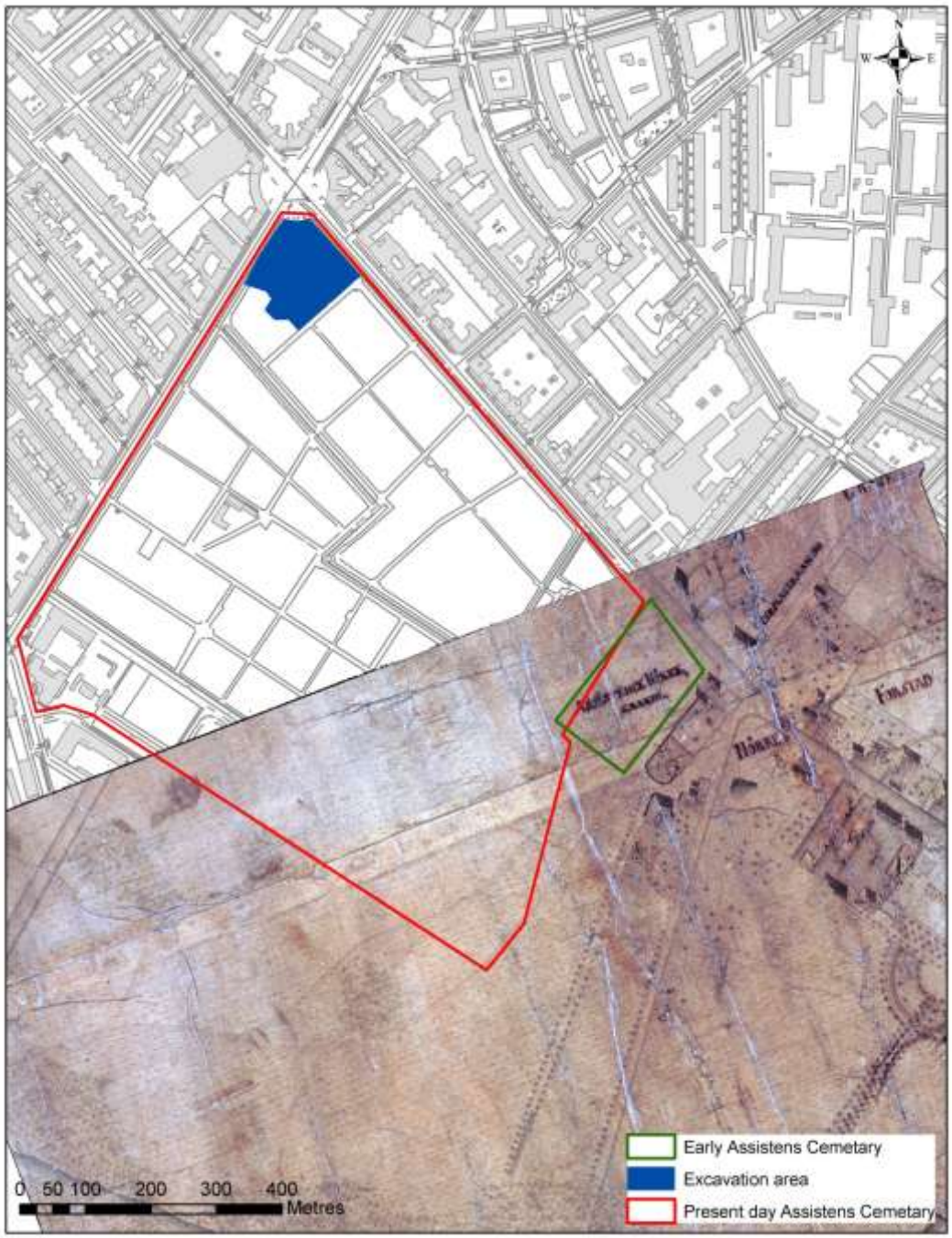


Fig 2 Christian Geddes' elevated map of Copenhagen and its suburbs, 1761 (Christian Geddes eleverede kort over København og de tilhørende forstæder, 1761)

At first, the distant location of the cemetery and the lack of a nearby church led the cemetery to be viewed with scepticism by the wealthier citizens of Copenhagen. In the first decades after the establishment the cemetery was, therefore, mostly used by poorer people. However, there was a slow turn in attitudes, which was partly helped by the decision of some prominent members of society, like the rich Copenhagener Johan Samuel Augustin in 1785, choosing to be buried at Assistens cemetery in the "open air" instead of under the floor of a church (Helweg 2010: 121).

In 1806 the cemetery was enlarged to contain the whole area from Kapelvej in the south up to Jagtvej in the north and from the present Nørrebrogade in the east up to Kirkegårdsfælleden (common lands at the cemetery). After the expansion the parishes received at least one further large area each (Areas B-G). There were also smaller sections for different religious groups, such as German and French Protestants and Catholics making it a cemetery for all citizens without discrimination against religious background. The area excavated is within Area G (Afdeling G), which belongs to the Trinitatis parish within the heart of the city. Area G is distinct for being both in a prominent position on the corner of the cemetery, but also for having the new gravediggers' house and garden placed in its centre. The gravediggers' house is the second built within the cemetery and was, among other functions, intended to be used for storing coffins prior to burial. There were also smaller outbuildings surrounding it. The house was built between 1806 and 1808 and designed by a prominent physician and city official called Jens Bang (Lindberg 2010: 87). He was also one of two persons appointed to plan the layout of the expanded cemetery. His idea was inspired by the contemporary English parks, with winding pathways, lush tree areas and flower arrangements. The other suggestion (by Ole Jørgen Rawerts) was more ordered and resembled very much the final design (Jørgensen 2007: 8). The earliest detail of the planned expansion is the map from the winning proposal (Fig 3); it closely resembles the final design that can be seen in later maps but it places the gravediggers' house directly over planned pathways. There are no details of specific plots, only a more elaborated plant line showing where the designated monument lines were to be placed. The gravediggers' house has a walled inner yard with two small buildings but there is no indication of the gravediggers' garden.

Fig 3 The chosen project draft design of Area G, *c* 1800s (Det vindende udkast til udformingen af Afdeling G, ca. 1800)

Outside the cemetery walls there were a great deal of changes and dramatic events taking place during the 1800s. In 1807 the Nørrebro area became a war zone when the English invaded Denmark and besieged Copenhagen. Temporary fortifications were built all around the area and bombs were fired by the English from Nørrebro into the city. Afterwards the old demarcation zones were reinstituted, which meant that no large buildings were allowed in the area from the city wall up to Jagtvej. This implied that the Nørrebro area remained relatively undeveloped and it is uncertain how many burials took place prior to the war. The war ended in 1814, and soon after normal

burialresumed in the cemetery. The rate of burials is perhaps suggested by a continued expansion of the cemetery, to the west into Kirkegårdsfælleden and the former tobacco fields (the areas H-T, X, Y and Ø; Nielsen 1939:113, Helweg 2010:122). Cemetery records of those buried from this period are maintained by the cemetery officials and are of variable quality, but often show some details of address, occupation and cause of death as well as administrative details of the grave plot. The first detailed map of the area (Fig 4) was drawn to show relatives of the deceased where the plots were: not all plots are present, possibly only those already bought.

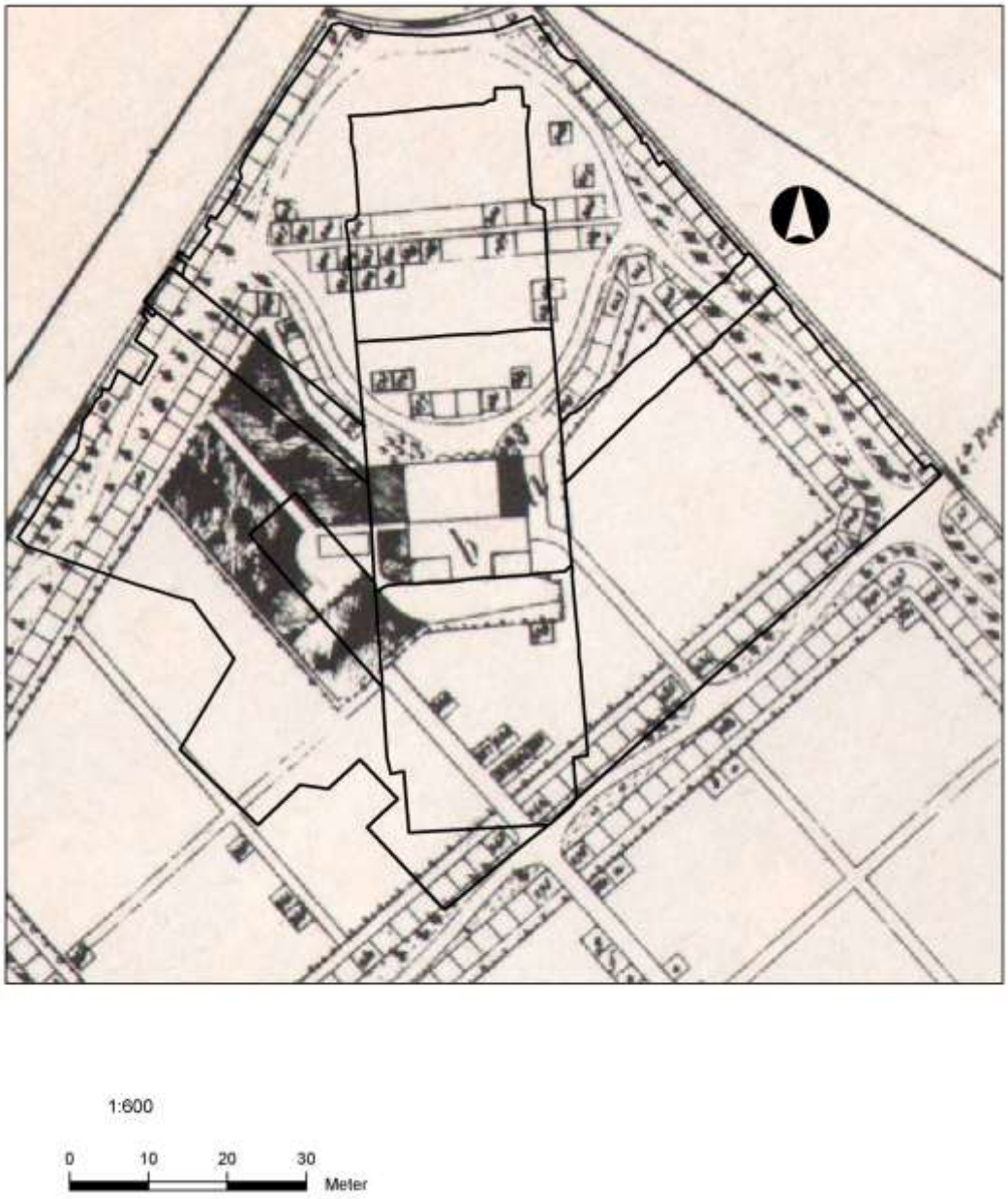


Fig 4 Historic map of Area G, 1831 (Historisk kort over Afdeling G, 1831)

One of the largest obstacles to greater development of the Copenhagen area was removed in 1852 when the building prohibition in the demarcation zone was repealed and the defences were removed. There began a swift transformation from countryside to a highly developed suburb of a growing city with five storey apartment buildings, shops, small factories and industries (Dahl 2010).

A map of the cemetery dated to 1868 (Fig 5) shows little detail except for a change with a new larger building replacing the originals behind the gravediggers' house. The foundation of another, much larger cemetery, Vestre Kirkegård in 1870 may have released some of the pressure on Assistens cemetery. Extensions of Assistens cemetery were therefore cancelled by the 1880s, and a church (The Church of the Holy Cross/ Hellig Kors Kirke) and two schools were built instead. In 1898 cemetery officials (begravelsesvæsenet) wanted to demolish the gravediggers' house, but it was instead renovated and converted into a house for cemetery officials (Nielsen 2010: 555).

A further great change to the cemetery occurred in 1880 when it was decided that the cemetery was to be maintained by the municipality of Copenhagen (Helweg 2010: 25). From that point on records of burials are far more standardised. A survey of the cemetery was undertaken and a new system of identification of the grave plots was implemented. The map of 1880 (Fig 6) which unites the old system with the new also shows some small changes to the plot layout.

The cemetery in the 19th century to present-day

Various regulations from the beginning of the 19th century show that the cemetery, as now, was used as a recreational area and that the activities sometimes became inappropriate, with drink and music, forcing the authorities to enforce appropriate behaviour rules for people visiting the cemetery (Helweg 2010: 121; Larsen 1960: 109).

Nørrebro became a fully integrated part of the city in the 20th century. Part of the western part of the cemetery was later decommissioned, and in 1909 Hans Tavsens Park was opened in this space (Dahl 2010).

Minor alterations to facilities have been made including renovation of the gravediggers' house, the demolition of old buildings and construction of several new buildings around a small yard area. A map dated to 1920 (not illustrated) shows only outline detail of the grave plots but does illustrate the removal of older outbuildings and the creation of a new building in the south-east corner of the gravediggers' yard.

By 1880, the municipality had already decided that there would be no more grave plots sold after 1960, and it would no longer be used as a cemetery after 1980 (after the standard 20 years of grave peace for the last graves). (Kjøbenhavns Borgerrepræsentanters Forhandlinger, 24 Febr. 1879; Helweg 2010: 126). The plan was then to keep the area as a park with the monuments displayed creating an aesthetically pleasing landscape. The decision to close the cemetery by 1980 was retracted in 1951, and the date postponed until 2020. A map dated to the 1960s (Fig 7) shows the final layout of the grave plots and the extent of outbuildings around the gravediggers' house.

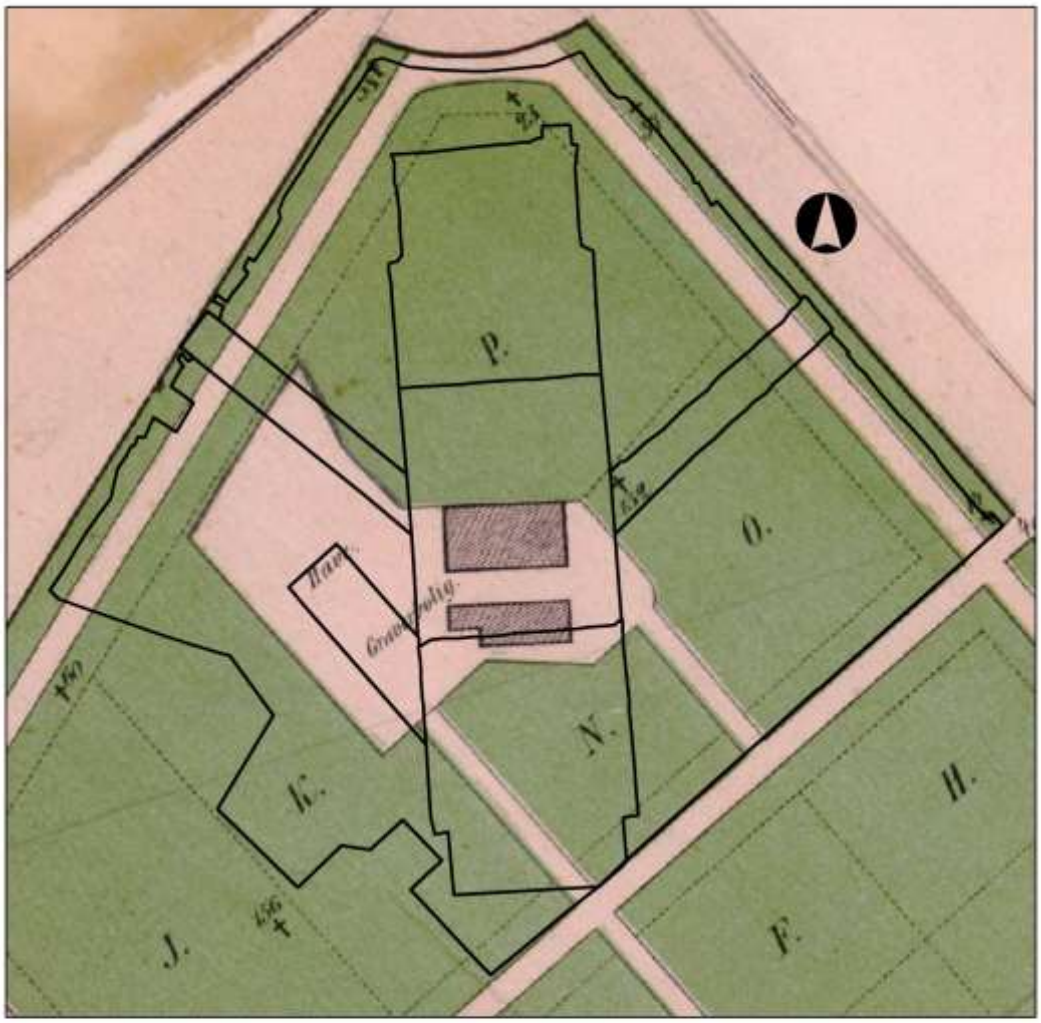


Fig 5 Historic map of Area G, 1868. Illustrating the original area designations and buildings (Historisk kort over Afdeling G, 1868. Kortet viser bygninger og de oprindelige områdebetegnelser)

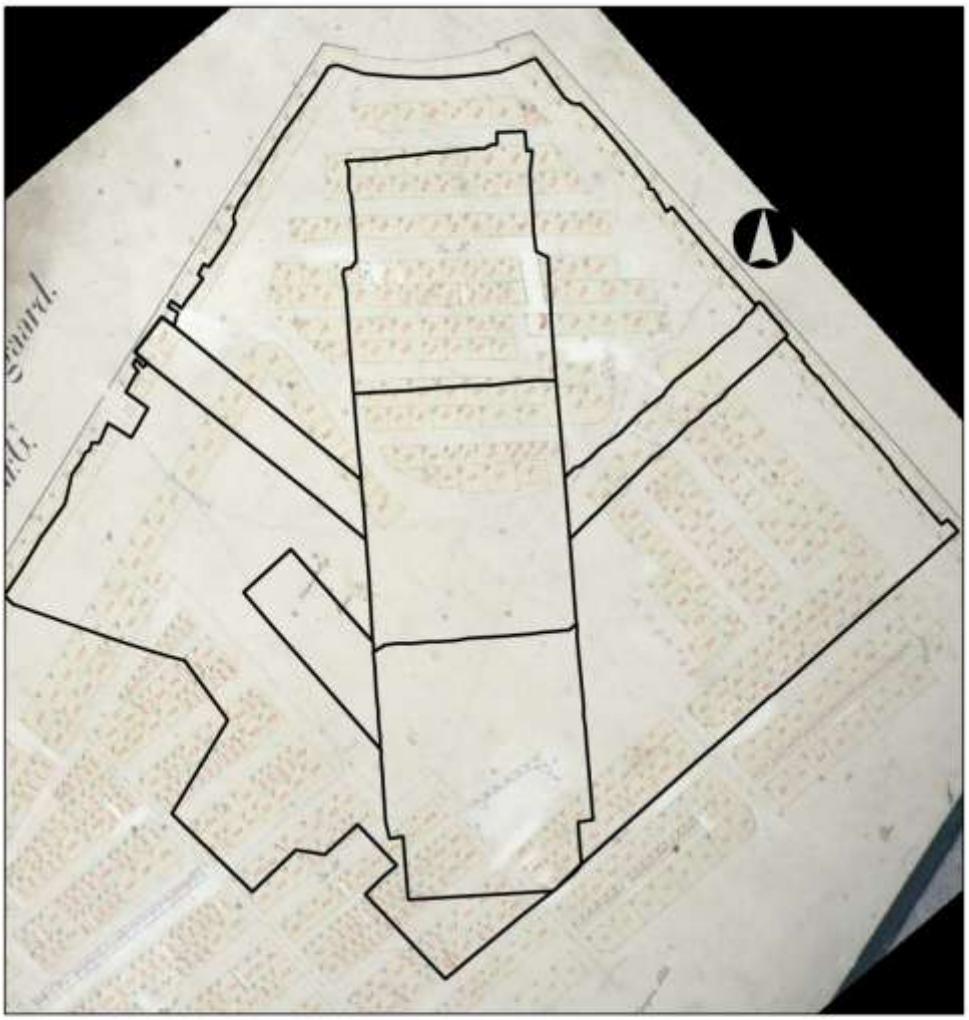


Fig 6 Historic map of Area G, 1880. The new grave plot identities are written in the centre of each plot, the old in the top corner (Historisk kort over Afdeling G, 1880. Gravstedernes nye numre er skrevet i midten af gravfelterne, mens de gamle numre er anført i hjørnet)

In the 1980s, there were considerable efforts to document, save and restore special monuments and prepare the cemetery for a gradual closure to take place. Areas A-D were made into a memorial park in 1983, where restored monuments from other parts of the cemetery can be placed. In 1989 the plans for the cemetery, which remain valid today, were approved. According to these, parts of the cemetery such as Areas J-M and parts of N would be used as cemetery for local residents until 2150. Areas B-F constitutes a memorial park, Area A is a museum area and the rest of the area, along

Hans Tavsens Park to the west and Jagtvej in the northwest, will become a park. However prominent persons in society can still be buried in the memorial park as well as those who have existing family grave plots and wish to be interred with close family members.

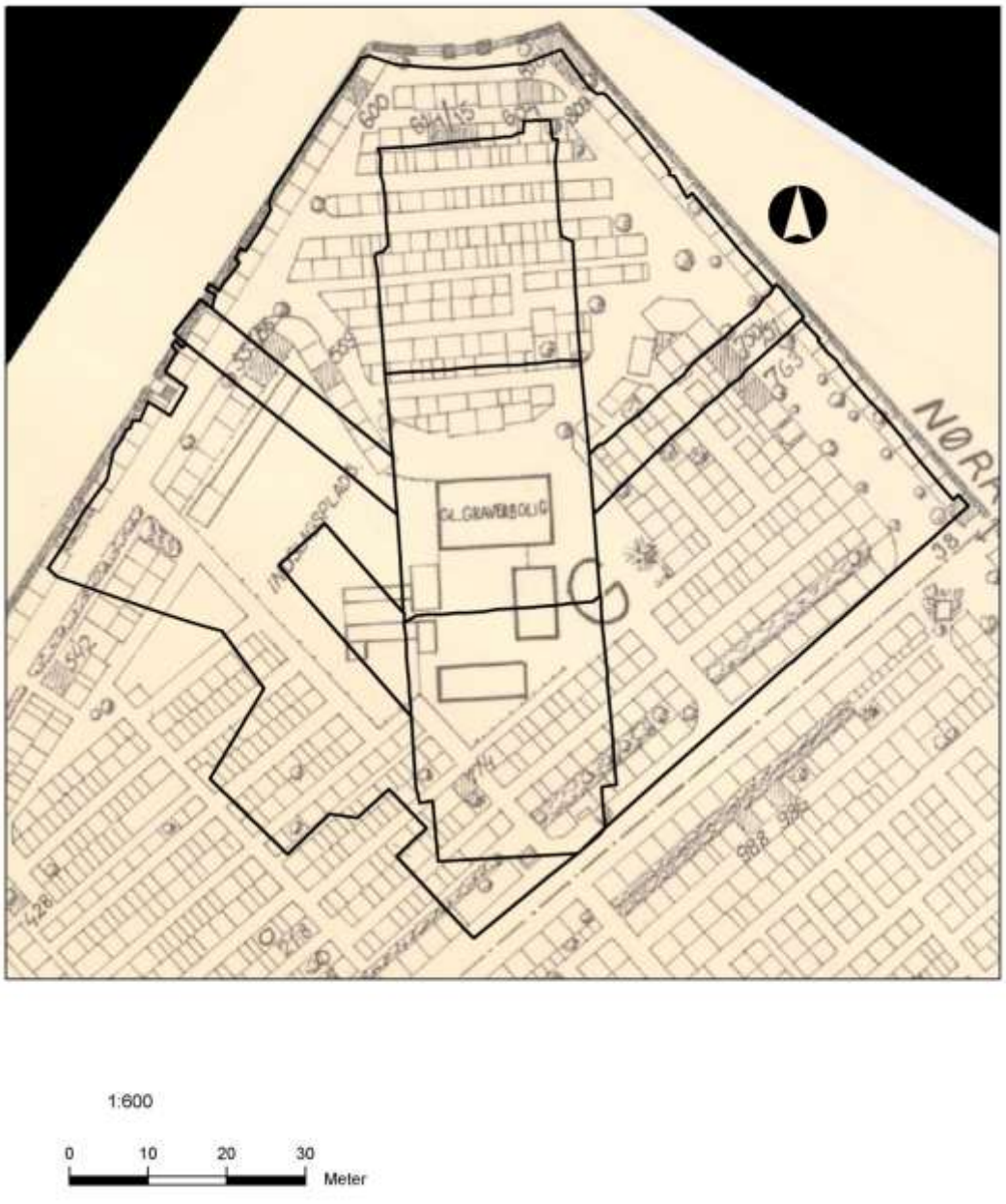


Fig 7 Map of Area G dated to 1960s but based on the 1880 map, showing extension of the buildings around the gravediggers' house (Kort over afdeling G. Kortet er dateret til 1960'erne, men er baseret på kortet fra 1880 og viser udstrækningen af anneksbygninger tilhørende graverhuset)

Even though some parts of the expanded cemetery were removed, it is still a very large area in the city, which has been relatively undeveloped for many years. Today it means

many things to different people - an historical centre, a tourist attraction, a nature reserve and a recreation facility. The main purpose as a cemetery and place of remembrance is perhaps slowly decreasing.

Organisation of the cemetery according to historic sources

Area G, which is the area where the excavation took place, was taken into use in connection with the expansion of the original cemetery in 1806. It was first used mainly for single, or line burials *(*linjebegravelser*)*, which were cheap individual burials placed in rows and without any possibility for extending the ownership rights. This means that after the period of 'grave peace' of 20 years the graves could legally be disturbed and removed to make room for new burials. The single plots had a size of 2 x 4 alen (1 alen = 0.63m). Along the walls and the main pathways were family grave plots, which had two price levels depending on location. The family plots could be bought for a long period of time and the period could also be extended. There was a third kind of grave, pauper's graves *(*frijordsbegravelser*)*, which were paid for by the city. These existed in the cemetery up until 1870, when Vestre Kirkegård took over as a location for these graves (Helweg 2010: 126). However, no pauper's graves are supposed to have been placed within the excavated part of Area G (Wiene 2010: 18).

Over time, the line burials become less common and family plots were constructed in their place. The family plots that are placed along the prominent and easily viewed pathways, known as the monument line, along the walls (blænding) and in the area between Runddelen and the gravediggers' house were 5 x 5 alen (3.14m x 3.14m). The other graves were generally 2 x 4 alen (1.26m x 2.51m), which were sometimes doubled (Wiene 2010: 20). Double family grave plots could also later be re-sold and split up into two smaller plots.

Two other grave types existed in the cemetery. Firstly, there were children's grave plots, which were line burials placed in special smaller rows. Children's graves were half the size compared to an adult and therefore could be placed into smaller areas. Secondly, there were cremations, which became more popular in the first half of the 20th century (Wiene 2010: 18).

There is no known map from the early years of the cemetery use until 1831. The layout of the grave plots and pathways has altered during the years, for example when line burials have been cancelled and exchanged for family plots. In the 1880s, when the municipality took over the administration of the cemetery from the different parishes, the layout of the cemetery was also affected. This was connected with a new system of numbering the grave plots. The maps from different time periods show no extreme differences in layout, only minor alterations.

The last burials within the area took place in the 1970-80s, but it seems that the burial rate decreased over the last half of the 20th century. Other cemeteries like Vestre Kirkegård, where there was more space, took over as the main burial ground. In the 1980s, when restoration efforts were made in the cemetery, some of the grave monuments, which were considered worth preserving, and had earlier been removed, were put back, and the cemetery walls were renovated. All was done in order to keep the atmosphere of an old cemetery according to the newly resolved guidelines of the

city council (Nielsen 2010: 555). Resources have unfortunately been lacking since, and Area G had become more and more overgrown with bushes and weeds. As a consequence of the construction of the Metro, the monuments were once again removed and are being stored in the cemetery.

The gravediggers

In the first years of the cemetery the gravediggers were very poorly treated. They had no salaries but were given housing and tips earned for grave digging and transportation of the coffin (Helweg 2010: 121). They had to resort to other ways to earn income and became known for selling food and drinks to visitors, using the gravediggers' house and the charnel house as inns. Protocols exist from 1805, 1814 and 1816 stating that the gravediggers must see that no eating, drinking, playing music or anything seen as amusement should take place at the cemetery (Lindberg 2010: 105). A major scandal in 1804 involved the gravediggers of the Assistens cemetery, who had dug up coffins and sold the wood. They were also accused of stealing linen and jewellery from the corpses (Jørgensen 2007: 9; Nielsen 1939: 147). A regulation on depth for graves was also brought in due to animals digging up bodies. This suggests that gravediggers did not always do their job properly. Later in the 19th century they received improved working and salary conditions and the control over the cemetery was stricter (Helweg 2010: 125) allowing the formation of a group of professional gravediggers leading to the professional cemetery staff of today.

Trinitatis parish, Copenhagen

Trinitatis Church with its distinctive round tower was built between 1647 and 1656. It was built as a church for academics, students and the parish. The size of the parish has varied since it was established in 1686 (Wiene 2010: 8). Up to 1804 it covered a section of the town delineated by Klareboderne, Købmagergade and Øster Voldgade and Borgergade until Sølvgade. In 1805 the area between Klareboderne and Kronprinsensgade, Sværtegade, Store Regnegade were added and the area between Borgergade and Ny Kongensgade was also conferred as a result of abandonment by Nicolai Parish. Until 1930, the parish also consisted of the area between Nørrebrogade and Øresund all the way to Emdrup and Hellerup. This area was sparsely populated until the abandonment of the demarcation zone in 1852 and removal of the ramparts in 1856. It was then rapidly densely populated (Wiene 2010: 8).

From 1930 to the present day the parish covers an area bordered by Gothersgade, Møntergade and Klareboderne, Skindergade, Fiolstræde and (on the other side of the old defence lines) Ahlefeldtsgade, Nørre Farimagsgade and again Gothersgade (Wiene 2010: 9).

Residents of the parish were probably not essentially different from the other parishes in Copenhagen during these periods. However, being near the university may have had an impact with academics and students living there. The parish also contained the Trinitatis workhouse from 1790 to 1840. Slums were also present through to the early 20th century, particularly around Brøndstræderne (Wiene 2010: 9).

The burial population and the inhabitants of Trinitatis

Not everybody who died in the parish was buried in Area G of Assistens cemetery. Also, people who lived elsewhere but whose families originally came from the parish could retain the family plots. Until 1760, people from the parish were buried in the urban parish cemeteries inside the ramparts. This continued until 1851 (Trinitatis Historiske Kilder 2010) but was vastly reduced during the later 19th century. In the earlier years of the 19th century residents from Trinitatis parish were also buried in the original section of Assistens. It is noted from the cemetery protocols of 1805 that burial in Area A would continue until 1828. Navy and military personnel and their families could also be buried in Holmens and Garnisons cemeteries. After 1870 Copenhageners could be buried at the Vestre Kirkegård. The excavated part in Area G is not noted in cemetery records as containing any pauper's graves. Therefore the excavated area is not fully representative of the inhabitants of the parish.

Some initial estimates of the number of people buried in Area G have been made based upon the funeral protocols of the family plots only (Funeral protocol for Section G, Vol. 1 and 2, Centre for Cemeteries Copenhagen, Bispebjerg Cemetery Office). The years recorded are from 1809-1991, where there are 182 years with 2381 recorded burials, this suggests an average of 13.08 burials (within family plots only) a year within Area G. However this average does not take into account the relatively scarce burials taking place in the area, particularly in the last 40 years and also excludes any burials taking place outside of the family plots.

Comparable investigations from Denmark

Only a few excavations of cemeteries belonging to the post-medieval or historic (*nyere tids*) period have been made in Denmark (Table 1). Minor parts of post-medieval cemeteries have been excavated in Copenhagen, however no major scientific work has yet been published on the subject; the excavations are only provisionally published or unpublished.

Excavations on post-medieval cemeteries in the Municipality of Copenhagen

Two small excavations have revealed a total of 12 graves from the **Vartov** cemetery close to the contemporary Vesterport; the western gate entrance to Copenhagen (Mosekilde 2010; 2011). The cemetery was in use from 1666 to 1760, and thus belonged to the very beginning of the "florissante periode", (the flourishing period). This was a rich period where trade and shipping flourished in Denmark, which lasted from the second half of the 18th century until the war with England in 1807. Vartov cemetery was connected to Vartov Hospital and Det Kongelige Vajsenhus (an orphanage); the latter might be represented in that seven of the excavated graves were child graves (Mosekilde 2010: 11; 2011: 5). The coffins were generally well preserved and quite elaborate: they were rectangular, had raised lids and narrowed towards the bottom. At least one coffin had internal gold leaf decoration and was possibly painted blue. As there is reason to believe that the buried children come from the orphanage, it is somewhat surprising that they were buried in elaborate coffins. This could be seen as an expression of the wealth of the period. The majority of the graves were east-west

orientation, with the head end pointing west, but three graves were north-south oriented, possibly following the orientation of a church built in the Vartov complex in 1755 (Mosekilde 2011: 6).

Except for the excavations on the Assistens cemetery, the largest excavation made in a post-medieval cemetery inside the municipality of Copenhagen is the pauper's cemetery on **Farimagsvejen**, which was in use between 1842 and 1858 (Poulsen 2006). The cemetery was connected to Almindelig Hospital on Amaliegade and was located in the present Stockholmsgade neighbourhood, just outside the contemporary ramparts of Copenhagen. Parts of the cemetery have been excavated in small trenches within the streets of the present Upsalagade and Malmøgade, which have revealed parts of approximately 200 skeletons. The burials were generally plain: all coffins were undecorated, rectangular and possibly made of conifer wood and there were some indications that the coffins were not fitted to the individuals, but were of a certain standard size (ibid, p.15). The only indications of burial clothes were small pieces of textile found in three graves and buttons found in nine graves (Winther 2009: 30 & 33). Two corroded copper finger rings were the only jewellery found. Coins were found in six graves. In one grave, several coins were corroded together, possibly representing the contents of a purse, while the single coins in the other graves could be interpreted as Charon's payment (Winther 2009*:* 32). A shell belonging to a foreign snail species (*Cypraecassis testiculus*) was found in one grave which may have been used for decoration on a grave (Winther 2009: 35). The burials were characterised by carelessness towards the deceased: occasionally more than one person was placed in the same coffin, amputated limbs were thrown on the torso with reverse orientation compared to the rest of the body and individuals were also buried with amputated limbs which did not belong to them (Poulsen 2006: 14). The mass grave contained up to three rows of coffins stacked in up to five layers. Some of these mass graves are possibly related to the cholera epidemic in Copenhagen in 1853, where approximately 5000 people died (Poulsen 2006: 6). However, according to a historical source, paupers were buried in communal graves of 6 or 12 bodies, one or two times a week (Rasmussen 1939: 109), and the mass graves are therefore not necessarily connected to the cholera epidemic. The graves were mostly north-south oriented, while some infant burials were east-west oriented. There did not seem to be any clear pattern in which direction the head end of the graves were oriented (Poulsen 2006: 10-14), which could be interpreted as an indication that the orientation of the graves were of less importance in this cemetery.

Another three investigations have been carried out in the Municipality of Copenhagen: one at the **Holmens Kirke** cemetery on Holmen excavated by the National Museum, one at the cemetery of **Holmens Kirke** on Østerbro and one under the floor of **Vor Frelser Kirke**, Christianshavn. The Holmens Kirke cemetery on Holmen was a cemetery for people associated to the Danish Navy and contained a minimum of 350 individuals. The cemetery is dated from ca. 1650 to 1850. No further reporting of the excavation is available at present. The latter two consisted only of sieving of machine-removed cemetery soil (J. Langkilde pers. comm. 2011; L. Uhrenhult pers. comm. 2007) and therefore do not contribute to the overall picture of the post-medieval burial traditions.

Excavations on cemeteries in other parts of Denmark

Some of the excavated cemeteries outside of the Municipality of Copenhagen have been in use for a very long time span. This is the case for the cemetery surrounding **Skt. Knuds Kirke**, the cathedral in Odense, where 500 graves have been excavated. The earliest graves were from the 12th century and the latest from the 19th century (Johansen 2001). The main focus of the investigation has been on the graves belonging to the medieval period therefore no details on the small amount of post-medieval material have so far been published. A long period of use is also characteristic of the cemetery at **Holstebro Kirkeplads** (Thomsen 2008). As at Odense, the excavation at Holstebro has only been provisionally published, and no attempt to date the individual graves has yet been made. The burials belong to a time span beginning in the 15th century (possibly earlier) and lasting up to 1865, where the cemetery use ended. A total of 2523 burials were registered but only 293 of these were fully excavated (Thomsen 2008: 18 & 21). The graves were generally east-west oriented, with the head end pointing west. However, many of the graves had a more north-west to south-east orientation possibly because of differences in the orientations of the older and younger church, which the burials seemed to follow (Thomsen 2008: 19-20). In a brief review of the coffins it is mentioned that some were covered with leather, some had bronze sheeting and some had traces of name plates made of metal. Many typical baroque coffin handles were also found. Many of the coffins had a slightly trapezoid form with chamfered/bevelled lid, while others had a more "simple shape". Some of the oldest coffins were reinforced with transverse wood strips in the bottom. One grave contained a young girl with a younger child in her arms.

The excavation under the floor in Skt. Olai Church in **Helsingør**, revealed burials from a more narrow time span, as at Vartov the burials are dated to the flourishing period. Due to the wealth of the time and because the burials are all located beneath the church floor, a burial place reserved for the wealthy, all the investigated graves could be described as rich. The 60 examined burials were generally very well preserved. Some of the coffins were covered with textile or leather and many had various metal decorations including plates with the deceased's name and/or different religious inscriptions or death poems (Hvass 2002: 76 & 96). With a few exceptions the burials were east-west oriented, with the head end towards west. A single person was buried on their side, but the deceased were normally placed on their back. Many, especially women, had their hands folded; a burial custom that was probably linked with piety. From the 1770s this custom faded away, and the deceased then tended to have their hands placed by the sides or loosely on the pelvis (Hvass 2002: 85-6). Considering the high infant mortality of the period, few child burials were found. Possibly, the children were more often buried outside because a lack of space or because of economic considerations of the relatives. There were a few examples of infants and pre-term infants buried in thin board boxes and one example of a woman who was buried in the same coffin as a newborn child.

The deceased were most often covered in shrouds made of linen, had a cap on the head, gloves on the hands, and wore a long white burial robe made of cotton and a shirt under this. The men were most often buried with their wig in place. A handkerchief made of paper or textile covered the face. In general the clothes were poorly sewn and

seemed standardized, which suggests that they were made especially for funeral use. At the end of the period people were, however, buried in their Sunday clothes. (Aagaard 2002: 100-10). Young girls' burials were especially sumptuously decorated with ribbons and an artificial flower wreath on the head of the deceased (Aagaard 2002*:* 107).

An underlay of wood shavings was found in the majority of the coffins and some had a plant layer in the base (Hvass 2002: 87-8). Flower stuffed pillows supported the heads of the deceased. The majority of flower and pillow fillings consisted of hop (Karg 2002: 133). Bouquets and branches of hyssop, marjoram, laurel, rosemary and lavender often lay scattered on the deceased. These plants are all aromatic and might have been placed in the coffins to cover the smell of decay during the burial ceremonies, but can also have been placed to keep away evil spirits (Karg 2002*:* 137). Branches of box were found in a few graves. These can simply have been decorative, but can also have had a symbolic meaning, as box is a widespread symbol of life (Karg 2002*:* 137). Other grave gifts included a box with dentures, collections of poems, hymn books and a copy of Voltaire's *Oedipus* (Hvass 2002). Only 12 bodies were osteologically investigated (Bennike 2002). The most surprising result of this was that several female skulls had a distinct long and low shape, probably deformed by the extensive use of constricting headwear.

A small excavation has been made in the remnants of the cloister **Lindegården**, which belonged to Vor Frue Kirke Maria; the Cathedral in Ribe. The earliest excavated graves were from the 15th century, but the main focus in the investigation has been on the 27 youngest, most well-preserved graves. These are from the period between the end of the 17th century and up to 1738; the year when the cloister was torn down (Madsen & Søvsø 2010). It was more prestigious and thus more expensive to be buried in the cloister, and the burials therefore likely represent the wealthier parts of the society and thus somewhat resemble the burials in Skt. Olai Church, Helsingør. Men were slightly overrepresented in the material. However, both women and children were present, which show that the distinguished burial place was not reserved for either men or adults (Madsen & Søvsø 2010: 66). The deceased were all placed on the back with the hands gathered on the lap. Some likely had their hands folded. All the graves were east-west oriented; the head end pointing west. There were two examples of children placed with a woman, which the authors suggest as mother and child. Nearly all textiles, leather and wood had decayed, however, it was clear that the coffins were made of wood and mostly trapezoid. They often had iron handles; three on each side, one at each end. Some coffins had four iron rings, two on each side, which probably had been used for lowering the coffin into the grave (Madsen & Søvsø 2010: 62-3). As in Helsingør, many of the coffins were decorated with metal decorations and nameplates, which were generally almost totally corroded. A lime layer was found in the bottom of four coffins. The lime may have been put in the coffin to temporarily preserve the body. Another possibility is that the lime was put in to absorb body fluids (Madsen & Søvsø 2010: 63). The only preserved remnants of burial clothing were pins found in the head region of female and child burials and possibly belonging to coifs, and thin, corroded copper wires from hair bands (Madsen & Søvsø 2010: 63-4).

An excavation on **Horsens Klosterkirkegård** has revealed 200 burials. The majority of the excavated graves are dated to the 18th century and somewhat resembles the finds

from Skt. Olai and Lindegården. The coffins were often decorated with stylized flowers and leaves made of metal, others with depictions of angels or skulls. The grave gifts include: artificial flowers; silk ribbons; and the remnants of a gold thread weaved bonnet and pins, which had possibly fastened shrouds covering the deceased. As in Helsingør, remnants of aromatic herbs were found in some of the graves, while wood shavings and lime in the bottom of some of the coffins are comparable to the mentioned graves in Lindegården, Ribe (Petersen 2010).

	Type of site	No. of exc. graves	Date	Layout	Coffins	Pres. textiles	Finds
Vartov	Hospital/ orphanage	12	1666-1760	Mixed	Elaborate	None	
Farimagsvejen	Hospital	*c* 200	1842-58	Mixed	Plain	Limited	Limited
Odense	Cathedral	*c* 500	Medieval - 19th century	?			
Holsetebro	Church	293	Medieval-1865	E-W	Elaborate		Limited
Helsingør	Cathedral	60	1690-1807	E-W	Elaborate	Large amounts	Large amounts
Ribe	Cathedral cloister	123	Medieval-1738	E-W	Mostly plain	Pins only	
Horsens	Church	*c* 200	18th century	?	Mostly plain	Limited	Limited

Table 1 Summarised information from comparative investigations in Denmark

Comparable material from international investigations

Direct comparisons of burial traditions can be sought from a wider geographical perspective. The period in focus is a time of common social changes throughout Northern Europe and North America. Thus they can be compared with the traditions seen in Denmark and Scandinavia. There will always be local, regional, and individual variants but there are similar commonalities in the change from medieval modes of thought and towards reflections of new societal trends (Gilchrist & Sloane 2005; Jonsson 2010). There is a large corpus of archaeological evidence concerning historic cemeteries which have produced physical remains that can provide new ways of thinking about the origin of contemporary burial traditions.

Vault studies

The pioneering study of historical burial tradition is from Christ Church, Spitalfields, London (Reeve & Adam 1993; Molleson et al. 1993) where the clearance of lead coffins from a crypt from the 18th and 19th centuries was undertaken under a specific research design. Similar vault clearances are concentrated on urban populations of affluent families who were able to afford this type of burial; some are of similar date to Assistens cemetery but they are generally closed from approximately the mid 19th century. Examples are St Pancras New Church, and St George the Martyr (Cox 1996b; Boston et al. 2009) which are all situated in London.

Among the results, the evidence showed a high use of burial clothing, coffin textiles, and elaborate coffin fittings and decorations. Overall there was little jewellery or individual gifts inside the coffins. The similarities of some of the funeral related finds (coffin fittings, textiles) show the increasing use of professional undertakers. However many individuals are from a more affluent population and burial in a vault is expensive which excludes other sections of society that cannot afford this type of burial, so vault investigations tend not to represent all sections of society. Burial in vaults also tends to be slightly earlier in date than Assistens cemetery. The location of the burials in vaults increased preservation but there is no ability to consider stratigraphy because the coffins were often mixed and moved from their original placements. The studies often have a concentration on coffin design, particularly as the coffins are not always opened, which restricts osteological comparisons. However, the high level of identification of individuals has often led to extensive documentary work to create biographies of individuals and their families.

Churchyards and chapel burial grounds

More common investigations are of urban parish churchyards or Nonconformist chapel cemeteries which are undertaken for commercial reasons. These can cover burials from the medieval period to the 19th century which tend to be buried in the ground, or within individual family vaults, outside of the church. Examples in the UK include St Martin-in-the-Bullring in Birmingham, Chelsea, St Marylebone, Bow Baptist and Quaker cemeteries in London and Voegtly cemetery in Pennsylvania (Brickley et al. 2006; Cowie et al. 2008; Miles et al. 2008; Miles in press.; Start & Kirk 1998; Ubelaker et al. 2003).

These types of site often show broader chronological change in burial traditions which generally include a transition from very simple medieval traditions to elaboration of new traditions which have good comparative potential with Assistens cemetery. Often they cover a broad cross-section of society with poor and rich included from the local parish. However, some sites can be restricted towards a particular faith or the investigations exclude graves buried within the church building. Extensive osteological work is often completed, but there is often a lack of ability to identify individuals as it is rare to find nameplates or be able to connect graves with Parish registers and, therefore, there is less capacity to complete biographical research. There is usually great potential to look at the archaeological information of cemetery management, including plot layout, grave cuts, dealing with charnel bones and truncation. Occasionally detailed archaeological recording is limited or simply not possible due to the frequency of burials.

Commercial cemeteries and the move away from religious control

Similar to Copenhagen, attempts to deal with the increasing populations from the late 18th century led not only to the creation of additional parish churchyards, but more radically the formation of new commercial cemeteries that were not related to any fixed parish church. They were often removed from the living community, placed on the borders of communities instead of at the heart. Examples are City Bunhill, Sheen's Burial Ground, Deverell Street, Lower St Bride's all in London (Connell & Miles 2010; Miles in press; Miles & Conheeney 2002). Pima in Tucson, Arizona provides a similar kind of

cemetery but in quite different circumstance in a small American frontier town (Heilen & Gray 2010).

In these types of site, burial traditions can still reflect religious belief but are often affected by mass consumption of funeral merchandise. These sites reflect the strength of the contemporary undertaking industry and contemporary mores of grieving. Burial traditions suggest less specialised burial clothes and night clothes with more everyday clothes and shoes used instead. There are generally few finds within coffins. There is also varied spatial management within these sites; some are overcrowded with stacked coffins and with a great deal of truncation, sometimes they are well regulated in plots with less reuse. Some sites are used specifically for poorer sections of society or serving largely immigrant parishes.

There was further development in ideas with the rise of garden, or landscape cemeteries located outside of cities (Rugg 1997). These are designed specifically as a new type of cemetery and have become iconic symbols for each city. These cemeteries contain a mix of sections of society and there is no longer necessarily a parish church, simply a burial chapel on the site, or sometimes no buildings at all. There are areas for different religions within the site rather than separate cemeteries. Cemeteries such as Père Lachaise in Paris, Skogskyrkogården in Stockholm, Highgate cemetery in London and Mount Auburn in Boston, USA have been studied from architectural, landscape and aesthetic perspectives. These types of cemeteries have a lack of archaeological investigation but there are above ground plots and cemetery management that can be examined from an archaeological perspective. Assistens cemetery is one of the earliest of this type of cemetery and the only known one that has been excavated.

Topography

Assistens cemetery lies to the north of the city of Copenhagen which is a naturally flat and marshy area next to the Oresund; the area of the city was prone to flooding and necessitated land reclamation and flood defences. However the cemetery lies to the north of the central core of the city, on a slight rise in natural ground level. At the northern end of Assistens cemetery, where the excavation site lies, it is *c* 9.4m above sea level. The ground slopes slightly downwards to the south to *c* 9.2m. The land thus drains away rain and ground water down to the south of the cemetery leaving the excavation site relatively dry. The geology consists of sandy silt.

3 Archaeological background

There were no pre-investigation observations or excavations on Assistens cemetery by archaeologists. No survey of the excavation area was undertaken prior to clearance of the remaining gravestones, grave plot markings or planting. There are also no known archaeological observations in the immediate Nørrebro area. Some observations were gathered from conversations with current gravediggers in the cemetery (T. Olsen, pers. comm. Center for Kirkegård). A small number of the most modern burials within the later excavation area were exhumed before the start of the project and reburied within the cemetery. This work was partly observed by the museum. Observations made in relation to these exhumations suggested that the area of excavation was not water-logged compared with other, more low lying parts of the cemetery in the south. Also, it suggested that some of the coffin wood and skeletons were still preserved reasonably well, and there was some evidence of brick structures surrounding the grave plots. There was no indication in the limited observations prior to the main excavation that there was soft tissue present, apart from some hair.

4 Cultural historical potential and aims

Overall project objectives and themes

There are several overarching archaeological objectives that are relevant to the overall Metro project; these are stated in the main methodology and project design (Thomasson 2009). Some of these were only of limited relevance to the Assistens cemetery site; however, there are also objectives that are specific to this particular project. Out of these objectives can be drawn several interlinked interpretive themes that directed how the archaeological work was organised and which fieldwork recording methods were most appropriate. These themes refer back to the stated, approved objectives found within the Project Design (Thomasson 2009) and, therefore, are directly linked within the approved framework for the Metro Cityring, stage 4 archaeological project.

The guiding principles and design of the Assistens cemetery project was set out in a Method Statement (Anthony et al. 2009) that covered the project aims and archaeological background of the excavation, and the methodology and processes that would be undertaken to achieve them.

The three main themes driving the archaeological excavations cover how Copenhagen developed into the city it is today. Principally by looking at **urbanisation** evidence is sought for how people were being drawn into cities and how this affected the individuals, the city and Denmark as a whole. Following on from this is how major **economic and demographic cycles** that are seen through historic documentation, shaped the city and whether detailed archaeological study can shed light on exactly how this affected the individuals in the ordinary population. This new concentrated **urban lifestyle** for Denmark, and Copenhagen in particular, brought new challenges through new ways of living, which can be seen by archaeological study and bring often new and unexpected results concerning the ordinary people of the historic period. There was also scope for examining and recording any activity on the site prior to the start of the cemetery and also concerning the methods of archaeological recording that will be used on the site.

The Method Statement suggested some specific questions for these themes; these have now been extracted and adjusted towards the excavated evidence.

Prehistoric/pre-cemetery activity

Although it was not anticipated that there would be significant remains of prehistoric date on the site, there was a possibility of low levels of activity in the form of residual artefacts and evidence of occupation. The site lies on the rise of a low hill surrounded by wetlands/marshlands and locations similar to these can be places of preferential activity during the prehistoric periods as they provide ample resources for seasonal activity such as hunting, fishing and foraging. Any information on the area during this period may help to clarify how it was used prior to the establishment of Copenhagen. There is

historical evidence of farming settlements around the city and it is likely that modern development has destroyed much of the earliest evidence for this.

Urbanisation in the 19th-20th centuries

The theme of urbanisation concerns the process of how the relatively small settlement of Copenhagen was transformed into a capital city, drawing people in and away from the countryside. This also changes the city as it becomes increasingly crowded in the historic core and leads also to the creation of the extra-mural and suburban areas. Prior to the cemetery, the area is noted as consisting of tobacco fields on historic maps; there is no settlement on, or nearby the site (Wiene 2010). The creation of the Assistens cemetery is partly a result of population growth due to the lack of space for burials in the traditional churchyards. The crowded conditions in the city provided an unsanitary living environment for the inhabitants which can be directly reflected in the skeletal remains through the diseases that are prevalent in these conditions. This may be reflected in comparisons of stature over time with environmental factors. It would also be possible to explore differences in health and disease for men, women and juveniles and between different occupations. This was the first opportunity to document and record data from a Copenhagen cemetery of this period.

Economic and demographic cycles

Within the trend of overall growth in population within Copenhagen over the historic period there will be smaller cycles of economic and demographic changes, reflecting historic events such as conflicts and periods of economic decline and prosperity. Economic factors could be reflected in the styles and quality of the burials, although social factors may be seen to override this as is seen in the UK (Howarth 1997). An overall demographic analysis can be made over the whole assemblage of skeletal remains which may highlight events in Copenhagen's history. This is where the historic sources and biographical data relating to individuals can complement or highlight differences in our understanding of this period.

The economic themes that can be illustrated by this information include changes over time between the relative quality and expense of the coffins, coffin artefacts and burial clothes. Although this may be affected by attitudes towards the importance of social display for funerals and burial, it could reflect changes in the economic structure during Copenhagen in this period. There may also be evidence in the re-use and change of ownership of the grave plots relating to periods of economic change.

Demographic themes can be highlighted through analysis of the age and sex data from the individuals. This can include looking at the frequency of child mortality through time. The same can be done for age at death for men and women, and/ or for different social groups, and these patterns may change over time. Archaeological documentation can provide a check and often, a contrast to the written documentary material that usually provides this type of information, such as military recruitment records or parish records. The direct source material and burial registers for the cemetery are present but not complete and therefore not reliable until the end of the 19th century. The archaeological work done at the Assistens has created a new data set on what can be

known from the people who were buried there. This can be compared with similar data sets from other urban contemporary excavations.

Urban life and culture

One of the themes that can be highlighted by the work at the Assistens cemetery is the lifestyles of individuals. These can be contrasted not only with assemblages from other urban centres but also from more rural settings in Denmark and Scandinavia. Migration within Denmark, from rural to urban communities could be identified. This has the potential to expose the effect the urbanisation and new lifestyles made on the bodies of individuals during the historic period, for example the effects of smoking and new diets. There may be evidence of the pressures of this new style of urban life in any evidence for violence on individuals. The effects on people from the changes in working practices that came with industrialisation can be examined along with changing social welfare care during the historic period. The work also has the potential to show changes in mentality connected with industrialisation and urbanisation, mainly through the study of burial practices. By studying the social topography of the cemetery (arrangements of graves by sex, gender, occupation, families etc.), suggestions about social organisation and strata in society can be made.

There may also be hints of social status or opportunity from the height or robusticity of individuals, this can be correlated with, or used as an indicator of relative status. Immigration from surrounding local areas or other countries can also show how cities acted as a hub for activity. This could be identified from local burial practice which may have been adopted or altered.

Industries, crafts, professions

From the time of the creation of the Assistens cemetery, Copenhagen was undergoing increasing industrialisation. There is an opportunity to study the effects of people's occupations within this parish of the city. Many particular crafts result in repetitive stress that will cause effects on the skeleton. The documentation of this could illustrate how the increasing pressure and concentration of crafts or particular jobs affected individuals.

Origins of health care and services

There are several areas that can be highlighted concerning the level and quality of health care provided in Copenhagen, such as instances of the treatment of injuries or chronic diseases, or the use of crutches or walking sticks. Dental care can be examined through the provision of fillings, tooth extraction and dental prostheses of varied materials. Demographic results showing a lower female average age at death could be related to the risk of childbirth. Surgical interventions on the dead body can also be explored with evidence for craniotomies, or evidence of autopsies involving the whole of the body.

Burial practices

By documenting burial practices the beliefs about death and how the people of Copenhagen related to the deceased are exposed. The theme of burial practices covers both rituals relating to the burial of an individual and how the cemetery and grave plots were managed by the families and the cemetery professionals. Study of the burial rituals and traditions could include the personal possessions, grave goods and textile remains within the coffin or grave. Ways in which people treated the dead person can also be seen in the style and arrangements of the coffin and coffin furniture and any specific ways of marking out the grave plots such as walls or vaults. The specific burial rituals and traditions may be identified from artefacts within primary deposits; the distribution of these over time may change substantially and could this be linked to historical events or economic cycles. Certain individuals can also be identified from coffin plates or personal belongings within the graves which may show discrepancies in the archaeological and historical data. It would be possible to compare the burial practices being used, with what the written sources state about beliefs and theological rules and practices.

Cemetery and grave management

This relates to how the professional gravediggers and cemetery authorities related to the dead, rather than the mourners. Spatial analysis of the graves and grave plots could suggest a variation in status across different areas of the cemetery. There may be a variation in status reflected across different time periods or between juveniles, females and males.

It has been suggested by the cemetery protocols that the designers of the cemetery intended to have burials of higher social status along the edges or major routes through the cemetery; the archaeological results may be able to confirm this or find other patterns in the practical spatial management of the cemetery. Analysis of the types of grave cuts can tell us more of the work of the gravediggers and how they created the graves and how they dealt with earlier skeletons and coffins by removing them or reburying them. The plans of the grave plots suggest a neat and ordered layout; the archaeological analysis of the graves will show how correct this is and where it deviates with burials not being undertaken to the expected protocols.

What does it mean if there are burials that do not conform to the expected standard protocols or further, undocumented burial plots? There are also documented charnel pits where disarticulated bones were placed, the management of these may suggest how careful the gravediggers were with human bones and how this reflects the period's attitude to death and human bones. There may be differences in treatment of the bones in comparing the more monumental family grave plots with the single line burials. Do the attitudes discovered from the archaeological evidence conform to social and religious standards of the period?

Methodological themes

There are further themes that can relate to archaeological practices and methods. A well-preserved cemetery population with identifiable individuals and biographical data can provide an important check upon archaeological assumptions used in osteology. Comparison of the estimated osteological age of individuals with biographical data can be assessed to determine the accuracy of the methods employed for this recording. Further questions on the preservation of the materials can help to plan future investigations and show how the conditions within the cemetery have affected the remains.

Preservation

Further subjects to be highlighted focus more on the preservation of objects found, such as the coffins and coffin furniture. Differing levels of survival may be accounted for by variation in the length of time since burial or the amount of movement and truncation after burial. The level of survival of soft tissue and general bone preservation may vary across the site and may also have been affected by the level of disturbance. The survival of textiles within the graves, including coffin materials and clothes worn by the individual are also affected by these factors.

5 Methodology

This chapter describes the methods and procedures used to create the project data, both during excavation and documentation. It also explains some of the theoretical and practical background behind aspects of the prioritisation of the overall aims and use of techniques.

Site facilities

Some of the methodology relied on the physical resources that were available in the form of facilities on site and the staff members available. During the excavation there were temporary cabins set up with good quality site welfare and office facilities enough for the *c* 30 staff working on the site. There were two tool storage containers and two storage containers for skeleton boxes; one for skeletons before osteological documentation (IN container) and one container for after documentation and prior to reburial (EXIT container). There was a cold storage container for the storage of soft tissue and intact coffins while waiting for reburial. A specially fitted container was built for the portable X-ray machine used on site (see below). Three cabins were joined together to create a combined finds and osteology laboratory, equipped with running water, drainage for easy cleaning and height-adjustable tables. A small photographic area was also set up.

Standard excavation equipment and storage was provided and due to the site being overlooked by residential buildings, excavation of graves took place under large tents which required lighting and walkways. Excavation on site took place through two unusually cold winters, with freezing temperatures of sometimes -5 degrees and snow lasting on the ground for approximately five months of the 12.5 months in total of excavation work. This required portable heating inside the tents and the large-scale use of winter mats to prevent snow building up on the ground and freezing soil. General heavy equipment and staff were provided by the contractors. Equipment included a large 20 ton excavator and a smaller seven ton excavator, plus use of dumper trucks and recycling skips for coffin wood and zinc.

Two Trimble Total stations S-9's were used for surveying and a digital camera was used for *in situ* photos of excavation. A camera with an additional macro-lens was used to document finds and skeletons in the laboratory.

Standard archaeological and osteological tools were employed on site; with hand tools included smaller trowels and brushes for delicate excavation. For the osteology documentation, an osteometric board, sliding callipers and spreading callipers were used. Soft brushes and tooth brushes were used to clean the bones. Dental curettes and tooth brushes were used when cleaning teeth. Safety clothing and gloves were used for dealing with skeletal material and facial masks were used in cases of strong odour.

A mobile digital x-ray machine, a Sedecal Dragon Canon was used on site as part of the recording. Access to the x-ray machine was limited to the laboratory staff only. In order

to operate the machine, staff received radiation protection training, and the arrangement of facilities and procedures were approved by Statens Institut for Strålehygiejne (SIS). The maximum radiation dose that was used was less than 90kV. The operating staff wore a dosimeter at all times. The dosimeters were checked regularly (every three months) by the SIS and the results were negative for radiation exposure for all staff over the entire period of use.

Principle documents

The standard methodologies used for the overall Metro project are stated in the methodology and project design (Thomasson & Høst-Madsen 2009). These specify the use of Museum standards for project management, the archaeological database software IntraSiS for recording and Museum policies on archaeological recording (Metro Cityringen Arkæologi Projekthåndbog 2009). Health and safety policies were set by the Metro Company occupational health and safety plans (Enterprise L2 2009), however the specific principles were set out in the Assistens Method Statement (Anthony et al. 2009). This chapter presents the excavation methods and field procedures followed by the documentation principles and procedures.

Excavation methodology

Prior to starting archaeological work on the site, any remaining gravestones or evidence of grave plots were removed by the cemetery staff; the grass and topsoil had also been removed. There was no survey of the visible features of the cemetery layout before the topsoil was removed. Some smaller buildings associated with the gravediggers' house that were unprotected by Museum law were in the process of demolition and their foundations removed during the first few weeks on site. One grave plot (Grave plot 759) was not to be disturbed during the entire project; this was fenced off and left in place. Another grave plot (Grave plot 611) was only excavated after the grave peace time limit was completed in June 2010.

Excavation took place within areas defined and numbered by the contractors, Areas 1-7: there was no archaeological basis for the definition of these areas (Fig 8). However these area numbers have been used to define some of the methods used in both excavation and prioritisation of documentation.

There were three levels of excavation undertaken on the site. In some of the site, where the Metro station and service trenches were located, full excavation was undertaken to remove all archaeological contexts. However areas outside of these designated locations were excavated down to only 1m from original ground level (Fig 9). This was to ensure that there were no graves or cremations that would be disturbed by general construction damage, heavy machinery or the routine excavation of small drainage or ancillary works such as landscaping or placement of cycle racks. In the areas excavated only to 1m, any disturbed archaeological features were excavated but any features that could be observed below 1m were surveyed and registered but not excavated. Orange netting was then laid over the excavated surface to act as a marker to warn future construction of the potential of graves underneath and the areas were then filled with clean natural sand.

There was also a small area of targeted excavation within Area 2, this was designed to remove graves that would be disturbed during the construction of the framework to move and contain the gravediggers' house in its temporary location. Only graves that would be destroyed by the large piling holes were excavated.

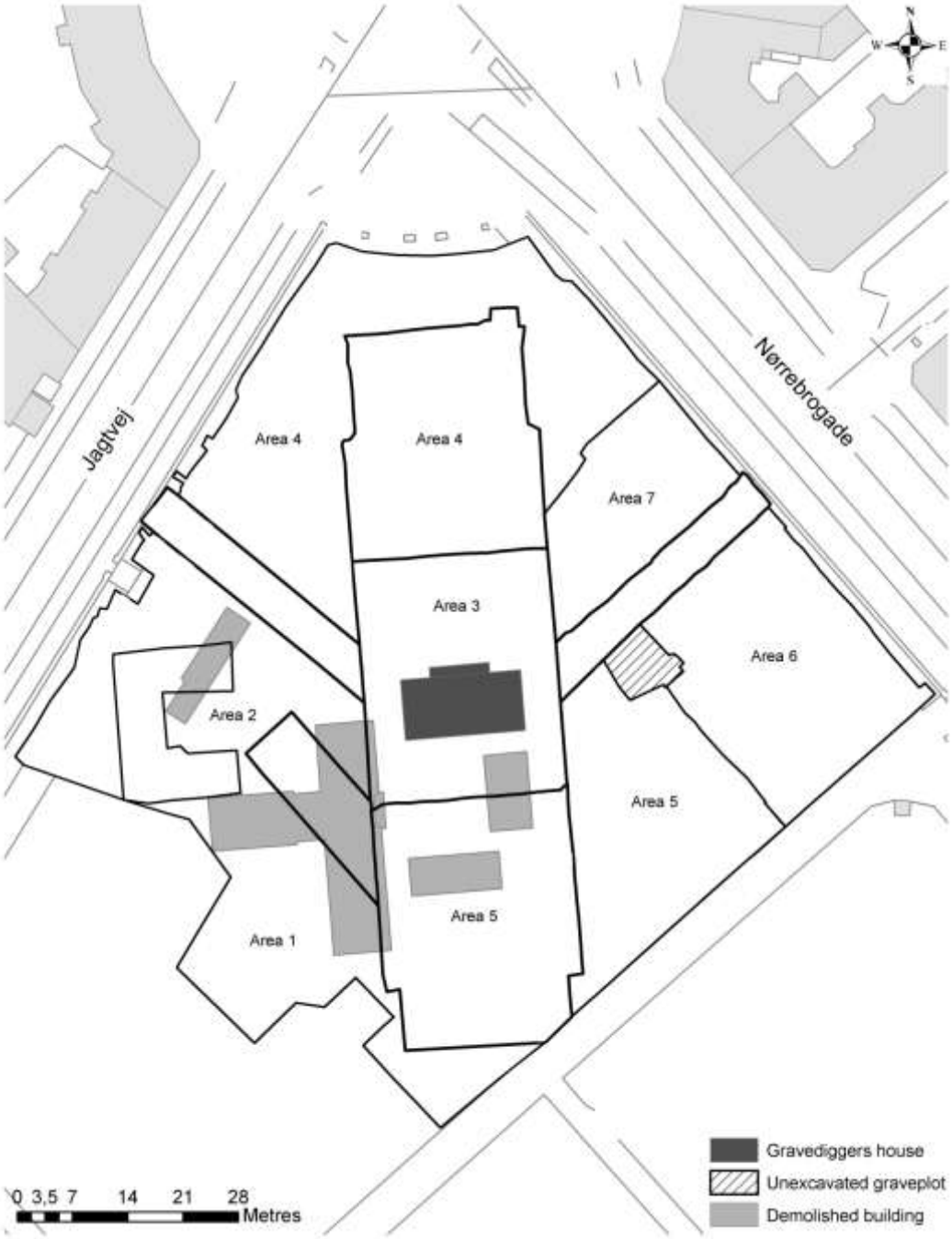


Fig 8 Map of the excavation site with trench areas (Kort over det udgravede område inklusiv grøftområder)

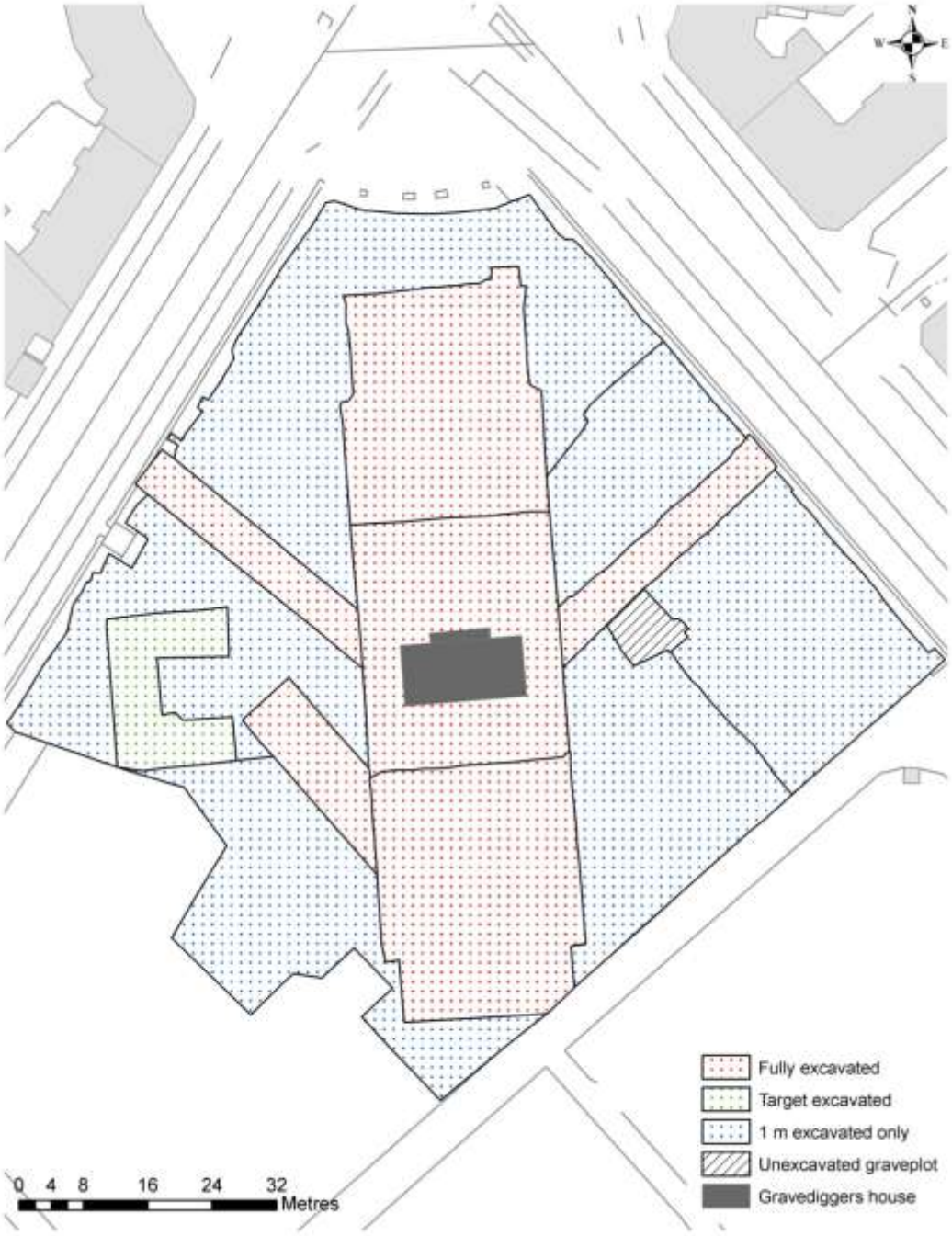


Fig 9 Map of excavation site showing which areas were fully excavated, target excavated or excavated to 1m depth (Kort over det udgravede område. Kortet viser hvilke områder der blev totaludgravet, hvilke der blev *target excavated* og hvilke der blev udgravet ned til 1 meters dybde)

A short watching brief (*tilsyn*) was undertaken during the construction of the perimeter fence around the site, this consisted of small holes, *c* 0.3m in diameter and *c* 1.5m deep for the wooden posts. An archaeologist was present at all times to monitor and ensure that no *in situ* human remains were disturbed; any residual human bones were collected and retained for reburial.

Machine removal of upper levels of cemetery soil was used to reduce the cemetery soil without primary archaeological contexts and also to reduce archaeological deposits down to the top surface of the first *in situ* coffin. This enabled over 1m of soil to be efficiently removed by machine. A small machine with a toothless ditching bucket was monitored by archaeologists during this process. Although grave cuts and deposits were visible just under the topsoil they were not surveyed until the machining had been completed, therefore the top level (z-value) of the contexts relates to the level of the coffin when first visible. The archaeological contexts and finds were then cleaned with trowels, surveyed and identified before being recorded or excavated. All contexts received a unique identification number, generated by the total station. A machine was also used to reduce natural soil between the primary contexts thus improving the efficiency and reducing the heavy workload to archaeologists.

Excavation was undertaken under stratigraphical methods excavating primary contexts in reverse chronological order, starting with the latest (or youngest) feature first, working down to the earliest (or oldest) and undisturbed natural ground. Excavation was primarily by hand tools, shovel and mattock followed by trowel and occasionally brushes and leaf trowels for smaller more delicate excavation. Each context was excavated in order and context sheets filled in on site. Three different types of context sheet were designed for the site; a sheet for describing cuts, deposits and structure; a sheet for describing the skeleton and a sheet for describing the coffin or urn (see 0 for descriptions). The skeleton was photographed, with geomarkers placed alongside the body, from a vertical view. All the contexts were surveyed and any finds or samples taken. Then it was decided if the skeleton was suitable for full analysis in the laboratory or to be assessed osteologically *in situ* (see below for prioritisation and parameters for this). The skeleton was then lifted and placed in a box and taken into the 'In' storage containers, any finds or samples were also collected and logged. The coffin was then removed by hand, with wood and metal being separated and disposed of in available skips and the cut excavated to find the original depth of the context.

Field procedures

Finds from *in situ* coffins or associated with a skeleton were collected for registration and they were then related to the identity of the coffin or skeleton from which they came. Finds from primary deposits such as grave fills were related to the deposit. Only if the precise location of the find was interpreted as important was it surveyed and given a Find Unit (FU). This identity was noted on the context sheet. Finds that were related to coffin furniture such as coffin handles or decorations were not always recorded as finds or registered as a Find Unit. These were described in the context sheets. Coffin nails were not described or collected. A few notable examples of coffin furniture were registered as finds to gain further detail and to be photographed. Residual or stray finds were collected and examined before being discarded on site or retained according to the principles laid out in the Finds Handbook (2010). All residual gravestones were collected, examined and registered if they had relevant inscriptions. These were retained by the cemetery staff.

Disarticulated human bone

The nature of the site meant that there were disarticulated or residual pieces of human bone throughout deposits on the site. These are pieces of the skeleton that are no longer *in situ* and have become disarticulated and can become redeposited by the movement of soil through grave digging. They were treated differently to *in situ* skeletons.

When they were observed they were collected, counted and recorded and then reburied with the other skeletal material. A further measure was employed to ensure that the soil removed from site by the contractors was free of identifiable pieces of bone or coffin wood. Soil removed was sent to a processing plant by the on-site contractors where the soil was processed and crushed so that any remaining bones would become unidentifiable.

Soft tissue procedures

Soft tissue in varying states of preservation was excavated on site and included preserved skin, hair, nails and adipocere. Where large amounts of soft tissue were preserved, a rapid assessment of the situation was made by Field Leaders on the methods of dealing with the situation. The first duty was to the staff conducting the excavation to ensure they were confident in dealing with the situation. If the skeleton was not suitable for recording i.e. there was too much soft tissue to warrant the work required in cleaning it: then no analysis was undertaken. The body was placed in a sealed plastic body bag, then in a coffin, labelled on the exterior and placed in the cold storage container ready for re-burial.

Where there was less soft tissue, the soft tissue was removed and securely double bagged within opaque bags in the field or in the osteological laboratory. The bags with soft tissue were labelled and stored in cold storage until the skeletal remains were ready to be reburied when they were reunited.

Intact coffins

Any intact coffins identified on site were not opened; only six were located. This was to minimise contact for staff with potentially surviving soft tissue and other biological remains. The exterior of the coffin was documented but no attempt was made to open it. Two coffins could be directly placed within a ready-made coffin, others were too big. For these four coffins, a separate wooden case was constructed to fit the coffins in; they were placed inside and reburied within these new cases.

Cremation urns

A number of cremation urns were excavated (81) on site; these were carefully excavated in the same way as other primary contexts and then placed in storage until reburial. They were recorded on standardised context forms describing in detail the type, material, size and preservation. If they were still intact they were not opened. No further analysis was made on the contents if they were open, as they consisted of bone ash only. Any cremation tag found was registered as a Find Unit.

Documentation methodology

The archaeological features were recorded according to the stratigraphical, single context method as described in Roskams (2001). Archaeological contexts are recorded and described down to the smallest visible event that can be identified by the archaeologist. These are then linked together to form a flow of events that happened through time on the site. This is the easiest and most efficient way to interpret and recapture the activities that have taken place on a site, which is the overall aim on any archaeological investigation. The specific documentation methodology for the Museum is contained in Thomasson (2011) and although the excavation phase of the project had been completed prior to the finalising of this document, it follows the intention and policy contained within it.

The archaeologist who excavated a grave was responsible for recording it in the manner explained above, both in the field and in the database (IntraSiS). The digital recording includes creating the stratigraphic relations, the contextual relations (finds, samples, photos, groups etc.) and any necessary editing of the geo-object (the measurement). The archaeologist also kept a matrix for the whole of the grave plot or more (an area matrix), with relations to the general cemetery soil and natural soil.

There were written guides and illustrations/charts of work flow available to help the archaeologists to record in the correct manner and to follow the correct steps through the procedures. As a part of the quality control of the documentation, there were also discussions and assessments on a regular basis. The Field Leaders checked the context sheets and aided understanding of them. The geo-objects and the matrices were also checked by the archaeologists with special responsibility for this.

Context sheets

Specific context sheets were created for this project, and these were revised one month into fieldwork to add additional fields and to make them easier to understand and fill in. There was one double sided form for cuts, deposits and structures, and forms for skeletons and coffins/urns. The forms for recording of archaeological features are divided into three sections:

- The first section comprises overall information and primary identification such as data about position in the field, date of documentation and signature of excavator, as well as the identity of the feature, what kind of feature it is (grave cut, posthole, pit etc.), its dimensions and type and its nearest stratigraphical relations (younger and older). Information about finds, photos and samples are also put on the form, as well as the opportunity to sketch the context.
- The second section contains a description of the context which concentrates on the attributes of the types of cuts located or attributes of soils present etc.
- The third section of the form holds the archaeologist's interpretation of the context – what kind of cut or deposit is it and what can we further suggest about it? In this part all the gathered information recorded in the first two sections should be seen as grounds for the interpretation.

To aid archaeologists in interpretation about the context, Field Leaders devised a series of questions to consider during fieldwork and registration which derived from the Method Statement research aims. These were to guide and inspire archaeologists in their thinking and interpretation relating to each type of context.

Deposits

- Is there something in the contents to suggest any special burial ritual? For instance, sand, pebbles, organic material such as plant residue or seeds.
- Are there disarticulated bones – a lot or a smaller amount? This could indicate change in ownership of the grave plot.
- Is there other evidence of previous burials? How have they been treated?
- Can you tell any sequence in different deposits within a grave plot? Is there any evidence of finds discarded by the grave diggers or redeposited soils from elsewhere?
- Are there redeposited grave stones that are unlikely to be from the immediate area?

Cuts

- Is the cut neat and straight, or more crooked and “sloppy”? Indicates digging practice and attitudes to the dead by the gravediggers.
- Has the cut disturbed earlier burials or is it affected by younger burials? Or do several cuts lie next to each other and respect each other? What could either alternative suggest?
- Does the cut respect the grave plot as seen on the plan/background map in IntraSIS? Or is it not correlating to the plots? What could either alternative suggest, for instance about dating and “coexisting” with other burials nearby?

Coffins

- Are there social or religious implications in type of coffin and decoration? Is there any pattern across the burials you have seen according to age, gender or marital status?
- Is there anything to suggest dating?
- How well did the type of coffin and coffin fittings preserve and protect the body? Did it encourage decay and composition?

Skeletons

- Are there finds which can tell about dating of the burial?
- Are there finds which can tell about status of the deceased? Age of the deceased? The deceased’s profession?
- Can finds tell us something about burial practices?
- Are there aspects of the position in the coffin that stand out? What could that mean?
- Is the skeleton in an unusual position? What does that tell you about disturbance of the burial, either by root action or later graves? At what stage of decay was the individual in when this happened, does that give you more

indication of the sequence of burial/preservation and timings of burials in that plot?
- How well preserved is the skeleton and coffin? Is that related to the individual circumstances such as the type and quality of coffin or the surrounding soil conditions?
-

Grave plot walls and cuts/deposits for grave plots

- Does it match borders of plots on the plan?
- Does it respect grave cuts or is it lying on top of burials? What does either alternative suggest?
- What is the status implication for the plot?
- Are there other walls or vaults in the vicinity? Status implication for the area? Is it in a known plot? Look at the historic plans of the area. If it's not a recorded plot, what does that suggest?
- Where is it on the cemetery? Are there social status implications to the placing? Is it on a prominent memorial line or pathway that people would have seen frequently?

Other features

- If your feature is not a grave: what kind of activity could be the cause? Do you think that the context is related to the cemetery or to earlier activities? (look at cemetery plan/background maps in IntraSIS)
- Is it a more modern disturbance by later gravediggers? Is it related to the gravediggers' house and garden or is it simply drainage and general maintenance of the cemetery?

Charnel deposits

- Position of the bones – were they grouped together in a pile, or were they scattered more randomly throughout the deposit?
- What kind of condition were they in?
- Were there any remains of coffins?
- Do you think they can come from the skeleton you have excavated in that stratigraphic sequence?

A standard was set in the project that only *in situ* skeletons would be defined as contexts and given a context identity (SB number). This ensured that the osteology database (which only recorded *in situ* skeletons) and the archaeology information in IntraSIS would accord exactly. Therefore residual bones were not counted as skeletons but as Finds; it is the archaeological definition that remains preeminent of an *in situ* context. This also means that large charnel deposits of almost complete skeletons were not defined as skeletons, simply because they were no longer *in situ* and had undergone a new process of removal and disturbance which placed them into a new archaeologically defined category.

The photographic documentation primarily consisted of rectified images of each skeleton *in situ*. Additional images were taken to depict clear stratigraphical relationships between graves and coffins, overall images of work on site and unusual or interesting finds and coffins. Image registers were created in the field recording an Image number (which was cross-referenced on the context sheet), context numbers, direction of image, archaeologist and date, comments and area. These registers have been scanned and are available on the Museum project folder.

Images of skeletons were uploaded onto IntraSIS and related to each skeleton by the archaeologist. This overall work and process and procedures created were overseen by an archaeologist with special responsibilities.

IntraSIS, which is a database built around an object-oriented data model that gives a great freedom in design of space-specific databases, was used for the project. The data collection is done partly with the total station and through manual data entries. The database structure is based on flexible metadata templates, which are managed separately for each excavation. The Assistens database was created specifically for the site and was designed to correspond to the context sheets. This means that the data can be entered with the same attributes and be related directly to the surveyed geo-object, allowing spatial and contextual analysis of the results.

Each archaeologist was trained on site in using the Total Stations to enable accurate survey of the contexts and for the efficient use of time and to improve their skills. On site downloading, checking the survey results and administering the database, plus training was overseen by an archaeologist with special responsibilities.

Higher stratigraphical interpretation

Contextual documentation followed the principles set out in the Museum guide to contextual documentation (Thomasson 2011). For this site grouping is the first interpretive stage after registration of each individual context; sub groups were not used.

In addition to the find identity numbers generated for every single context by the total station, every *inhumation, cremation, charnel or construction* was given an identity number (a Group number). When starting to document a grave, the archaeologist reserved an identity for the grave from a list with consecutive numbers. All data connected with that particular burial (grave cut, deposits, coffin, skeleton, finds, samples etc.) would then be linked to the group number by relationships made in IntraSIS. To relate and group all data from a grave is partly a way to make the documentation more manageable and easier to overview, but primarily it forms the basis for interpretation and analysis of the stratigraphic sequence. It can separate out individual events within each grave plot, such as the primary burial followed by exhumation and burials of further individuals upon a change in ownership. Group registers were created which logged each group number (which was cross-referenced on the context sheet), context numbers, archaeologist and date, comments, and area. These registers have been scanned and are available on the Museum systems.

Although the actual identification and formation of groups occurred during fieldwork, more work needed to be done to fill in the attributes, integrate the information and

form interpretations of the data. As several people participated in this stage, a template was created to help guide the process and suggest a uniform way of dealing with the interpretation, particularly of the free text. The aim was to register the attributes in a uniform way and try to consider the information and ask the same questions of the data in a consistent way. Free text was also written divided into three areas: placement and stratigraphy, the burial and individual, and a summary. These would form the basis of describing the potentials of the data for each group which could be referred to without having to individually search for each attribute.

Inhumation and cremation groups form the largest groups within the data; each was given specific attributes to interpret the descriptive detail entered in the context identities. Lists of attributes are in Appendix 1. The term 'inhumation' was used to describe an *in situ* burial within a coffin and was used as a clear and defined term easy to distinguish from the many confusing synonyms such as grave or burial. The term 'cremation' was used to identify an *in situ* burial of a cremation urn.

Human bones that were found within stratified, primary deposits such as grave deposits were treated differently to disarticulated residual bones and registered as finds of human bone. During excavation archaeologists found that many bones were just thrown back into the grave, but some were also deliberately placed in specific locations. During the early months of fieldwork it was decided to formulate a new way of dealing with these deliberate depositions to see if new information could be gained out of recording more data. A new group (charnel) was formed to interpret this action. The word charnel derives from charnel houses, which were specific buildings to store bones of the dead, often for reinterred bones from disturbed graves.

On any cemetery, however, there will be a large amount of unstratified or residual human bone and not all of it could be described as a deliberate deposition or secondary burial. So a definition was created to separate the interpretation of deliberate and unintentional actions. Finds of human bone were divided into charnel groups which represent deliberate actions or disarticulated bone which represent unintentional actions. Disarticulated bone represents the residual bones and no further interpretation was undertaken. The bones were simply treated as finds within a deposit. A charnel group is defined as an assemblage of (usually) disarticulated human bones that indicate that a previous inhumation has been dug up and partially removed, generally to create space for a new inhumation. These bones are then placed back into the grave, either underneath or above the new coffin to fill the grave up. Occasionally they are placed deliberately inside another coffin or in some particular position or pattern. This action of destruction and actively redepositing the bones is the action that we are recording archaeologically, not the earlier inhumation. A charnel deposit is an action taken by people that could be ignored in the archaeological record, but as a form of agency by gravediggers it should be recorded as part of the biography of an inhumation. It is also an indication of how many people have been buried in the plot and later removed, so it is vital to describe and record archaeologically. There is also the possibility of identifying and describing where there was deliberate deposition, for example bones placed carefully in a corner of the grave cut, on top of a coffin, or even inside a coffin. There are

protocols in the historic records for the cemetery that describe how to remove earlier graves.

Identification and definition used

Where there were large assemblages of bones found which could indicate a charnel deposit, the description was defined as consisting of: *'at least five major bones'***.** For this definition the major bones are: skull, humerus, radius, ulna and clavicle, substantial amounts of vertebrae, sacrum, pelvis, femur, tibia, and fibula. The idea behind this lay with trying to identify a large deposit of bones that was equivalent to *c* 10-20% of a single skeleton that would have been easy for a gravedigger to observe and have to make a decision about what action to take with it. This definition would not place too much emphasis on the residual pieces of bone that are common on cemeteries. These percentages try to equate to approximately 10-20% of the skeleton as defined using the percentages of: skull = 20%, arms and hands = 20%, legs and feet = 20%, torso and pelvis = 40%.

A second possibility could define a charnel deposit:

'a complete articulated part of the body such as a foot or hand or limb'

The premise is that an articulated section of the body would also have been an obvious item that a gravedigger would have to make a decision about. However, a skull by itself is not defined as a charnel deposit although it would equate to *c* 10-20%; skulls are bones that are easily recognised and disturbed and are moved easily. Neither are the disarticulated bones of a single arm or leg, unless there is clear evidence that it was deposited articulated and thus represents a single individual.

If a collection of bones answered to either of these descriptions, the deposits they were in (usually the grave fill deposit), was then redefined as a charnel group with the find of human bone being described also as charnel. Small amounts of bone that were not considered as charnel groups were recorded as finds but described as 'disarticulated' remains. These were then simply described as part of the grave deposit and remained part of the inhumation group.

Registration procedure

The procedure started when an archaeologist identified a charnel deposit within a grave deposit, it retained the identity created for the deposit (SD number). The bones were not given a skeleton (SB) number. The bones were treated as an inclusion and noted on the inclusions attribute in the deposit. A separate group was created by the archaeologist, 'Group/Charnel' which separated the grave fill deposit from the primary *in situ* inhumation. The bones were retained and taken to the laboratory. The bones were identified by the osteologists and a paper recording sheet filled in with osteological information. This information and the formal decision on if it was designated a charnel or disarticulated bone was then reviewed by the Excavation Leader and the information entered onto IntraSIS as a find of human bone. Attributes recorded for charnel groups included if it was a deliberate or random deposit, MNI, sex and possible age, also the parts of the body that were represented.

Structures and Other groups

A small number of structures were identified and general attributes were devised for these. They were divided into interpretations of grave plot wall, grave vault, gravestone marker or occasional structural contexts such as the well. Similar attributes to inhumations and cremations were entered including dating, interpretation and phase. Miscellaneous 'Other' groups are divided into prehistoric and cemetery management activities. Attributes such as phase, subtype and interpretation are used. The majority are simple categories; however grave plots that were observed but unexcavated can be either a single grave plot, or actually represent multiple grave plots recorded together.

Finds registration

Finds from Assistens cemetery were treated differently from standard Museum of Copenhagen finds procedures due to the different circumstances in the project. Prior to formulating the methodology of the project, it was decided by the Museum that all artefacts retrieved from inhumations or cremations would be registered and photographed, but then reunited with the individual burial and reburied. Therefore, normal Museum protocols for finds retention and conservation are not applicable for this site. Despite this, the finds retrieval policies of the Museum were followed where applicable for registration (Finds Handbook 2010). The general character of the finds can be described as deliberately deposited artefacts relating to the cemetery activity, there were also smaller amounts of cemetery management artefacts relating to the lives of the gravediggers and residual artefacts from general unstratified contexts. A small amount of prehistoric finds was also recovered.

A find identity (F) was created when a find was registered. Finds from burials were registered in the field by the Excavation Leader and then re-associated with the skeleton with the exception of textiles, which were registered by an archaeologist with specialist textile education. Residual artefacts, such as ceramics and ceramic tobacco pipes from deposits were registered in the Museum by the Excavation Leader or archaeologists. Finds were divided into classes primarily based on their material – metal, ceramic, bone, textile etc. Specific attributes were then created within IntraSIS relevant for those types. Some additional subclasses were created during the excavation such as specific ones for buttons and gravestones. A specific subclass was created for human bone to allow registration and definition of charnel and disarticulated bones from deposits. It was seen as necessary during the excavation to describe in further detail those types of finds that were very common and would require more detailed attributes and an easier method of searching for analysis. Free text descriptions were also written for each artefact. Photographs of finds are logged in an Image Register (Excel spreadsheet) and stored on the project folder.

The textiles have been registered using standard methods used on textiles (Walton and Eastwood 1983). Measurements, weave, spinning direction of the thread, thread thickness and threads per cm as well as the location of the textiles have been recorded. Initial fibre analyses were made with the assistance of the Centre for Textile Research, Copenhagen. No colour analyses were made. Appendix 2 lists all subclass categories and attributes for finds.

Reburial and collections

Reburial of the finds took place during fieldwork so that no burial related finds were removed from Assistens cemetery. After each find had been fully registered and photographed they were reunited with the skeleton and then placed together in the coffins used for reburial.

There were some exceptions to the policy of non-retention - residual archaeological finds discovered outside the grave plots or having no clear association with any particular buried individual were retained by the Museum with prior agreement of the Collections Department. Examples of these are the 20th century jacket (F200929) and some examples of the conch shells (F200355) which were not associated with any burial but were deemed significant and relevant for future Museum collections. The artefacts resulting from the prehistoric contexts were also retained for the permanent collection. Samples of skeletal material and textiles were also retained.

Osteology

Aims of documentation

The purpose of the osteological examination is to extract information from skeletal remains and contribute to the reconstruction of individuals' and populations' past lives and enhance knowledge of post mortem treatment of skeletal remains. The aims of the documentation were designed to conform to the project objectives set out by the Method Statement for the project (Anthony et al. 2009). These objectives were achieved by analysing the individuals for indicators of sex attributes, age, stature and pathology.

Prioritisations and sampling

The most decisive factor in designing the methods and priorities of the site was the decision to retain all skeletal material on the cemetery site and rebury all human remains during the period of excavation. Normally, archaeological and historical skeletons that are excavated in Denmark are stored at designated facilities for future analysis (e.g. the Laboratory of Biological Anthropology at the University of Copenhagen or the relevant museum). The consequences of this decision were wide and included effects upon the timing and cost of the project, facilities needed on-site and staff. The method of documentation also had to be of appropriate and exceptionally high quality which would justify the efforts put into the project by using comparable and internationally recognized standard methods for recording. This enables future direct research comparisons that can be made to contemporary collections nationally as well as internationally.

A temporary laboratory was set up on site enabling storage, processing and registration of the remains before reburial. Nothing was kept except for small tissue samples for scientific analysis. Because time was limited by the length of excavation, balance had to be made between detailed data collection and effective recording. In order to respect the scientific value and to allow future scientific investigation and analysis, the data had

to be recorded to the highest standard in a concise and effective manner, which meant that professional osteological staff with wide experience was needed.

There were implications for both the osteology methods and the expert osteology staff available. But as with any scientific endeavour, there are obstacles. The fact that more skeletons were recovered than expected forced a change to the methodological approach. In order to obtain maximum information from the site a strategy had to be adopted in which resources were targeted at areas that would produce the greatest returns in terms of data collected and information obtained (

Table 2). The priority for selected skeletons being fully analysed had to be altered and the level of documentation was graded depending on several factors. It was decided to concentrate on specific areas where the most information could be gained from fully excavated individuals which were in a good level of completeness and preservation.

All subadult skeletons were prioritised and were fully analysed. The majority of adult skeletons, from the area north of the gravediggers' house in Areas 4, 2 and 7, where preservation allowed it, were chosen to be fully analysed. Skeletons recovered in Area 3 underwent a low resolution analysis. Most of the individuals recovered from the other areas underwent a less detailed field assessment that only aimed at understanding the social demography of the groups (i.e. age, sex and stature). If these individuals outside the "chosen" area were complete, the preservation was good and/or otherwise contained further information that would benefit both the osteological as well as the archaeological interpretation they would undergo full analysis. To complete this new prioritisation it was also decided that archaeologists with osteological education should conduct field assessments with guidance from an experienced osteologist.

	Staff	Information obtained	Methods
Full analysis	Osteologists	Tabular skeletal and dental inventory; preservation and completeness; sex; age; stature; metrical data of skull and long bones; detailed dental and skeletal pathology incl. joint and vertebral recording; scientific samples	Morphology, All metrics, Radiographs
Low resolution analysis	Osteologists	Sketched skeletal inventory; preservation and completeness; sex; age; stature; dental inventory; descriptive summaries of dental and skeletal pathology, incl. vertebral and joint recording; scientific samples.	Morphology, Metrics for stature only, Radiographs
Field assessment	Archaeologists	Preservation and completeness; sex; age; stature; rough pathology; scientific samples	Morphology, Metrics for stature only

Table 2 Overview of analysis, staff, information obtained and methods used

Work procedures for skeletal material

Skeleton processing

The skeletons were signed over from the field to the osteology processing staff and written into the osteology log which stated the precise shelf location in the 'In' storage containers. They then went through the osteology documentation processes and were then stored in the 'Out' containers. This signified that they had been completely

analysed on osteological grounds. This new shelf location was logged on the Osteology log, so they could be easily located. Any finds were then reunited after registration and double checked to ensure they were returned to their correct owner. When this process was checked and completed each skeleton with artefacts was then ready to be reburied.

Washing/cleaning

Skeletons suitable for analysis were cleaned to expose the bone surface or teeth completely. This was done using a soft brush. Water was used if remains were very dirty and or already wet. Where skeletons had substantial amount of adipocere attached to the bones removal was not attempted as it would destroy the bones. For some cases, this limited the osteological recording to only a field assessment to establish a demographic overview. If soft tissue could be removed, this was placed in a plastic bag labelled with the skeleton identity and stored in a cooled container until reburial could take place with the rest of the skeleton. Skeletal material which only underwent the field assessment were generally not all washed but specific surfaces were often cleaned to get a clear observation of specific features. Another exception would be if remains had too much soil covering them, therefore cleaning enabled clear x-ray images (the iron particles in the soil would make “noise” on the image).

Images

All fully analysed remains had a working shot of the skeletal inventory. Furthermore, where preservation allowed it, the fully analysed remains had photographs taken of right and left auricular surface, right and left pubic symphysis, the dentition, skull and pathology. These images allow future clarification of the assessment where the bones themselves are not available for study. In selected cases, images of sternal rib ends and sternal end of clavicles were taken. The skeletons of low resolution analysis had an overview shot taken *in situ* by the osteologist. Specific pathologies were photographed in the laboratory. The field assessed skeletons were photographed *in situ* by the archaeologist. Field assessed skeletons were only photographed in the laboratory if specific pathologies were observed. All dentures (full or partial) observed were photographed.

All photographs were recorded in a log book and an individual skeleton photo log. The logs included details of image number, skeleton number, description of image and view, date of image taken and initials of photographer.

X-ray

Selected individuals with long bones and/or cranium intact were x-rayed to document measurements, trabecular and cancellous appearance in femoral and humeral heads as well as to document pathologies. The view of the elements was always taken in an anterior posterior plane. Intact crania were x-rayed in an anterio-posterior and medio-lateral plane. Where it was found necessary for further documentation, elements were taken in a medio-lateral and superio-inferior plane (e.g. crania and vertebrae). A link was set between the laboratory computers and the x-ray machine allowing direct viewing and storing of the images on after the image had been taken. This was enabled by the specific radiographic program, KPAX, used for viewing radiographic images in the

raw Dicom format. All radiographic images are labelled with skeleton number, object and view. They have been transformed into .jpg images with scale bar allowing direct measurements from the images. All x-rays were recorded in a log book and included details of skeleton number, date of images taken, a description and view of each image. All information was uploaded to the Museum server.

Osteological documentation

Overall skeletal documentation

Documentation followed the guidelines by Museum of London Archaeology (MOLA) outlined in Connell and Rauxloh (2003) and Powers (2008), who base their recording procedures on international standards for best practice (e.g. Buikstra & Ubelaker 1994; Brickley & McKinley 2004). The dental inventory followed the Fédération Dentaire Internationale (FDI) system (1971) of tooth identification (Hillson 1996).

The data was recorded according to standardised osteology recording forms and subsequently entered into a specifically designed Access database. An inventory (pictorial and tabular) was created. Each anatomical element or component thereof was recorded on a presence (1) or absence (0) basis. At least 50% of a bone or bone segment had to be present before it was counted as present. Details of the analytical methods are described below. The database provides information on the archaeological context, skeletal completeness, demographics, measurements, and pathology. The individual skeleton number in the database refers to one skeleton only (i.e. MNI = 1 individual in the database).

The structure of the Access database was created in collaboration with AOC Archaeology, London and follows the guidelines by Connell and Rauxloh (2003) making adjustments to suit the information needed from this excavation. It is compatible to the Wellcome Osteology Research Database (WORD) used by the Museum of London. The Access database links via the skeleton identification number to the archaeological database, IntraSIS where the contextual information for each skeleton is recorded. The data was supplemented by photographs, and radiographs when appropriate which were uploaded onto individual skeleton folders on the Copenhagen Museum server system.

The original documentation proposed of using an Excel spreadsheet was found to be lacking functions provided by a suitable database system therefore documentation was altered to a specially designed Access database.

Full analysis

For full analysis more than 50% of the skeleton had to be preserved. This detailed analysis included tabular skeletal and inventory, preservation and completeness, metrical data of skull and long bones, detailed dental and skeletal pathology, radiographs and samples for scientific analysis. All subadult skeletons were fully analysed. Adult individuals where less than 50% was preserved would only undergo full analysis and subsequent x-ray if more specific information besides age, sex and stature could be gathered.

Low resolution analysis

A less detailed analysis was carried out for individuals from Area 3. Due to prioritizations of the budget available, a full analysis was not possible. The skeletal inventory was recorded by marking out missing elements on a skeletal sketch. The dental inventory was tabular. Recording was also made of the preservation and completeness. Besides information relevant for a demographic profile and stature, descriptive summaries of skeletal and dental pathologies were made and registration of joints and vertebrae were noted. However the assessment of sex and age, and the recording of joint and vertebral pathology followed the same standards as the fully analysed skeletons. The maximum femoral length was used when estimating living stature. Further bone measurements were documented by x-ray and are available from archive.

Field assessment

A rapid scan of the remains or coffin *in situ* decided whether further recording was appropriate. Skeletons of less than 50% complete, poor preservation or outside the agreed area of full or low resolution analysis underwent a less detailed osteological assessment. This was done by archaeologists with osteological experience and was based purely on morphological observations *in situ*. The majority of the assessments were supervised by the experienced osteology staff. The observations included assessment of age and sex in order to allow a demographic overview. Bone measurements (with the exception of maximum femur length used in stature estimation) were not undertaken. Metrical data from field assessed skeletons of more than 50% complete can subsequently be taken from the x-ray images available in the archive. Initial pathological observations were noted by the experienced osteologists, but were not completed to the same detailed standards as fully analysed individuals. Therefore, it is more likely that pathological conditions may have gone unnoticed within this assemblage.

Disarticulated skeletal material from stratified and unstratified contexts

Disarticulated remains from stratified or unstratified contexts were not registered in the Access database. A basic summary of the data of disarticulated remains were entered onto a paper recording form and subsequently entered into the IntraSIS database only related to the context it originated from (Deposit; SD identity). An estimated minimum number of individuals (MNI) within each deposit were made based on the presence of repeated elements or those where age, morphology or preservation indicated clearly that they were not from a single burial. The MNI was noted for adult and sub adult remains. Sex and evidence of pathologies were noted where morphology and preservation allowed this.

Preservation and completeness

The general state of preservation was visually assessed and estimated on a three grade scale from Good (1) to Poor (3). The preservation categories follow the definition after Connell (2008, 9). Completeness was based on the proportions of the skeleton and assessed in 5% increments from 5-95%. A complete skull is 20%, legs and feet 20%, arms and hands 20%, torso and pelvis 40%. All individuals were assumed to have at least one or two smaller elements absent so that none could achieve a score of 100%.

Determination of sex

Sex refers to the biological sex, unlike gender which refers to the socio-cultural differences (Roberts 2009). Sex is usually only estimated for adult individuals as it is based on sexually dimorphic features that emerge after the onset of puberty. It can therefore only be ascribed with any degree of accuracy in skeletons aged greater than 16-18 years. Some adolescent individuals in their late teens may display very significant sexually dimorphic features which may allow sex estimation. The limited level of accuracy should, however, be acknowledged for these individuals. The methods for sexing are based on a macroscopic assessment of features of the skull (including the mandible) and pelvis and follow the criteria summarised in Buikstra & Ubelaker (1994). Metric data of long bones was also used following Stewart (1979) and France (1983) cited in Bass (1995). For adults, all evidence from these methods was considered, but emphasis was given to indicators on the pelvis and skull. Research has indicated the most reliable estimates can be made from these two areas of the skeleton (Molleson et al. 1993). The sex categories “possible male” and “possible female” was used where there was marked uncertainty but where there was sufficient traits tentatively suggesting the sex of the skeleton. “Ambiguous” was used where there were equal markers to suggest both male and female sex. “Unsexed” was applied to those individuals where sex could not be determined from any of the elements present i.e. subadults or poorly preserved adult remains. Overall sex was assigned on a scale with 1 being hyper male and 5 being hyper female. The number “9” signifies an adult or subadult of undetermined sex (Table 3).

Sex	Sex code
Male	1
Possible male	2
Ambiguous	3
Possible female	4
Female	5
Unsexed	9

Table 3 Sex categories with corresponding sex code used when recording in IntraSIS

Determination of age

Osteological age reflects the biological age not the chronological age of the individual. The difference between osteological and chronological age, in part, is due to genetic influences, but largely the result of external factors such as nutrition and lifestyle, that impact on skeletal growth and subsequent degeneration (Schwartz 1995: 185). Specific techniques largely depend on the preservation and completeness of the remains. In complete individuals, adulthood was defined by the complete fusion of the epiphyses, with the exception of late fusing centres of the sacrum and medial clavicle. The complete eruption of the third permanent molar was also used to signify adulthood. The adult age was estimated from a combination of several morphological features including the pubic symphysis (Brooks & Suchey 1990), the auricular surface (Buckberry & Chamberlain 2002) and the sternal rib morphology (Iscan et al. 1984: 1985). Both right and left elements were scored. To minimize inter observer errors, a minimum of two observers had to score the elements and the mean was used. Femoral and humeral

heads were x-rayed in order to score the appearance of the trabecular and cancellous bone in the proximal ends following Acsádi & Nemeskéri (1970). A mean age was then estimated from the various methods. Methods related to dental attrition were derived from prehistoric and medieval populations (e.g. Miles 1963; Brothwell 1981). It was therefore thought inappropriate to apply these methodologies on 19th and 20th century individuals.

To estimate age at death of subadult individuals, indicators such as dental formation and eruption (Fig 10), long bone length and epiphyseal closure were used. Whenever possible, age at death was estimated from the extent of dental formation, using the standards by Moorrees, Fanning & Hunt (1963), Shour & Massler (1941) and Gustafsson & Kock (1974). The age estimate from bone development, long bone length and maturation is based on Scheuer & Black (2000).

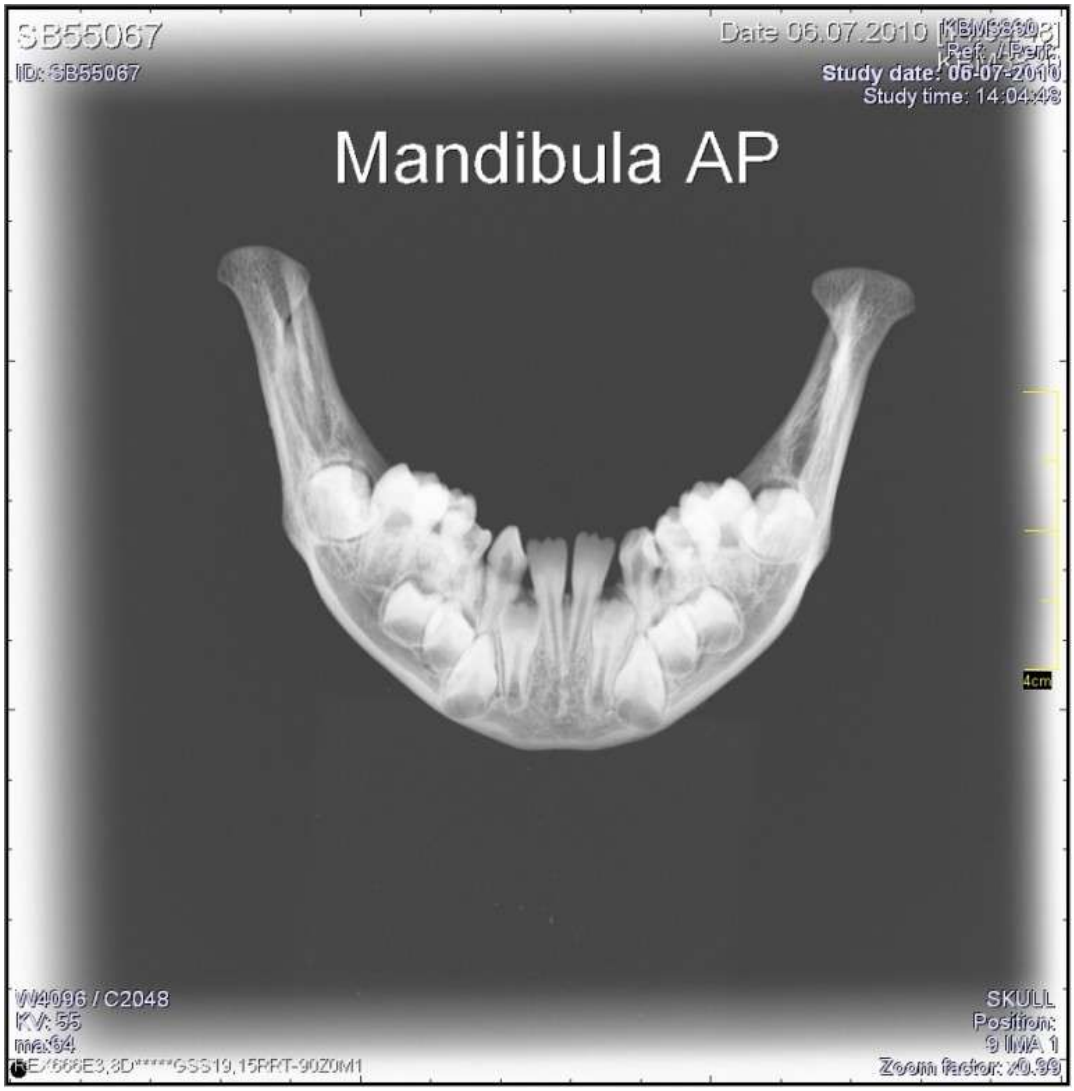


Fig 10 Anterior view of a subadult mandible, *c* 6 years old. Image shows mineralisation stage of permanent dentition in the alveolar crypts used for ageing (SB55067) (Underkæben af et ca. seks år gammelt barn, set forfra. Billedet viser miniraliseringsgraden af det permanente tandsæt i alveolerne, hvilken kan bruges til aldersbestemmelse (SB55067))

The different ages were ascribed to age groups following Powers (2008) with amendments to the old adult age groups, which were divided into an Old adult A (56-65 years) and Old adult B (66+ years) (Table 4). It is recognised that difficulties exist in ascribing age estimates to adult remains. Older adults are often assessed as under-aged and young adults are often assessed as over-aged (Molleson et al. 1993). Therefore, broad age groups are used for analysis. The field assessed remains were put in wider pooled categories as the assessment was less detailed and based on purely morphological features. In order to compare the demography between the analysed and field assessed individuals, the subgroups in the analysed remains were pooled to match the field assessed groups.

Blind testing of age and sex methods was carried out with no historic or known information accessed during the analysis. This allowed an unbiased estimate of data, which can be used to test the accuracy of the osteological methods employed on site. Such a comparative study was never intended for this report, but will be carried out in future investigations, when further identifications of individuals have been made using contextual analysis of the archaeological and historical records. However, a limited initial study is included in the report.

Description	Age range	Age code	Pooled age groups	Pooled age code
Inter-uterine/neonate	<4 weeks	1		
Early post-natal infant	1-6 months	2	Infants	15
Later post-natal infant	7-11 months	3		
Early childhood	1-5 years	4	Children	16
Later childhood	6-11 years	5		
Adolescent	12-17 years	6	Adolescent	-
Young adult	18-25 years	7	Young adult	-
Early middle adult	26-35 years	8	Middle adult	17
Later middle adult	36-45 years	9		
Mature adult	46-55 years	10	Mature adult	-
Old adult A	56-65 years	13	Old adult	18
Old adult B	≥ 66 years	14		
Adult	> 18 years	11	Adult	-
Subadult	< 18 years	12	Subadult	-

Table 4 Age groups with description, age range and corresponding age code used when recording in IntraSiS

Estimation of living stature

The stature was calculated by applying measurements of the maximum length of the long bones to regression formulae of white males and females devised by Trotter

(1970). Since the material dates from the 19th and 20th century, the method was thought appropriate to use on the material. Measurements of the lower limbs, preferentially the femur was chosen over those of the upper limbs, as they carry less error (Buikstra & Ubelaker 1994). Any further metric analysis of the skull, post-cranial skeleton and teeth, used for determination of ancestry, investigating genetic relations, robusticity and sex was beyond the scope of this report, but this information has been retained in the archive for future studies.

Pathology recording

In prioritised skeletons pathological changes were described and subdivided by disease category. Where diagnosis was possible, this was coded according to Connell & Rauxloh (2003) and supported by summary descriptions. The field assessed skeletons where not fully examined for pathology and therefore were not coded in the same system. However gross pathologies and evidence of autopsy or the presence of dentures was noted by the person responsible.

Sampling methodology

Samples were surveyed in the field as sample units with a Total Station and given the identity 'P'. The bone samples were taken during analysis and recorded on paper logs. These were later registered in IntraSIS as bone sample units (PO) and recorded with certain attributes such as type of bone or tooth which would enhance control of samples and the ability to search for certain types of samples.

Environmental sampling

Environmental samples were limited on the site to bulk sampling of soils and monoliths from prehistoric contexts; these were all taken prior to the formulation of the Museum science policies and, therefore, did not follow guidelines now available. Soil samples of five litres or more were taken from prehistoric pits and postholes. Two monolith columns were taken through the sections of a large pit group.

Pit samples

The pit samples were taken as bulk samples, often more than one sample from the same pit. From each of the samples chosen for analysis, 100 ml of soil was wet-sieved as part of the normal sample processing from the Metro excavations. The wet-sieve residue was then scanned under a microscope with magnification up to x100, and any seeds were taken out and identified. The remaining parts of the samples were processed but not analysed. These processed samples are stored at the museum.

Some soil samples were taken from the stomach or pelvis areas from under some skeletons to increase the collection rate of small infant bones or kidney stones, these soil samples were discarded after being sieved by osteologists.

Plant samples

Within the excavated coffins, botanical remains were encountered, which were sampled either whole or in part by the field archaeologists and kept in labelled plastic bags. Arriving at the lab, they were kept in the freezer and taken out one by one to prevent further decay. No processing was necessary, and the samples were analysed under low magnification and identified as far as possible.

Skeletal sampling

There was a strong academic case that small samples of important scientific interest should be taken and retained from the skeletons for future laboratory research. Advice from the Danish National Committee on Biomedical Research Ethics was sought to confirm if the intended recording and sampling strategies needed their approval. Since this kind of analysis does not fall under the regulations for medical research it does not require approval by the ethics board (De Videnskabsetiske Komiteer).

Sampling was dictated by the immediate reburial of the skeletal material; *in situ* skeletons were prioritised because the secure context could provide more culturally relevant information that would benefit future research. All tissue samples were taken in order that future research could test for questions into pollution, migration and dietary patterns. Samples of bone (compact bone, preferably proximal phalanges), tooth (preferably canine and premolar), hair and nails were sampled where preservation allowed it. Where kidney stones, gall stones and or bladder stones were present, these were also sampled. The samples were removed by hand, wearing protective gloves and put in sealed containers labelled with individual corresponding skeletal identity numbers and identification of contents. Selected individuals had soil samples taken underneath the pelvic area to enhance collection of bones and possible organic remains such as kidney or gall stones. These samples were discarded after sieving and are not retained.

Reburial procedures

The principle decision affecting skeletal material and associated finds was the rapid reburial within the Assistens cemetery during the time of the excavation. No human bones were removed from the site and none are retained by the Museum with the exception of small samples (see above). Originally it had been planned to rebury each skeleton within the original cardboard box used for storage, this happened on the first reburial occasion. However, the cemetery staff in charge of this process was unable to continue this safely and efficiently. New ready-made wooden coffins, which were easier to lift into the new grave cuts, were then used and this became the standard procedure. On average *c* 15 adult skeletons could be placed in one coffin. If residual bone was reburied *c* 5-6 boxes could fit into one coffin.

Prior to reburial, the information for each skeleton was checked for completion of registration in IntraSIS, that images and grouping had been completed and that osteological analysis was complete, and all finds were reunited. Lists were made of the identities of the skeletons placed in each separate coffin and were checked against IntraSIS. This system enables identification of the new burial location for families and the cemetery records. An Excel spreadsheet was made of this information, which is

stored on the project files and has also been sent to the Københavns Kommune, Center for Kirkegårde.

Archive material

The physical archive consists of *c* 35 A4 folders containing the paper records of the site; this includes the field context sheets, paper matrix, osteology recording sheets and copies of some registers including osteology processing logs. There are *c* 20 books which contain image and x-ray registers and group registers which have been scanned and saved as .jpgs on the project folder. There are also *c* 15 Total Station survey books which are not scanned.

Due to the decision to rebury all burial related finds, there are limited finds in the archive. A small collection of retained finds consists of two boxes of prehistoric pottery and flint and four boxes of historical artefacts which are not related directly to any burials. A small box of textile samples is placed in cold storage in the Museum. Several boxes of skeletal samples are currently stored at the Panum Institute to aid research. Any decision concerning the permanent retention of these artefacts is to be made by Collections Department.

The digital archive consists of all files in the project folder on the Museum Terminal Server under the Museum number for the site – KBM3830. Digital copies of this report are stored there. This report forms the key reference for using the stored archive information. There is also the main IntraSIS file (Project file K200901) which consists of the surveyed geo-objects and the contextual information entered from the field sheets, with associated rectified and digitised historic maps. Rectified images of each in situ skeleton are uploaded onto IntraSIS but there are no related images of other contexts or finds on the database. There are 83.3gbs of digital images of burials and field photos, finds photos, of which 53gbs are the x-ray images. Digitised historic data includes two Access databases of cemetery protocols (Begravelses protokoller and Assistens database). There are also several related management administration folders plus a spreadsheet (Final reburial list) describing the specific coffins in which skeletons were reburied, this will be able to be cross-referenced with the new location where the skeletons are reburied.

6 Results

This chapter presents the descriptive results of the excavation, with a brief description of the prehistoric archaeology but the main focus on the cemetery period data. Further cultural interpretation is presented in Chapter 8.

The prehistoric remains

The prehistoric remains were concentrated in two areas: Area 4 and 6. The main concentration of pits was found in Area 4, while the main concentration of postholes was found in Area 6 (Fig 11). Both of these areas were excavated down to approximately one metre below the present surface. The prehistoric features were found under the cemetery pathways, which were only slightly disturbed by cemetery activities. However, the prehistoric finds, which occasionally were found in grave fills, show that other prehistoric contexts were likely to have been destroyed by the cemetery activities. The prehistoric finds were few and scattered, and the stratigraphy was correspondingly uncomplicated. Most of the contexts were not cut by younger contexts and were cut into natural soil. Since the area has not been built on and has not been exposed to intensive agriculture in the last two hundred years or more, the state of preservation of the prehistoric contexts was relatively good in the areas which were not disturbed by graves. 20 contexts were recorded, all were cuts and deposits. All contexts recorded were excavated fully despite being within the 1m zone.

The prehistoric contexts are roughly summarized in the following tables:

Context type	No.
Clay extraction pits/waste pits	13
Cooking pits	1
Postholes	6
Total	**20**

Table 5 Summary of prehistoric features

Dating	Group no.
Prehistoric	G159, G168, G171,G173, G289
Neolithic/Bronze Age	G1288
Bronze Age/Iron Age	G169
Late Bronze Age/Early Iron Age	G172, G174
Pre-Roman Iron Age	G395
Early Pre-Roman Iron Age	G183

Table 6 Prehistoric contexts dated by finds

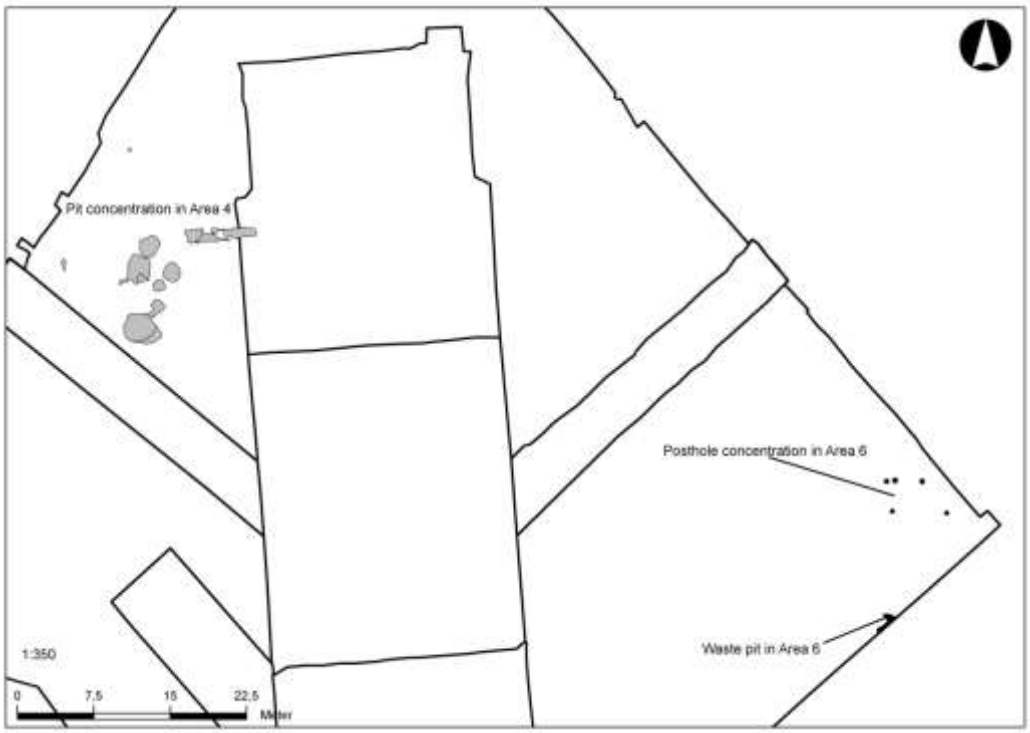


Fig 11 Overview of prehistoric contexts in Area 4 and 6 (Forhistoriske anlæg i Område 4 og 6)

The cemetery

The following results relate to the period that the site was in use as a cemetery, 1806-2010. They have been separated into the different types of activities carried out on the site and, where possible, specific aspects of these activities are discussed. In a small number of cases there was a tendency to under record certain traits so that they appear in the data as relatively rare when in fact they were very common. While no attempt has been made to alter the data to reflect this difference it has been stated alongside the relevant results where this is the case.

Contexts and groups

During the excavation a total of 4579 stratigraphic units relating to the cemetery period of the site were recorded (Table 7). The most common type of context recorded were cuts, closely followed by deposits. Not every context that was recorded was excavated.

Type	No.
Skeleton	854
Coffin	960
Urn	80
Deposit	1288
Cut	1328
Structure	60
Disturbance	9
Total	**4579**

Table 7 Total contexts recorded

All these contexts were assigned to a group together with the contexts that related to the same specific activity. These groups were split into five types; inhumation burial, cremation burial, charnel, construction and other (Table 8). Inhumations were the most common group type.

Type	No. groups recorded	Unexcavated
Inhumation	1107	153
Cremation	81	3
Charnel	204	1
Construction	41	8
Other	67	30
Total	**1500**	**195**

Table 8 Cemetery period groups

As the entire site was not excavated in the same manner it was not surprising that many more groups were identified in those areas where deep excavation down to the natural soil was carried out (Table 9).

Type	1m zone	Targeted excavation	Deep excavation
Inhumation	167	41	899
Cremation	31	0	50
Charnel	8	8	188
Construction	18	6	17
Other	46	3	18

Table 9 Location of recorded groups

Inhumation burials

The inhumations are the burials of *in situ* individuals. They normally consist of the grave cut, a coffin, a skeleton and a deposit back-filling the grave. However, in some cases there was no skeleton present or where the inhumation was identified but not excavated, the skeleton was not observed as the coffin was left unopened. In addition, some had no coffins due to preservation being too poor for it to be recorded. In a small number of cases there was more than one skeleton in a single inhumation. Where the back-fill of the grave contained enough human bone to be identified as a charnel deposit the fill was included in a separate charnel group rather than the inhumation group.

Contexts - skeletons

By far the most skeletons came from the area of deep excavation, where 805 were recorded. In the small targeted excavation area 44 skeletons were recorded and in the 1m zone 27 were recorded. Not all of the skeletons in these areas were excavated, in total 854 skeletons were excavated from in situ contexts.

Skeletons were graded by the archaeologist on its state of preservation at the time of excavation as good, medium or poor. 235 were in a state of good preservation (27.6%). 331 were in a state of medium preservation (38.8%) and 288 were in a poor state of preservation (33.7%) (Fig 12). It should be noted, however, that the preservation of the skeletons was also separately recorded as a part of the osteology recording.

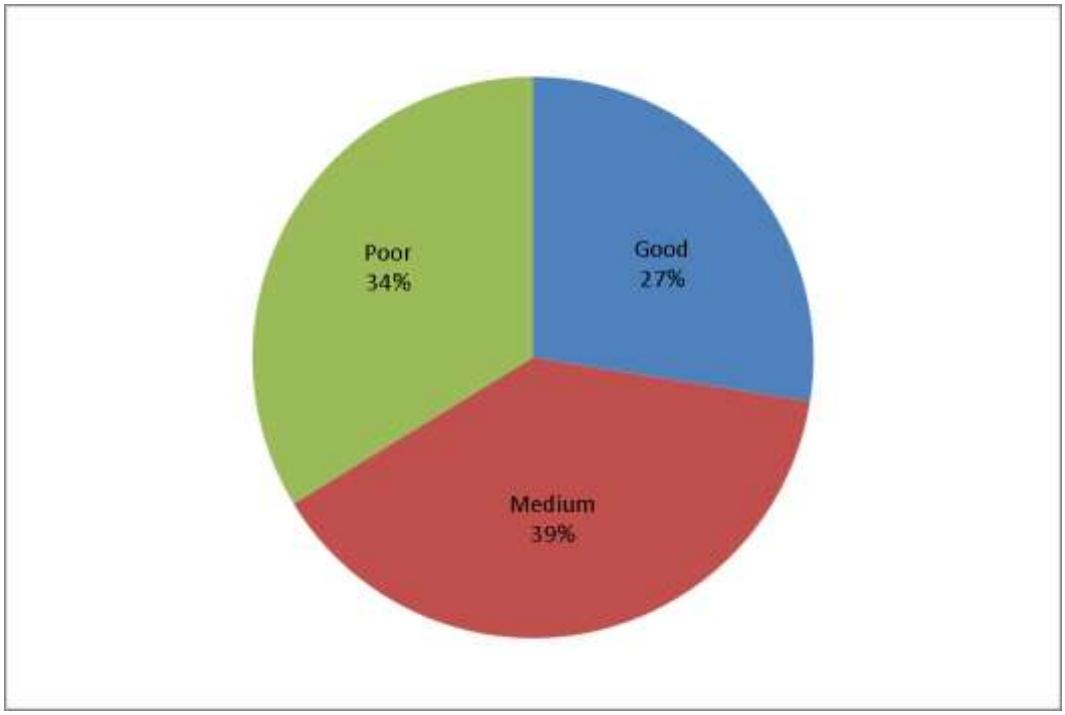


Fig 12 Degree of preservation of skeletons according to recording by archaeologists (Skeletternes bevaringsgrad ud fra den arkæologiske registrering)

In many of the skeletons a number of bones were missing. As well as being the result of poor preservation this was also often due to disturbance by other graves or activity in the cemetery. Each part of the skeleton was marked on the completeness by the excavating archaeologist (Fig 13). The skull was the most likely part of the skeleton to be found complete but, also to be not present at all. Overall the arms and legs were to most likely parts to be found whether complete or incomplete. It should be noted that the completeness of the skeletons was also separately recorded as a part of the osteology recording.

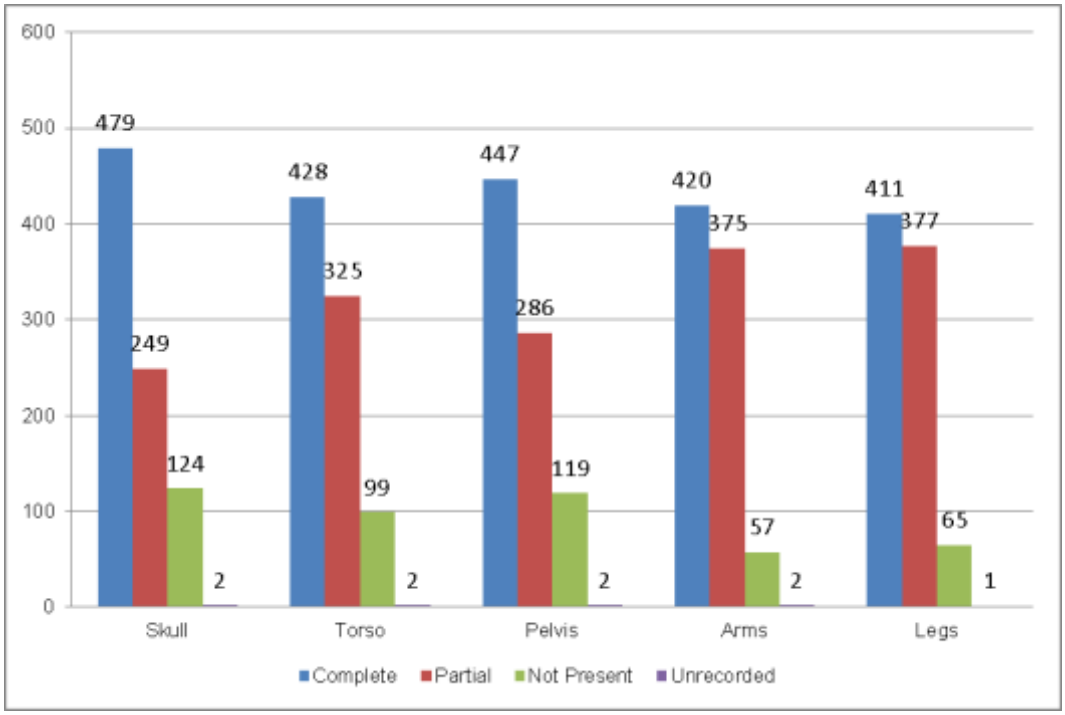


Fig 13 Completeness of skeletons according to recording by archaeologists (Omfanget af skeletternes bevaringud fra den arkæologiske registrering)

The skeletons were aligned in a north-west south-east orientation with the heads at the north-east end except for those in the plots between the gravediggers' house and the northern entrance to the cemetery that were aligned in a north-south orientation, with their heads at the north end. They were laid in the coffins in a supine position with their legs stretched out and their arms generally by their sides, though some had their arms crossed on the chest or their hands together on the waist. There were only a few exceptions to this trend. One individual had been buried face down in the coffin (SB22861) and three individuals (SB7143, SB16841, SB57594) were lying with their heads at the south or south-east end of the grave. There were four others lying at right angles to the other skeletons (SB7639, SB16809, SB56570, SB201336). There were two graves that were at right angles to surrounding graves but contained no skeleton (G994, G1576).

On many skeletons there were pieces of fabric and buttons that were interpreted as a sign that the individuals had been clothed when buried. Evidence of clothing was found on 147 skeletons (17%).

Specific individuals could often be identified by comparing the cemetery protocols with inscriptions on jewellery or nameplates. In other cases skeletons were identified by comparing the osteological and stratigraphical data with the protocols. Of the 854 skeletons recorded, it has so far been possible to assign a possible identity to 283 of them (33%).

Contexts - coffins

The vast majority of coffins were recorded in the deep excavation area. However, the lids of many were identified and recorded in the 1m zone but not excavated as they

were too deep. In the targeted excavation area the excavation of the coffins depended on their position in relation to intended piling work by the contractor. There were 871 coffins in the deep excavation area, 38 in the targeted excavation area and 51 in the 1m zone.

Of the 960 coffins recorded 70 were empty, containing no skeleton. Many of these coffins were empty due to extensive truncation by later cuts that removed the entire skeleton but left behind a small amount of the coffin.

The coffins were also graded on their state of preservation using the same scale as the skeletons; good, medium and poor. 78 were in a good state of preservation (8.1%); 255 were in a state of medium preservation (26.6%); 616 were in a poor state of preservation (64.1%) and 11 (1.1%) did not have their state of preservation recorded (Fig 14).

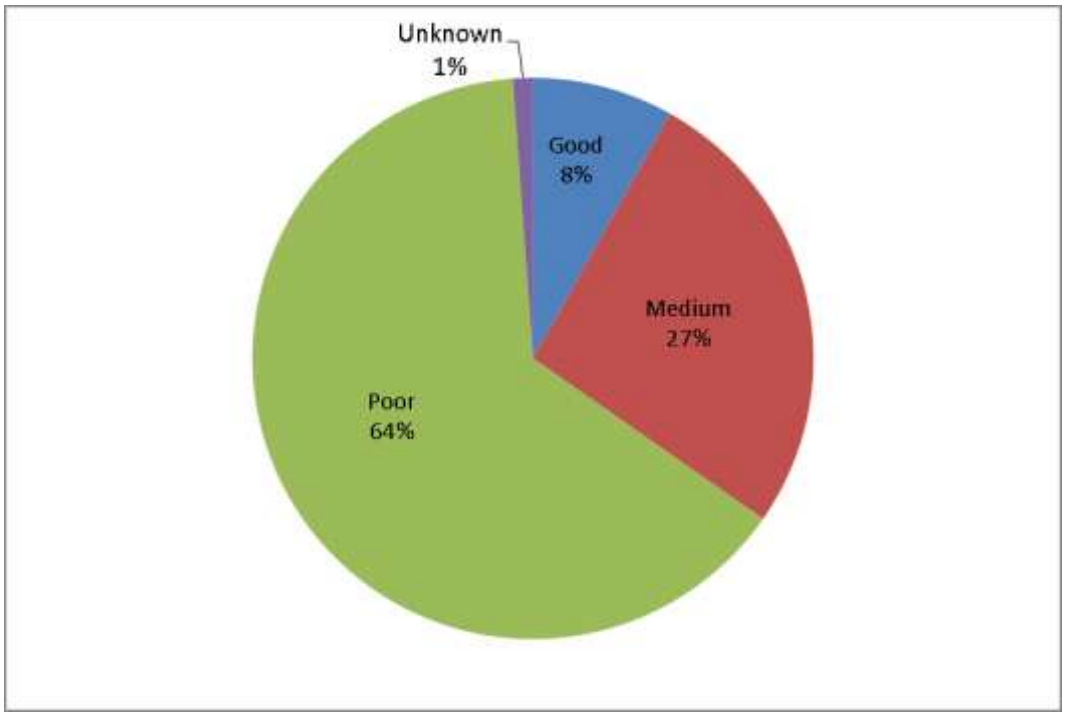


Fig 14 Degree of preservation of the coffins in percentages (Kisternes bevaringsltilstand angivet i procent)

In many of the coffins a number of parts were missing. As well as being the result of poor preservation this was also often due to disturbance by other graves or activity in the cemetery. Each part of the coffin was marked on its completeness by the excavating archaeologist (Fig 15). The lid was the most likely part of the coffin to be missing while the base was the most likely part to be complete (or present in any state).

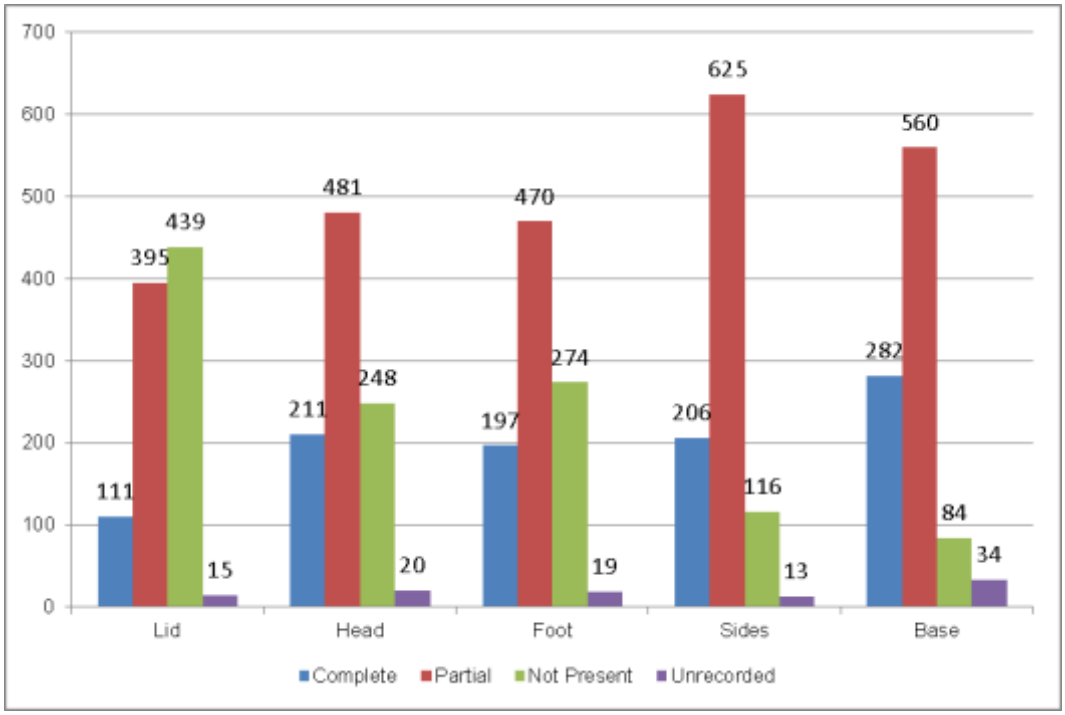


Fig 15 Completeness of coffins (Kisternes bevaringsgrad)

Where the state of preservation allowed, the archaeologists recorded aspects of the shape and design of each coffin. This included the shape in plan, the style of lid and other notable decorative and construction features.

The vast majority were rectangular in shape (835), though there were some that were tapered (21) and three where the shape was unclear and so were recorded as “other”.

The coffin lids fell into two general types. There were flat lids and raised lids. Raised describes a lid with a chamfered or bevelled roof-like structure. In most cases the lids had collapsed down into the coffin but the style could often still be observed. Where the lid was intact enough to record, 146 lids were flat and 163 were raised.

All the coffins identified were constructed using wood but a significant number also contained a metal element (not including nails or coffin fittings) (Fig 16). These metal coffins were either made with a thin sheet of zinc or lead sandwiched between two boards of wood or with a separate lead coffin placed within an outer wooden coffin. In total there were 40 coffins constructed with metal (4.2%).

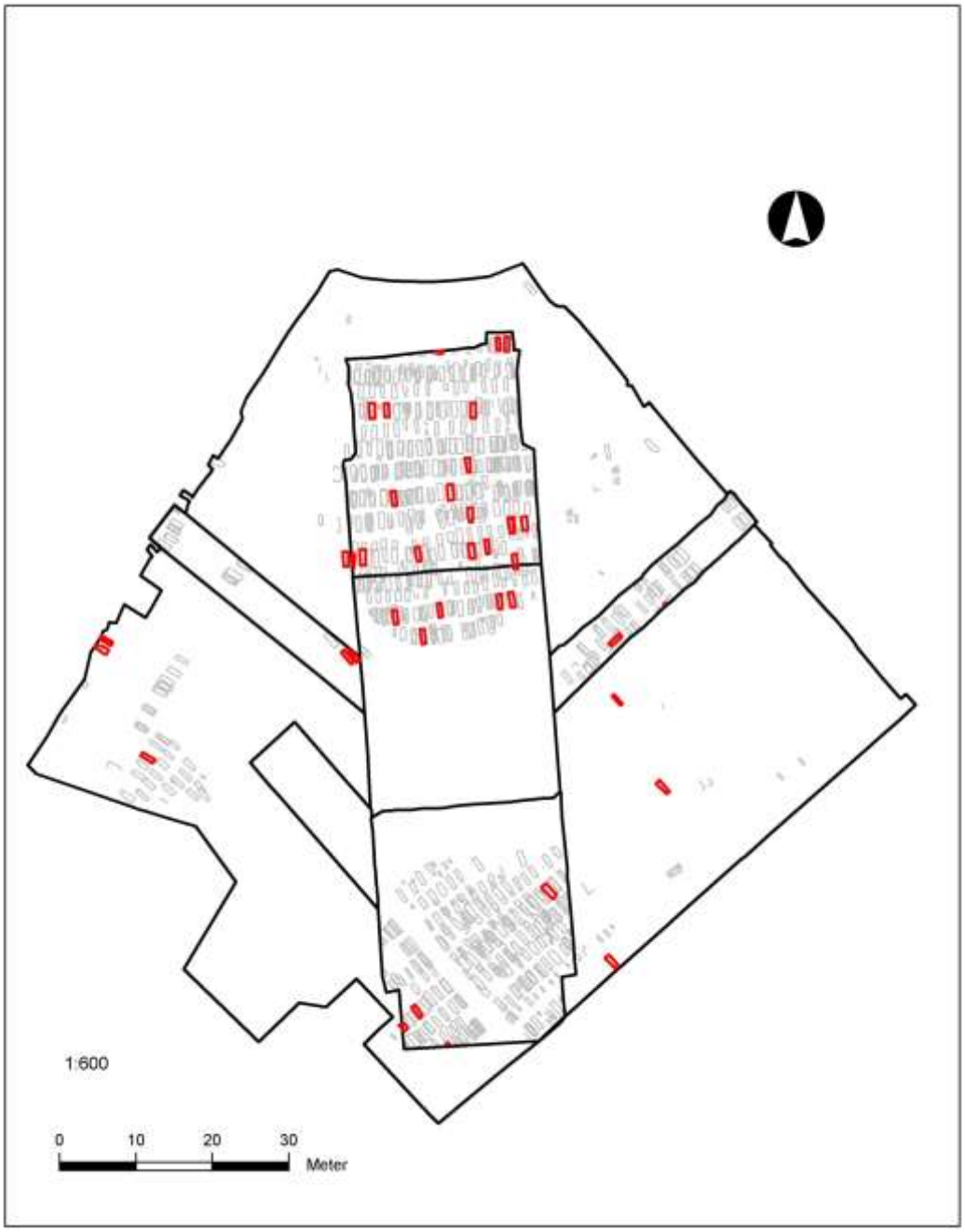


Fig 16 Location of metal coffins (Metalkisternes placeringer)

Exterior coffin details

A total of 302 coffins had external features recorded, many having more than one (Table 10). The most common of these features was a coat of white paint. The recording of such features is dependent on the state of preservation of the coffin and as such the collected data can only be seen as a sample of what was originally present, a crude prevalence rate.

Feature	Frequency
Cross	38
Feet	32
Handle	55
Iron ornament	1
Moulding	50
Name plate	4
Painted	140
Plants/Flowers	49
Plaster work	43
Sash	6
Textile	2
Wire ribbon	18
Other	36

Table 10 External coffin features

The crosses were attached to the coffin lids, generally in the centre towards the head end. They were made of wood and about 10-20mm high. Often where the cross itself had not survived an impression or area of unpainted lid revealed its presence.

In all cases the feet were made of wood. There were two main styles that were (Fig 17); a carved wooden foot, with one in each corner and one on each side of the centre, and a double foot design, where there were three sets of feet present across the width of the coffin base.

Fig 17 Two common styles of coffin feet (SK55870 & SK59516) (To almindeligt forekommende typer kistefødder (SK55870 & SK59516))

In most cases the handles were made of rope with a leather covering. However, there were many iron handles, often with decorative patterns. One coffin had plastic covered handles. The single iron ornament may have been part of a coffin handle.

The moulding design on the coffins most commonly took the form of two or three outlined rectangles on each side and one at each end separated by a vertical column (Fig 18). However, in some cases other decorative features were made with this method. On one coffin this moulding decoration was made of plastic (SK57529).

All the surviving nameplates were made of lead and had been attached to the coffin lids (see finds results).

Where the outside of the coffin was painted it was almost always white except for a small number where the colour is described as a yellow or light brown. The non-white paint is highly likely to be stained/degraded paint that was originally white. Three coffins are described as having black exterior paintwork.

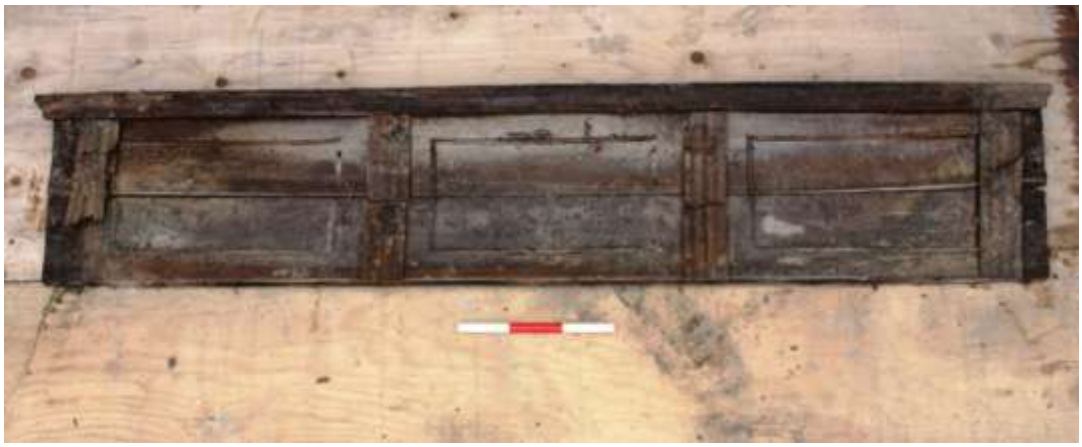


Fig 18 Example of common moulding design on a coffin exterior (SK59740) (Eksempel på hyppigt forekommende kistepynteliste (SK59740))

Plant remains generally fitted into three categories: remains of flowers, often as bouquets, found on the coffin lid, palm leaves placed on the coffin lid or pine branches lining the base of the grave cut, under the coffin.

The plaster work decoration was poorly preserved but where its original design could be seen there were two general types (Fig 19); a cherub and a floral design (often in the form of a wreath).

Fig 19 Examples of plaster work coffin decoration (SK13200) (Eksempel på kistepynt af gips (SK13200))

Where a sash was found this refers to the long strips of material that was used to lower the coffin into the grave.

On one coffin, textile was found suggesting the coffin had been covered in cloth with ornamentation attached on top of this. The other example of textile on the outside of the coffin was interpreted as either part of a cloth covering or the remains of a toy placed on the lid. In both cases the textile was poorly preserved.

The wire ribbon, in most cases, refers to collections of thin metal threads or wires generally found on the lids of the coffins. They have tended to be interpreted in the field as ways of holding in place floral decorations placed on top of the coffin.

Miscellaneous external features were generally decorative in nature but too poorly preserved to identify with any certainty.

Examples of rituals outside of the coffin were seen in association with 15 inhumations which had small deposits of white or light grey fine sand. In all cases the sand was found on the coffin lid or, where the coffin lid had collapsed and degraded, on top of the skeleton. Eight of the inhumations were of females, five were of males, one an unspecified adult and the other from the inhumation of an infant.

Interior coffin details

A total of 204 coffins had internal features recorded at the time of excavation (Table 11). Features like these are dependant on preservation rate, and the data collected in association with is should merely be seen as a sample of what could be present. It appears that the packing, textile and upholstery studs have been vastly under recorded.

Feature	Frequency
Charcoal	7
Coal	1
Coin	1
Corks	2
Handles	2
Packing	39
Pillow	22
Plants/Flowers	19
Plaster	1
Tar	14
Textile	9
Upholstery studs	18
Other	18

Table 11 Frequency of internal coffin features

The charcoal was found as an area of crushed or powdered charcoal, always inside the base of the coffin and either covered a patch of the base or all of it.

The coal and coin both came from the same coffin (SK10828). They were found under a pillow with four bottle corks. The coin itself was smooth and may have been a token rather than an actual coin.

The handles came from coffins with unsecured interior structural elements.

Pillows were identified by either preserved parts of the filling, such as feathers, or the outer fabric.

Packing was observed in many coffins but under recorded, perhaps due to its ubiquity. It generally consisted of wood shavings (the type produced by a lathe) or sometimes hay

and was found in the bottom of the coffin underneath and sometimes surrounding the skeleton.

Flowers were often found as bouquets placed on the body.

Where tar was found in a coffin a thin layer of it covered the internal base.

The upholstery studs were sometimes found loose but were often still pinned into the coffin wood (Fig 20). When still attached to the wood they were always found on the internal side.

Fig 20 Ceramic upholstery studs (SK52251) (Keramiske polstringsstifter (SK52251))

Miscellaneous internal features were often remains of paint from the inside of the coffin. Others included objects placed inside the coffin that were recorded as finds (see finds results) or were too poorly preserved to identify with any certainty.

Contexts - cuts

There were 1075 recorded cuts associated with inhumations. The average size of untruncated adult grave cuts was 2.16 x 0.85m. The maximum length was 2.60m and the maximum width was 1.55m. As the upper part of the grave cuts were generally excavated by machine as the site was stripped it was not possible to record accurate complete depth measurements for each cut. For the untruncated graves of infants the average size was 0.90 x 0.42m.The maximum length was 1.71m and the maximum width was 0.50m. For untruncated graves of subadults the average size was 1.27 x 0.55m, though this group covers a much broader range of individual's ages and corresponding heights. The maximum length was 1.95m and the maximum width was 0.84m.

Many graves had been truncated by later cuts and disturbances. There were 493 (46%) that had been truncated by later inhumations.

Contexts - deposits

The grave fills resembled the cemetery soil (G4) very closely. They consisted of brown sandy-clay with occasional inclusions of pebbles. There were often additional occasional inclusions of residual pottery sherds, ceramic building material, charcoal and bone (both human and animal). In areas of the cemetery that had seen less intensive activity and, therefore had less disturbed graves the fills tended to resemble more closely the natural soil (G2).

Groups - inhumations

Of the 1107 inhumation burials identified it was possible to approximately date 321, of which 201 were dated to the 19th century (63%) and 120 to the 20th century (37%). However smaller numbers of burials could be dated to within 50 years (Table 12). 786 inhumations have not so far been dated. The dates were arrived at by comparing the stratigraphic relationships and dates from the finds with the cemetery records for those individuals who could be potentially identified.

Date	No.	Date	No.
1800-1849	30	1900-1949	90
1850-1899	84	1950+	11
*Total from 1800s	114	*Total from 1900s	101

Table 12 Dates for inhumations identified to within 50 years

The vertical position of the inhumations in the grave plot was recorded. These were split into single depth, double depth, third level, fourth level and fifth level or more (Table 13). These definitions were derived from the terms used in the cemetery protocols where burials should have been placed at either single or double depth. Where inhumations were located in an area only to be excavated down to 1m below the surface they were recorded as being in the top 1m. It should be noted that these positions do not necessarily relate to their stratigraphic positions.

Depth	No. inhumations
Top 1m	31
Single depth	582
Double depth	309
3rd level	35
4th level	4
5th level +	1
Unknown	145

Table 13 Burial depth of inhumations

Cremation burials

Cremation burials are the burials of cremated human remains, usually reduced to ashes. They normally consist of a grave cut, an urn containing the cremated remains (the remains themselves were not recorded separately) and a deposit back-filling the grave. In some cases an urn has not been recorded as the burial was too deep to be excavated

and the urn was not seen, while in others more than one urn was identified as being in the same cut and, therefore, assigned to a single group. Due to the shallow nature of most of the cremation burials many were identified while the topsoil was being machined. In some cases this led to too much of the cut or fill being disturbed for them to be recorded.

Contexts - urns

There were 80 urns found during excavation, many were found in areas that were not fully excavated and all were found within family grave plots. One cremation burial contained no urn. Similar to the skeletons and the coffins, the urns were graded on the level of their preservation. There were 11 (13.75%) in a good state of preservation, 30 (37.5%) in a medium state and 38 (47.5%) in a poor state. One urn was not graded.

The urns were made of ceramic (3), wood (10) or metal (65), in two cases the material was unknown (Fig 21). The majority, 72 in total, were round in shape with six of a square shape. Two were of unknown shape. None of the six square urns were made of metal, four were made of wood, one was ceramic and one was of unknown material.

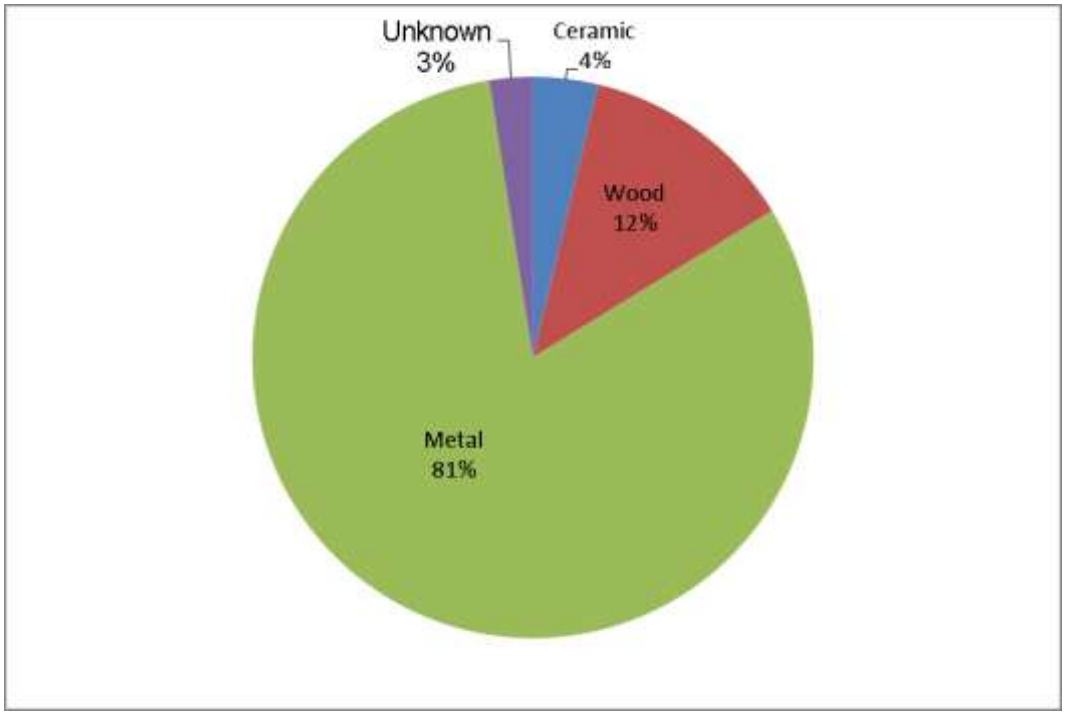


Fig 21 Materials used for cremation urns in percentages (Frekvensen af de forskellige urnematerialer angivet i procent)

Two cremation burials contained two urns (G1134 and G193) while three unexcavated burials had no urns recorded.

26 of the urns had cremation identity tags observed with them (32%).

Contexts - cuts

Only 63 grave cuts were recorded for the cremation burials. The grave cuts were either roughly square or circular. Of the 63 cuts, 28 (44%) were circular and 35 (56%) were square. They had an average size of 0.3 x 0.3m.

Contexts - deposits

65 of the cremations had deposits recorded with them. The deposits were in general brown sandy-clay and consisted of redeposited cemetery soil/top soil. Five of the deposits had frequent inclusions of small pebbles that did not resemble the surrounding cemetery soil (two had moderate inclusions of small pebbles).

Groups - cremation

Of the 81 cremation burials it was possible to date 62 (Table 14). No cremations were dated to earlier than 1900. Almost twice as many date to the first half of the 20th century as the second. The dates were identified by comparing the stratigraphic relationships and dates from the finds with the cemetery records for those individuals who could be identified.

Date	No. cremations
1900-1949	41
1950+	21
Total	**62**

Table 14 Dates for cremation burials

There appeared to be no area on site where cremation burials were common or where they were unusually absent (Fig 22). Only one excavated cremation burial (G379) and the three unexcavated cremation burials were recorded as being below 1m beneath the surface.

Charnel

Charnel groups generally consist of a single deposit but there are several cases where there is also a cut.

Of the 204 charnel deposits identified, the bones from 66 (32%) are interpreted as being clearly deliberately placed with some care, while 137 (67%) are interpreted as having been randomly deposited.

Of 57 charnel deposits that could be dated most (39) came from the 20th century, with 18 from the 19th century. Where the deposits were more accurately dated there was a noticeable increase in the frequency of charnel deposits over time (Fig 23).

The vertical position in the grave plot of the charnel deposits was recorded. These were split into single depth, double depth, and third level (Table 15). Where charnel deposits were located in an area only to be excavated down to 1m below the surface they were recorded as being in the top 1m. It should be noted that these positions do not necessarily relate to their stratigraphic positions.

It was possible to potentially identify the cremated remains of a total of 53 individuals (65%).

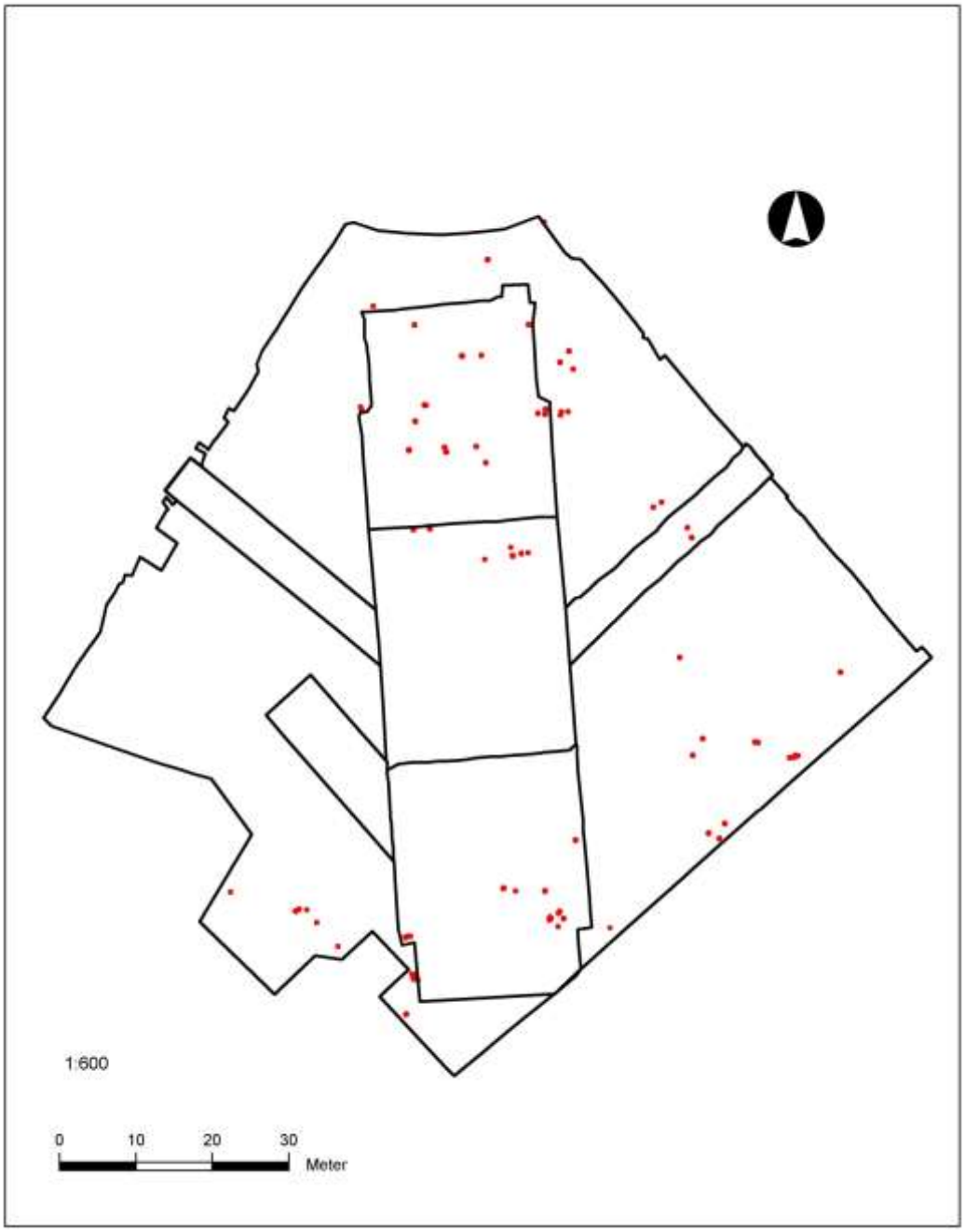


Fig 22 Location of cremation burials (Urnegravenes placering)

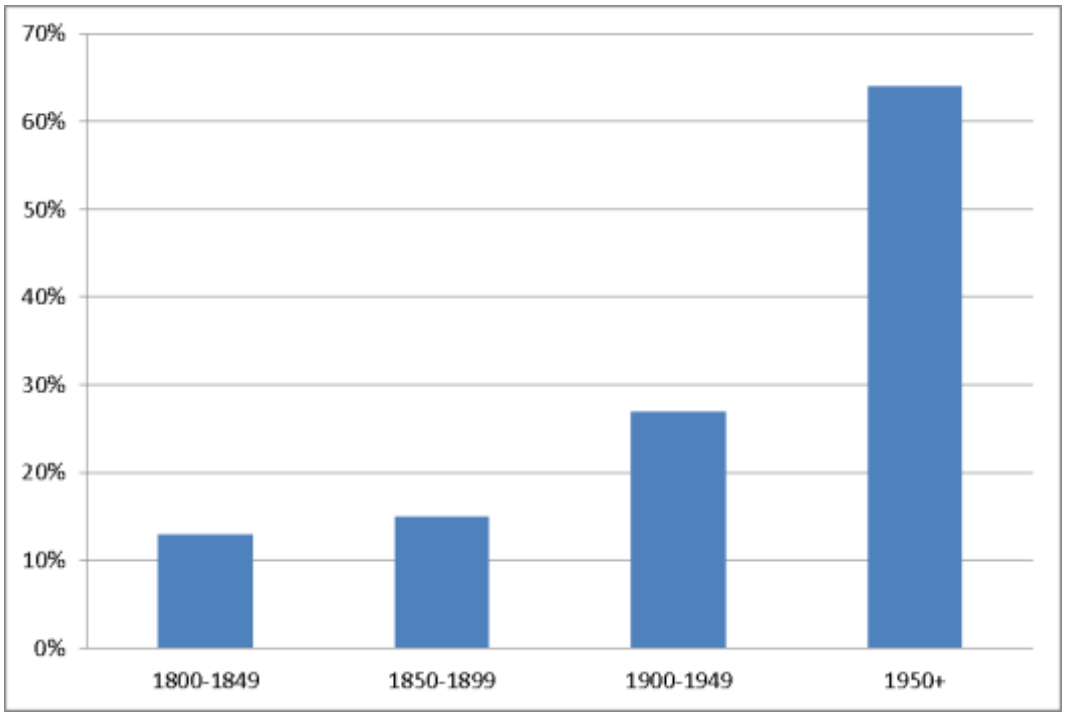


Fig 23 Charnel groups, in percentages, divided by date (Knoglekulerne inddelt i procent efter datering)

Depth	No. charnel
Top 1m	7
Single depth	97
Double depth	75
3rd level	6
Unknown	19

Table 15 Depth of charnel deposits

Fourteen charnel groups contained cuts. Five of these were in fact inhumation grave cuts where a charnel deposit was placed in the grave before a coffin, therefore not related to charnel activity. Nine were separate cuts made just for a charnel deposit although the interpretation of seven of these is uncertain because they were possibly related to existing inhumations or grave plots. The two remaining grave cuts had spaces made in them specifically for the charnel remains, either a deeper section in the base of the cut or an area dug out of an earlier grave at the head end.

Constructions

Construction groups are made up of structures and their associated construction activities. These generally include a cut, a physical structure, such as a brick wall, and a deposit back-filling the original cut. The group may contain more than one structure where those structures were intended fulfil parts of one overall objective, such as two sections of wall surrounding a single grave plot.

Contexts - structures

Within the 41 constructions there were 53 separately recorded structures. 28 of these were walls; six were foundations, one a vault and 18 were classed as “other”. All the walls, except two, and the vault were constructed of brick (Table 16).

Material	No. structures
Brick	31
Stone	10
Wood	2
Unrecorded	10

Table 16 Material of individual structures

All the brick structures were made using yellow bricks, although five contained occasional red bricks. All the bricks were approximately 220 x 110 x 40mm in size.

Two structures, forming one grave plot wall (G140), were made of limestone. The rest of the stone structures consisted of worked sandstone and reused gravestones.

Groups - construction

Of the 41 construction groups identified, two had their form recorded as vaults, 22 as parts of grave plot walls, one a gravestone and 16 classed as “other”.

The grave plot walls and vaults tended to be located close to the cemetery walls in plots parallel to the bordering streets, Jagtvej and Nørrebrogade, though this was a trend rather than a rule (Fig 24).

Only 14 construction groups could be dated, 11 from 1800-1849 and 3 from 1900-1949. Both the two vaults were dated to the period 1800-1849.

Vaults

The two vaults were located on the north-west side of the site in the same row of plots parallel to the cemetery wall along Jagtvej.

The more southerly of the two (G47) was square in shape, the sides being 3.2m long, with two sprung arches stretching over the entire span but with a central opening, presumably the entrance. The structure itself was 2m deep and there is no evidence that it was visible above ground. There was an elaborate herringbone brick floor and iron loop attachments, possibly for holding shelves, were fixed into the walls. There is some evidence of a brick platform in the west corner which could have been the footing for a monument. It had been filled by three disuse deposits (G1593).

The vault to the north (G186) consisted of a low wall around the entire boundary of the plot, 6.3 x 3.2m in size and between three and four courses high with a deep vault, to a depth of nearly 2m, in the centre.

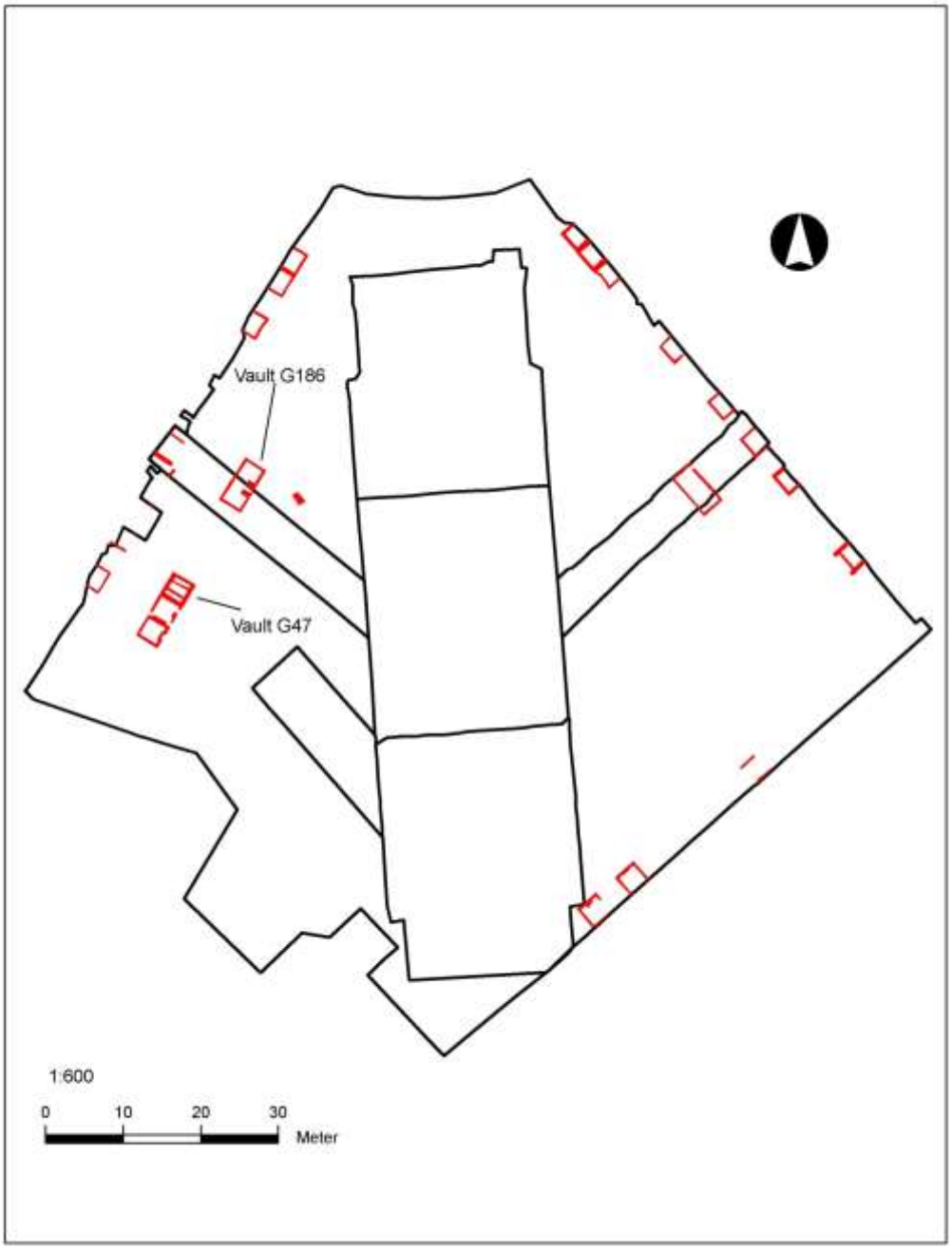


Fig 24 Location of grave plot walls and vaults (Gravhvælvingernes og gravvæggenes placering)

The vault consisted of two piers, jutting into the plot, with an arch connecting the two. The piers had a rubble and brick foundation layer followed by even coursed English bond brick. Each pier was 33 courses deep, 1.1m long and 0.66m wide, the springer course was still present and remains showed a high narrow arch. The arch did not reach over to the other side of the vault structure but ran alongside the south-east wall. Opposite the vaulting on the north-west wall was a deeper section of wall about 2m deep.

Grave plot monuments and walls

There were 22 grave walls, all surrounded plots, or parts of plots. There were no brick or stone lined grave cuts.

Ten groups were related to the foundations of gravestones or monuments.

Only one grave plot, plot 611, was able to be recorded prior to it being excavated along with a number of gravestones lying within it (G1427).

Gravediggers' house and surrounding constructions

The position of the gravediggers' house was surveyed but it was not recorded beyond this. Located just to the south of the gravediggers' house and dated to 1800-1849 was a chimney, classed as a construction group "other". It was a hollow rectangular brick structure with 15 courses surviving, laid on a wooden plank and mortar bed. The inside was covered in soot and had been filled by a disuse deposit (G137).

Two small structures had been constructed using reused gravestones but they appeared to be unrelated to any plot or individual grave and are instead connected to general cemetery work activities.

Other groups

There were 66 groups classed as "other". Included within these are the natural soil (G2), the soil below unexcavated contexts (G3), the cemetery soil (G4), the topsoil (G5), modern disturbance (G6) and the shoring (G7). Amongst the remaining groups, 28 were grave plots; 15 were pits; four were tree holes; four were deposits; three were postholes; two were wells and one was a drainage ditch.

There were 17 groups that could be dated, 12 of which were from 1950+, one from 1900-1949, two from 1850-1899 and two from 1800-1849.

Grave plots

In areas where excavation only went down to 1m below the surface, patches of dark disturbed soil which appeared to reflect the pattern of the cemetery plot layout were recorded as grave plots. The 28 grave plots recorded show the position of the other known grave plots on the site. They demonstrate the extent of the many unexcavated graves within the site area.

Miscellaneous cemetery management

All the remaining groups were related to non-grave related cemetery management. The pits included a number of refuse pits containing domestic waste. A drainage ditch, aligned in a south-east to north-west direction from the south end to the east side of the site, and a connecting well were part of the water management relating the landscaping of the cemetery. The tree holes are also are examples of landscaping of the cemetery.

Less than 2m to the south of the gravediggers' house was a brick lined well (G136) dated to 1800-1849. It had ivy leaves around the inside of the bricks suggesting it was open for some time before backfilling. When no longer in use the well was backfilled in one episode, no finds were recovered from this phase of the well.

Finds

Prehistoric finds

In general the scattered prehistoric finds can be characterized as common settlement finds. The largest category is the ceramic sherds (Fig 25). None of the sherds were decorated and they were generally of a coarse and uncharacteristic nature. Only a few distinctive rim sherds were found. The size of the sherds varies from very small, crumbling, fragments to large (up to 150mm in diameter) thick body sherds probably belonging to storage vessels. A small range of uncharacteristic lithics have also been found. These mainly consist of flint debris; but also a single tool, a scraper, was found. A few pieces of daub and a few pieces of well-fired clay were also found. Animal bones found in the prehistoric pits were very fragmented and burnt, but it was however determined as belonging to at least two different species: sheep/goat and cattle. Since prehistoric finds from the Municipality of Copenhagen are rare, all of them were kept and incorporated in the Museum Collection. Thereby it is possible to use the find material in future research on the prehistory of the Copenhagen Area.

The prehistoric finds are roughly summarized in the following tables:

Type	No.
Ceramic sherds	136
Lithics	36
Pieces of daub	24
Pieces of hard burnt clay	6
Pieces of animal bone	51
Unidentified bone	2
Total	**255**

Table 17 Number of prehistoric finds divided into types

Type	No.
Stratified finds	244
Residual finds	11
Total	**255**

Table 18 Number of stratified finds compared with residual finds

Only very few of the finds are distinctive for a certain period. The lithics are so indistinctive that none of them with certainty can be dated to a specific period, not even to the Stone Age, as they might as well belong to later periods. However, the time span of the prehistoric settlement can be narrowed down by the characteristics of some of the ceramic sherds: All of the datable sherds belong to the Bronze Age or the Iron Age. The most narrowly datable sherd belongs to the Pre-Roman Iron Age (500-0 BC), while several other sherds belong to the wider period of the Late Bronze Age/Early Iron Age (1100-0 BC).

Fig 25 The prehistoric ceramic sherds are generally coarse and can be characterised as settlement ceramics (Den forhistoriske keramik er generelt grov og kan karakteriseres som bopladskeramik)

Cemetery finds

This chapter describes finds from the cemetery period of the site and will start by presenting the complete assemblage through the subclasses presented in IntraSIS before describing the principles of classifying the assemblage. Each major subclass will

be presented and some overall features discussed, special finds are individually highlighted. Textile results and later interpretations used within Chapter 8 are from Rimstad (2011). Human bone is described separately at the end of the chapter.

Subclass	No. of Reg.	Total	Weight (g)	Comments
Buttons	189	382	311.85	Individually weighed
Ceramic	153	530	12546.8	
Tobacco pipe	25	75	153	
Coin	14	15	73	
Glass	30	116	6136	
Gravestones	43	73	0	None weighed
Jewellery	118	136	512.6	
Leather	9	14	479	
Metal	80	144	22080.6	
Textile	133	154	1332.3	Few weighed
Other (Miscellaneous)	82	326	51983.5	Individually weighed
Total	**884**	**1980**	**95622.15**	

Table 19 Registered finds material (except human bone and prehistoric) divided by subclass

There were a total of 1980 finds registered that are identified from the period relating to the activities of the cemetery from 1806-2010 (Table 19). Each registration often describes more than one find with, for example, ten buttons from a single registration. The majority of the finds are within the subclass ceramics however finds within the miscellaneous and metal subclasses weighed more. Gravestones were not weighed at all due to being too heavy and would have resulted in having the highest subclass weight. Ceramics contain an average of 3.46 pieces in each registration although this is surpassed by the subclass glass with 3.87 and the subclass miscellaneous which contains an average of 3.98 pieces in each registration. However this is misleading as there were several contexts that contained a very high amount of finds, such as unstratified finds from the topsoil and particular rubbish pits.

Assessing results by these categories has not proved meaningful due to the combination of finds subclasses which mix general type of material (such as ceramic or glass) with more interpretative subclasses (such as jewellery or buttons). This has resulted in a more interpretative division to analyse the finds, by using the four new divisions: *Funeral Find, Personal Find, Residual, cemetery related* and *Residual or non-cemetery* this allows a more structured and meaningful way of presenting the finds (Table 20). This allowed interpretation of finds which were located *in situ* and deposited with direct intention for the person and traditions relating to the coffin and contrast them with finds that are residual. There are high numbers of residual finds that are not directly cemetery related, these results are skewed by the large amount of ceramics (497) because different types of ceramics often result in more registrations. The discussion of results follows these classifications.

Classification	No. registrations	Total	Weight (g)	Description
Funeral finds	153	245	24670.9	Finds generally related to a coffin which are more symbolic of general funeral traditions and rituals which are not necessarily directed to, or for the specific person. Often mass produced items for the funeral trade
Personal finds	444	708	3329.25	Finds generally related to the skeletons which are generally more symbolic of specific, or more personalised traditions and rituals, directed towards the specific person. Often unique items that people owned during their lifetime
Residual, cemetery related	83	215	41871.5	Finds related to unstratified deposits or constructions that have a clear cemetery related function or meaning
Residual or non-cemetery	204	812	25750.5	Finds related to unstratified deposits, they could represent cemetery related activity but are not necessarily connected. Also stratified contexts that are uncertainly related to cemetery activity
Total	**884**	**1980**	**95622.15**	

Table 20 All finds separated into classifications of Funeral Finds, Personal Finds, Residual, cemetery related and Residual or non-cemetery

Funeral finds - traditions relating to the coffins or urn

There were a total of 245 finds that could be classified as Funeral Finds, relating directly to the coffin or urn. The majority of these were made of metal and textiles. These are divided into different types of finds (Table 21).

Type of find	Total	Weight (g)
Handles and sashes	49	4616
Exterior decoration	79	12179.5
Interior decoration	49	344
Cremation tags	25	775.8
Flowers and organic finds	37	2101.6
Other finds	6	4654
Total	**245**	**24670.9**

Table 21 Funeral Finds divided into type of find

Handle type	Material	Total
Handles	Leather	12
Handles	Textile	22
Handles (2 lead, 5 iron)	Metal	7
Handles	Rope	3
Handles	Wood	1
Handles	Plastic	1
Sash	Textile	3
Total		**49**

Table 22 Summary of types of coffin handle

Handles and sashes

Coffin handles were predominantly recorded as part of the coffin rather than as finds, so they appear under recorded. However some examples were registered as finds to record detail on some of the more common features. There were usually six or eight handles on each coffin. Of the 49 registered handles (Table 22) most were textile, these were produced in a standardised way, consisting of a braided cord or rope in the middle, wrapped in textile and nailed to the coffin with an iron nail in each end (Fig 26). Most of the handles are tabby woven but fragments of twill were also found. The coffin handles can be different within the same coffin, which shows that consistency of coffin design and decoration were not always kept.

Fig 26 Example of suede coffin handle, originally contained rope inside to strengthen it (F202596). (Kistegreb. Grebets kerne består af tovværk der sikrede dets bæreevne, mens det yderste pyntelag er af fløjl (F202596))

Leather, or generally suede handles were found with rope inside them. Of the registered metal handles, some with decorative zinc finials, the more elaborate examples were registered and x-rayed. One example of a white plastic handle with a rope interior was registered. One thinner wooden hollow handle was also found although this may have been more decorative than practical as it appeared too delicate to bear the weight of the coffin. Inside the coffins were often separate wooden body boards – upon which the body could be placed to help move it during an open viewing or after preparation. These boards had rough rope handles attached into the wood.

Examples of what may have been coffin sashes were also found, these are long pieces of textile used to help lower the coffin into the ground. These were often found in place underneath or by the coffin side. Usually they are pulled out by the gravediggers but their presence suggests that some coffins were heavy and trapped the sash.

Exterior features –functional and decorative

Type	Material	Total
Coffin furniture	Metal	29
Nails	Metal	5
Nameplates and decorations	Metal	9
Token	Metal	1
Coffin furniture	Wood, plaster	29
Coffin covers	Textile	6
Total		**79**

Table 23 Summary of Funeral Finds as exterior features

Coffin furniture

This section excludes the handles and sashes found. The finds are dominated by the ornamentation of the coffins, both in metal fixtures that form both practical and decorative elements such as nails and hinges but also nameplates (Table 23). The metal decoration consists mainly of coffin studs (17 items), more were excavated but not registered as finds but few were found in any surviving identifiable decorative patterning. Other metal furniture is represented by coffin fittings which is a general term describing hinges and nails, one is a lead cross made to be viewed from all angles which screwed into the coffin lid. It had decorated finials and the figure of Jesus on the cross on both sides (F202054). Three identical decorative coffin fittings were spade shaped with raised flower decorations which allows for the screw piece to fit onto the coffin. They would have been screwed into place and then bent to lay flat on the coffin (F200695). There were also other decorative nails and a single token which are identified as coffin fittings.

One particularly elaborate set of decorations came from a metal coffin (SK14142) containing six separate coffin motifs laid out on a fringed textile coffin cover (Fig 27). The nameplate has details of the person, his name, year and place of birth and year and place of death (he died in 1844). There was also a crown over an hourglass and scythe with a long thin spear or bone. A figure of an angel designed to lean on the nameplate holds an open book. The writing on the book is damaged but suggests reference to a Bible chapter, possibly Matthew. There was also a small flaming double spouted lamp and a tree trunk representing an eternal flame and the tree of life. A decorated thin plate with four rosettes shows other decoration was present on the coffin.

Fig 27 Decorative coffin motifs and nameplate from the coffin SK14142 (Kistepynt og navneplade fra kisten SK14142)

Four other nameplates were registered; all of the same design consisting of a lead scroll with rosette decoration. Although some italic script was visible on all of them only one was readable (F200354) which was of Caroline Haagen/a female who died in 1834. Other registered coffin ornamentation was made of plaster (18), wood (6) and plastic (4). The plaster consisted of flower motifs (calendulas), wreaths and most frequently cherub faces with wings. The wood items consisted of wooden lion feet and panel decorations. The four plastic items derived from one coffin (SK57529) and consisted of white crosses and wreaths with swags of flowers. Not all decorations were able to be registered as finds, particularly the plaster which was seen on many coffins as residues that could not be lifted intact; many wooden items are also not registered as finds but mentioned in the general coffin description. This chapter therefore represents only a small sample of what was observed.

Coffin covers

Only six textile fragments come from coffin covers, these are large cloths draped over the coffin. A large piece of black tabby woven textile (F202062) was found underneath a coffin nameplate on top of the coffin lid and it might have supported the plate. Imprints of wooden flower decorations from the coffin were observed on the back of the textile. Another plain wool coffin cover was also found under a nameplate and other pieces of metal decoration (F202367. Pieces of perhaps felted fibres were also found slid between wooden linings of another coffin (F202761). The function is uncertain but may have cushioned the wood linings. Three different coffins had a fringe-like decoration, one around the coffin feet and another fallen inside the coffin (F201135, F201139). It is possible that these represent larger pieces of cloth or simply have been fringes attached

directly to the coffin. The fringes are made the same way as the skirt of the Danish Bronze Age girl from Egtved (Jensen 1998: 10-20), with twisted cords, woven together at the top. Another piece of corded fringe was found in a deposit which may also derive from a coffin cover (F202177).

Interior features – functional and decorative

Type	Material	Total
Upholstery pins	Metal	4
Coffin linings and lace	Textile	11
Pillows and fillings	Textile	16
Blankets	Textile	4
Corks	Organic	14
Total		**49**

Table 24 Summary of Funeral Finds as interior features

Decoration of the interior of the coffin was dominated by textile finds with 31 finds (Table 24). There were also considerable amounts of ceramic upholstery pins found, of which just four were registered to gain a small sample. All were the same style with a white ceramic head with small metal pins that could be pushed through material of the coffin lining to hold it in place.

Coffin linings

Nine fragments were found that may relate to the lining of the coffin, some with nails in them showing that they are part of a coffin lining (F200367). This fabric was used to keep the filling of plant fibres in place and to cover the wood of the coffin as well as for aesthetic reasons. The linings are mostly tabby woven, sometimes of a rather coarse quality, and there is even an example of the use of corduroy textile (F202275) and brown leather lining (G297). The lining has been held up with iron or copper upholstery pins.

In three coffins, fragments of white nylon lace were found with simple stripe patterns. The lace pieces are generally of the same kind, about 20-30mm wide, the longest fragment measures 2m. The lace seems to have been used in various ways. A length of lace (F202302) comes from a coffin (SK54552), it was found in the head area, and as it has an iron nail still attached to it, it is likely to be some sort of coffin decoration, perhaps a welt (an ornamental seam or border) on the coffin lining. Another example of lace (F202168) was in a coffin (SK59159) where it was found on the underside of the lid, used to decorate the coffin lining. Remains of winding sheets were rarely seen, most likely because they were made of linen which decays quickly. Some small and very fragile fragments (F202335) might be remains of coffin lining or linen winding sheets. They are often just preserved as an imprint in a clayish material, but they reveal a tabby woven structure and a very thin type of fabric. In one coffin (SK10615), two long pieces of lace were lying on the skeleton, beginning at each side of the head. A smaller piece was laid across the arms (F201449). The two long pieces continued underneath a blanket on the lower part of the body, so the laces could not derive from the coffin lid.

Instead, they might have decorated a linen sheet that had been wrapped around the person, before the blanket was put on. A piece of lace had also been tied around the head, in order to keep the jaw closed.

Pillows

Remains of at least 11 pillows were identified and five finds of packing of feathers are also likely to derive from pillows or mattresses. The pillows vary in their designs, but five of them seem to be of the same kind (Fig 28). They all measure about 300 x 200mm and have a base of tabby or twill woven fabric. The front has been decorated with about 2mm wide cords, except for F201117 which has cords on the 200mm wide edge. The cord decoration is made as a rep tabby weave, with a thick warp and a much thinner weft that has not been preserved. It is possible that the cords were coloured in certain patterns, but it wasn't observed. Some of them also have cord decorations at the edge. Another pillow (F200359) has thinner cords and also had two *in situ* buttons at the back, showing how the pillowcases were attached. The buttons were of copper alloy, wrapped in white tabby fabric.

Fig 28 Intact pillow with fringes found with SB20357 (F202156) (Intakt pude med frynser fundet sammen med SB20357 (F202156))

Three pillows have different designs: one pillow (F201144) was made of 65 x 60mm fabric squares that were sewn together, but only a few of these were preserved. The use of squares is also seen on another pillow (F202396), which has fragments of silk squares in at least two different colours. They are now light brown and dark brown, but some red staining was found in the soil, which might come from the pillow. On one of the sides, the pillow has been decorated with 6mm wide cord, braided in various patterns. Another pillow (F200261) was made of finely tabby woven silk and seems to

have been filled with hay or another organic material. One other item used as a pillow was a folded blanket. Two remains of pillow cases were found, one made of silk squares. None of the pillows seem to be bed related, they are more reminiscent of sofa or furniture pillows from the early 20th century and there might have been a custom of using these types of pillows to furnish the coffins.

Blankets

Four blankets or fragments of blankets were found in different graves. One (F201733) was found wrapped around the lower part of the person. No woven textile remained, only the remains of felted fibres. A second blanket (F200524) was found folded, but completely preserved, underneath the head of the person. It was twill woven and measured 1.75 x 1.50m. The blanket had a light brown colour, which might have been originally white with four 28mm long dark brown stripes at each end. The blanket is of a type which could have been used in daily life, perhaps in a living room and it has most likely been used before being placed in the grave. A small twill woven fragment in light brown wool (F201145) might also be from a blanket, but as the find spot is unknown, this interpretation is uncertain. Two other potential blankets were highly fragmented.

Corks

An unusual find within the coffin were bottle corks; in six inhumations 14 corks were found, all straight corks with no markings on them, they were often discovered within the packing under the head or body. The function is unknown.

Cremation tags

There were 24 ceramic cremation tags and one cardboard tag (plus one residual tag, see below) making a total of 25 tags found *in situ*. The majority were found within the cremation urns which had decayed, spilling the contents. They ranged between 43,5g and 10g in weight, most were rectangular and light pinkish grey, a few showed evidence of charring (Fig 29). Many had identifications on them often consisting of a year and a number, presumably the registration number of the funeral for that year. There were three that had no year identification on them. The paper tag (F201123) consisted of a rectangular tag with a handwritten identification and year followed by the name of the person (Carl Brorson). There was a hole to fix the tag to the urn.

Flowers and organic finds

Flowers and plant material that represent Funeral Finds are the arrangements related to the coffin, either on the coffin lid or lying below the coffin. The majority of the flowers were not recorded as Finds but as Samples. The results are presented together to allow an overview of the three Finds and 12 Samples which were taken from 15 different inhumations (Table 25). Three inhumations contained both flower arrangements externally as funeral finds and also inside the coffin as personal finds. However the majority of flower and plant arrangements or the metal wires used to secure flowers to the coffin were not registered as Finds therefore this amounts to only a small fraction of what was excavated.

Fig 29 Examples of cremation tags (F200236, F200233, F200932, F200238) (Eksempler på kremeringsmærker (F200236, F200233, F200932, F200238))

ID	Group	Location	Type	Species	Comments
9606	391	Coffin lid	Branch	Palm	Single branch
22611	1492	Coffin lid	Flowers		
55323	815	Coffin lid	Leaves	Unid	Found with metal flower wire
59294	1378	Coffin lid	Flowers	Unid	
200234	271	Below coffin	Branch	Pine	Cover for pile of bones under coffin
200240	302	Coffin lid	Leaves	Unid	Possibly residual
200368	258	Below coffin	Branch	Pine	Many branches found
200432	450	Coffin lid	Branch	Yew	
200434	460	Coffin lid	Branch	Palm	Dried and artificially coloured leaves
201131	827	Coffin lid	Leaves	Box	
201504	191	Below coffin	Branch	Pine	Found under coffin
201505	688	Coffin lid	Flowers, leaves	Unid	
F201299	518	Coffin lid	Bouquet	Unid	Two plastic flower tags only, no flowers
F201447	692	Coffin lid	Ribbon		Paper string
F203441	1315	Coffin lid	Branch	Palm	Single branch

Table 25 Summary of Funeral Finds, identified plant material combined from Samples and Finds

There were three examples where pine branches were placed underneath the coffin; one in particular was noted as covering a large pile of disarticulated bone. There were also four examples of palm leaves or yew branches placed on the coffin lid, sometimes only a single branch. There were also remains of two plastic tags from a florist located (F201299) and a piece of ribbon for tying bouquets. Wreaths were also used but none recorded as Finds, they could be rounded or shaped as a cross and sometimes there were several on one coffin. There are also a further 32 pieces that represent the arrangement of the flowers, with five pins and a collection of wires that would have held down the wreath together and fixed it onto the coffin.

Other

There were only six unidentified pieces or fragments that were classified as Funeral Finds, most probably represent coffin fittings. One was a metal bracket deriving from the wall of a vault structure (F203882), there were four originally in the structure and only one was registered. The bracket is a single piece of shaped iron, fixed into the wall with mortar; it was identified as a potential shelf support for coffins within the vault.

Personal finds – traditions relating to the person

Subclass	No. Reg	Total	Weight	
Button	189	382	311.85	all weighed
Ceramic	3	3	252.5	all weighed
Coin	4	5	11.5	all weighed
Glass	3	3	426.5	all weighed
Jewellery	109	126	441.6	all weighed
Leather	2	2	17	all weighed
Metal	18	28	90	all weighed
Textile	84	96	220.3	3 weighed
Other	31	63	1558	all weighed
Total	**443**	**708**	**3329.25**	

Table 26 Summary of all Personal finds, by subclass

Personal Finds suggest a more deliberate and personal relation with the individual buried and thus generally is recorded as related to the skeleton rather than the coffin. There were 443 registrations of finds classed as Personal Finds with 708 items registered in total (Table 26). Subclasses are dominated by buttons indicating clothing which suggest more textiles were originally deposited but have decayed. The results are presented by type of find (Table 27) for clearer discussion. There is some overlap in these types, as some items, for example cufflinks, could be considered buttons or clothing accessories and some items classed as jewellery also have a religious dimension such as the rosary.

Type of find	Total	Weight (g)
Jewellery	126	441.6
Clothing (textiles only)	96	96
Buttons and fastenings	393	463.65
Flowers and plant material	14	132.5
Religious items	4	309
Medical related items	12	302.5
Unusual items	63	1584
Total	**708**	**3329.25**

Table 27 Personal Finds divided into type of find

Jewellery

A total of 126 items were classified as jewellery (Table 28), the majority of the items are gold or other metals. When combining all the different metals (104/126) they form 82.5% of the subclass. Only a few registrations contain more than one item, 14 in all, with 31 items. The majority of these are paired items such as earrings (seven sets) and hair combs (four sets).

Material	No. Reg	Total
Bone	5	5
Copper alloy	7	9
Glass	1	1
Gold	58	61
Iron	3	5
Metal	23	29
Organic	6	6
Plastic	6	10
Total	**109**	**126**

Table 28 Summary of subclass jewellery by material

There is a predictable range of types within each material type (Table 29) with hair combs being bone, tortoiseshell or plastic replicating tortoiseshell. Simpler hairpins are all plastic. The majority of the jewellery are made of metals, with most being precious metal.

	Bone	Copper alloy	Glass	Gold	Iron	Metal	Organic	Plastic	Total
Brooch		1	1			2			4
Comb	5						6	4	15
Earring		4		11		6			21
Hairpin								6	6
Other				1	5	3			9
Pin		1		1		5			7
Ring		3		48		13			64
Total	**5**	**9**	**1**	**61**	**5**	**29**	**6**	**10**	**126**

Table 29 Distribution of types of jewellery by material

Brooch

Four brooches were recovered which were all quite different in style. One was more of a monogram or insignia of copper alloy sewn into textile, possibly based on a gothic design (F201683). Another small silver coloured badge, a *Kongemærke* (F201902) was mass produced in 1940 to commemorate Christian X's 70th birthday, these had another symbolism of national pride against the German occupation. A third brooch may be more of a clothing attachment (F201498). An unusual brooch was made of black glass, with an Art Deco stylised leaf shaped design (F201500) (Fig 30).

Fig 30 Art Deco style brooch (F201500) (Broche i art deco-stil (F201500))

Comb

The 15 combs were from different materials and often found paired together, some were simple, straight and undecorated hair combs of plastic, others were decorated and of tortoiseshell. One of the most intricate was a single piece of tortoiseshell carved in an elaborate shape (F201310).

Earrings

Of the 21 earrings many were paired together (14 in total), some were simple hoop earrings with little decoration. There were also some examples of glass paste beads in amber or red (Fig 31). There were no maker's marks or engravings on any of them.

Fig 31 Earrings with amber coloured glass bead (F200211-2) (Øreringe med ravfarvede glasperler (F200211-2))

Hairpins and pins

There were six plastic hairpins, some made to imitate tortoiseshell. There were also seven metal pins which were registered as part of clothing or accessories, some of them for the hair, some for clothes. One set of plain metal grips were with the remains of a light grey silk hairnet (F201338).

Other (miscellaneous)

Nine items were from other categories. A metal cross with wood inset and copper alloy figure of Jesus with two rings forming the start of a chain (Fig 32) is perhaps not strictly a piece of jewellery as it may be too large for daily wear (F200522). Another religious item was a set of rosary beads and a metal cross. It was found in the right hand of the person with the beads laid out over the arm. The string was decayed but the

beads had fused together (F202315). There were two examples of either male collar buttons or cufflinks, both plain, one of gold and one of unidentified metal. There were also four metal rings of uncertain function and a small set of metal rings that may have been a necklace chain, possibly copper alloy.

Fig 32 Metal crucifix fused onto a fragment of textile (F200522) (Metalkrucifiks. Krucifikset er sammenkorroderet med et stykke tøj (F200522)

Rings

Of the 64 rings the majority were gold of 18 or 14 carat identified through their jewellers' stamps, some were of lower quality gold which showed in the discolouration and tarnishing of the surface. The average weight is 2.73g with the smallest 0.5g and the largest 7.5g. The average diameter is 20.5mm with the smallest 17.5mm and the largest 24mm. The width of the band varied from 1mm to 8mm. The diameters of nine rings were not recorded mostly due to warping from daily wear which shaped the ring to the finger. There were a total of 151 stamps found on 49 rings with many rings having multiple stamps. The most

common were the 18K assay stamp marking the quantity of gold often in association with the city of Copenhagen stamp based on the city coat of arms (Table 30). There were also some common jewellers' stamps.

No. of stamps	No. of rings
0	15
1	6
2	16
3	2
4	19
5	5
6	1
Total	**64**

Table 30 Summary of number of stamps on rings

There were 38 rings with some form of inscription, 22 only had initials rather than a full name and only one was unreadable. Dates on the rings varied from the earliest in 1816 to 1912. Eight of the rings with inscriptions had no date (Appendix 4).

There were 11 rings with some form of decoration or embellishment. Six rings had decoration in the form of inset stones; two of these rings were identical. Four of these had stamps and two inscriptions but there were no dates (Fig 33). Only five rings had some other form of decoration and none of these had any stamps or inscriptions (Table 31).

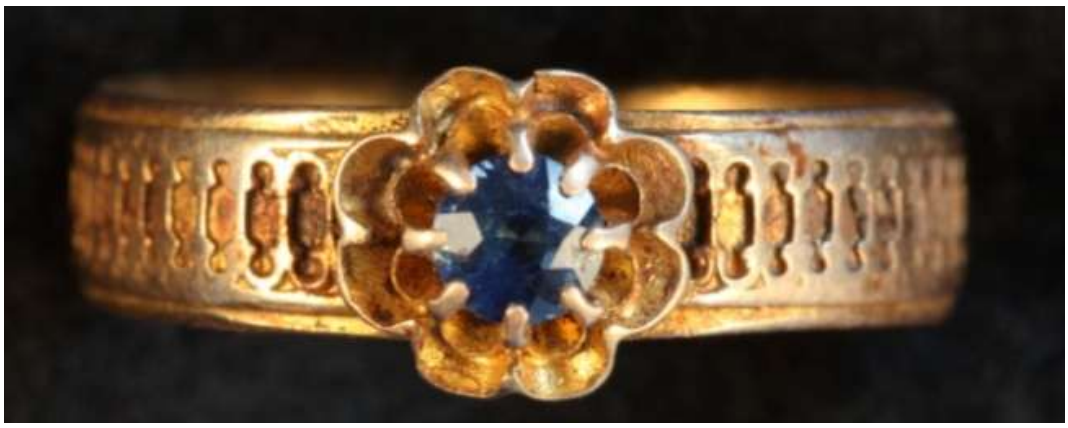


Fig 33 Gold ring with blue stone (F202372) (Guldring med blå sten (F202372))

Clothing and buttons

Clothing is represented in two forms– through the fabrics (96 finds) and through the attachments that have survived, generally buttons (393 finds). Some other attachments such as cufflinks are discussed as jewellery (see above). Many graves had multiple finds relating to clothing. There were more cardigan fragments than any other type of clothing and smaller amounts of shirts, ribbons and socks (Table 32).

ID	Description
201054	Decorated externally without turned edges forming rims around the edge, stippled decoration on the external face. Inscription - unusual as made by stippled points, not engraving. KH ? 19 Januari 1816
201728	Metal, possibly very low gold content. Unusual decoration, on the external surface is an inset band of greyish unknown material. It is held into place by two bands of metal. The material looks organic as it has horizontal striations layered through it but it has dried out and cracked in several places. The internal surfaces have been bevelled on one edge only, perhaps to fit over another ring. No stamps, marks or inscriptions.
201046	Constructed of a single length of flattened gold wire wound around in a spiral four times and joined together on the exterior. The end is decorated as a serpent head with eyes, the other end a simple flattened end. The coils are alternately decorated with dots and incisions to create the effect of a spine and ribs or snake skin. Gaps can be seen between the coils showing they were only loosely wound together. No stamps, marks or inscriptions.
202334	Made of separate light gold (less than 14K?) ring, each individually made and 4,7mm diameter, then soldered together to form a rigid chain and then a ring. No stamps, marks or inscriptions.
203439	Two rings that have been entwined together with a simple twist in the metal where they would fit together on the finger, otherwise plain but well made. No stamps, marks or inscriptions.
201043	Low carat gold ring. Ring in good condition with round blue glass inset into an 8 pointed star. Inscription: HB Stamp: unreadable, perhaps a maker's mark. Paired with F201056
201056	Gold ring with a glass stone inset. Discolouration and accretions around the stone, probably from the base metal setting. Paired with F201043. Inscription H Bomditz 26/3. Two stamps: LB:- maker mark and 585 - 14k.
201446, 203816	Two identical rings, thin with three red stones inset in a line.
200779	Thin gold ring, the top is thicker and contains an inset clear stone within an 8 pointed star setting. The stone sits flat to the ring surface. Looks more like glass than diamond, it is cut poorly and is worn and seems quite dull even after cleaning. Stamp: 585 - 14K.
201372	Exterior decorations of two lines around the edge with stamped pattern resembling a lozenge. Elaborate fitting for stone in form of 8 leafed flower with 8 pieces holding the glass stone *in situ*. Small clear deep blue stone cut with flat round area on top and small triangle facets around the side, followed further down by a pentagon and then by triangles Two stamps very worn: IB and possibly 14K but uncertain.

Table 31 Details of decorated rings and rings with inset stones

Type	No. Reg.
Cardigan	39
Hat	2
Handkerchief	2
Jacket	1
Other - personal	24
Ribbon	11
Shirt	6
Shoe	1
Sock	9
Underwear	1
Total	**96**

Table 32 Summary of types of textiles

Cardigans

Most of the textiles found proved to be wool knitwear. A lot of the fragments were found in the chest area, many with copper alloy buttons, and some fragments reveal how parts of these knitted garments looked. F200568, F200358 and F201143 are all fragments from the front part of a cardigan, where the two sections meet and are closed with copper alloy buttons. Other finds were fragments of sleeves, showing that these could be knitted in a rib pattern in order to gain elasticity (F200682-83). The same feature was found at the end of F201656, but not all cardigans may have had rib patterns. A ribbon fragment was found with the cardigan fragment F202338, indicating that some cardigans might have been tied near the neck in a bow.

One fragment (F200788) has been closed in a seam with a safety pin (Fig 34). This could be a sign of repair as well as a decorative element, if the safety pin has had some sort of decoration attached. The seam itself is coloured red whereas the rest of the cardigan has a yellow-brown colour similar to other cardigan fragments. Few other signs of dyeing have been found and it might be due to the cardigans being made of natural coloured, white or light brown wool.

Fig 34 Cardigan fragment with safety pin attached (F200788) (Fragment af cardigan med fastgjort sikkerhedsnål (F200788))

The knitwear from these cardigans is generally of a fine quality and machine-knitted with 0,2-0,4mm thick yarn. The copper alloy buttons have mostly been wrapped in white tabby woven fabric, which is still preserved on some of them. They measure 12-16mm in diameter. There may have been quite a lot of minor variations in the design of the cardigans, but the relatively standardised look of the fragments as well as their large amount, suggest that these cardigans may have been special burial clothing.

Shirts and jackets

Only one complete and very well preserved shirt was found (F201129) (Fig 35). The excellent preservation is due to the artificial fibres. It was a large sized classic shirt, woven in a tabby variant, “English tabby”, with a collar and a pocket at the left side. However, it had no buttons and therefore might be a special burial shirt.

Fig 35 Detachable collar of shirt (F201129) (Aftagelig skjortekrave (F201129))

One knitted wool fragment seems to be from a shirt rather than from a cardigan (F200362). It is a large fragment with a reinforced neck opening with spaces for three white porcelain buttons (Fig 36). The knitwear is of a high quality, knitted on machine, and has a yellow-brown colour. Other fragments (F200517, F200776) might also derive from a wool shroud or shirt.

One find combined two different types of textile with a middle layer of knitwear placed between yellow brown twill. On the upper surface were three white porcelain buttons with two holes. This garment was located on the torso of the individual and has been interpreted as some form of padded jacket (F202172).

Fig 36 Detailed image of button on shirt (F200362) (Detaljefoto af skjorteknap (F200362))

Face cloths

Remnants of two different handkerchiefs used as face cloths were discovered *in situ* on the face of two females. The face cloths were delicately woven in tabby and twill respectively and were decorated with embroidery. The most well preserved one (F200467, Fig 37) had embroidery of one large flower with 16 petals at each corner, surrounded by leaves, smaller flowers and scrolls. From the second face cloth (F202139) only a small fragment was preserved and this showed embroidery of a rhomboid-shaped figure as well as plant leaves. The face cloths seem to have been coloured, perhaps in green and red shades.

There appears to be no wear on them however they could be ordinary handkerchiefs belonging to the person.

Fig 37 Detail of embroidery on handkerchief used as a facecloth (F200467) (Detaljefoto af broderet lommetørklæde brugt som ansigtsdug (F200467)).

Hats

Fragments of an almost fully preserved silk skullcap (F200686) were found *in situ* in a middle-aged male's grave. It is made of five triangular fabric pieces, each with a double layer of two different fabrics. The outer layer is rep tabby woven and the inner layer is tabby woven, both in a very fine quality. The cap is similar to a Jewish kippah worn by Jewish men or a Catholic zucchetto which was only worn by the clergy. However it has five parts instead of the usual four or eight. It is therefore difficult to connect the skullcap to a specific religion, but since it is one of a kind at Assistens it might mark a special status or affiliation of the person.

Another unusual hat find was a student cap (F202409), which was found in a older female's grave. The cap is a classic 19th century black student cap, rep tabby woven of a possible silk mixture. It had a rounded leather visor and a leather ribbon that could be adjusted underneath the chin to keep the cap in place. The front of the cap was decorated with a small fabric rosette, most likely with a metal buckle which unfortunately, was not found in the grave. Up until 1875, only men were allowed to take a high school exam and if the grave is identified and dated it will be possible to determine whether the cap could belong to the woman herself or to a relative.

Bows, ribbons and cords

Bows, silk ribbons and other decorative items were occasionally found in the graves. Small bows of silk were used as hair decoration (F200516) as well as clothes decoration, or tied underneath the chin (F201737). A mixture of these variations was found in a grave of a female (SB4253); she had a silk bow tied around the two hair braids on her shoulders, to keep them in place in the grave.

A large silk ribbon (F201132) was found tied in a knot over the pelvis of a person. It has pointed ends and might have been tied around a bouquet of flowers. Another ribbon (F201750) from the pelvic area of a male seems to have had a different purpose. It was made of wool and tied in a knot with some hair attached to it. It could be a belt or a ribbon securing clothing or a shroud, but no certain interpretation can be made.

In another grave, a female was found with a mandible ribbon (F202339) tied around her chin (Fig 38). The ribbon was made of a diamond shaped piece of tabby woven fabric that had been folded into a ribbon. The use of mandible ribbons has however been rarer in the graves than might be expected, and only two in total have survived.

Fig 38 Squared cloth folded diagonally to create a mandible ribbon *in situ* (F202339) (Firkantet tørklæde, som er blevet foldet diagonal til et kæbebånd *in situ* (F202339))

Scarves

Some of the knitwear had larger patterns and thicker yarn than the cardigan fragments. Their design reveals that they are not cardigans, but rather scarves. A clear example is F200363, which was almost fully preserved, knitted in a zigzag pattern; it had been fitted around the body on top of a shirt (F200362). Other fragments (F200786) might be of the same kind and they could be hand knitted. Some have a very loosely knitted structure, indicating that they were made of wool and another fibre that has now decayed.

Footwear

In four graves, socks and stockings were found with varying designs and preservation. The most well preserved were beige or white coloured nylon stockings (F200357) found in a middle-aged female's grave. They were made with a seam at the back and reinforced toe and heel areas and they stretched to the middle of the thigh, held up by elastic suspenders with two iron buckles. The stitches have loosened in a few places, which indicate that the stockings had been used before being worn in the grave.

A pair of dark brown knitted wool socks (F202166) was found in the grave of a male. The socks were well preserved and went up to right under the knee. They had been knitted in one piece with no seams and no reinforcements. At the thigh was a rib pattern, which would have had an elastic effect to keep the socks in place. A similar pair of socks, as well as fragments of the same were found in a female's and a male's grave respectively (F201119 and F201137). However, the woman's socks were knitted with a thicker type of yarn at the heels to reinforce the socks. This kind of footwear thus seems to have had unisex use.

Only one pair of shoes was found (F200791). These were dark brown leather shoes and only the soles were preserved, the left more than the right. The shoes had a rounded front and a narrow mid shoe. Moreover, they had a 30mm high heel, made of three layers of leather, whereas the sole was made of more than three layers of leather. The size and shape of the shoes suggest that they belonged to a male, which the skeletal analysis of the skeleton (SB14267) agrees with.

Other items

There were 24 pieces that were unusual or unidentified. A single piece of cloth found was interpreted as possible underwear from the location by the pelvis (F202466). It contained a single copper button but had no other identifiable feature. A possible hairnet was also located by the side of a skull, consisting of a shiny netlike material, possibly flax (F201956). Found within one autopsied skull was newspaper folded around a knitted piece of textile (F201501). The paper had degraded and was not identified; the original function of the knitted textile also could not be identified.

Buttons

Overall 382 individual buttons were registered from *in situ* contexts; buttons being more robust than textiles they were often extremely well preserved and indicate a much higher original deposition of clothing or shrouds within the coffins. Comparing the material types, there are many copper alloy buttons, almost twice as many as the nearest material – porcelain (Table 33). There were a small range of other material types including bone, cardboard and shell (Fig 39). However on average there are less copper alloy buttons in each registration – 1.89 per registration compared with porcelain buttons (2.73) this indicates that where porcelain buttons were used there were more per garment. A mistake in identification of materials was made in the original registration of buttons; white porcelain buttons were misidentified as plastic. Subsequent re-classification has taken place in the report but remains unaltered in the Intrasis database.

Material	No. Reg.	Total
Bone	11	13
Copper alloy	105	198
Horn	2	6
Metal	13	20
Organic	12	22
Other	2	6
Paper	6	15
Plastic	1	1
Porcelain	37	101
Total	189	382

Table 33 Button material types

The buttons were divided into three types based upon how they were attached to the textile: shank buttons (those with some form of rear projection which contained a hole); studs (those that formed two pieces of metal that were individually sewn into separate pieces of textile and then pressed together) and buttons with holes. There were far more buttons with holes (227/382), 59.4% of the assemblage than either of the other types (Table 34). Porcelain buttons were almost all using holes rather than shank or studs however there were fairly even divisions between types of buttons in other materials. Buttons with holes generally had either two, or four buttons (Table 35). Of the two dominant materials, copper alloy buttons tended to have two holes, the porcelain buttons were strongly associated with four holes. The size of the button seemed to correspond also with the number of buttons with two holed buttons being between 15mm and 25mm in diameter and the four holed buttons *c* 10mm in diameter.

Fig 39 Shell buttons (F202322) (Perlemorsknapper (F202322))

Generally the colour of the buttons represented the material they were made of however porcelain buttons were generally white. Buttons covered in cloth could generally not be identified to original colour. Of all the buttons only 72 had traces of textiles, either impressions of the weave formed through metal corrosion or threads still present, most of these were copper alloy. Some buttons were found *in situ* on pieces of textiles and these are discussed as part of the garment (see above). There were only 17 buttons that had some form of decoration and in four buttons this consisted only of a slightly altered shape rather than obvious decoration, 11 porcelain buttons had grooved rims and two buttons had a flower pattern on the front.

Type	Bone	Copper alloy	Horn	Metal	Organic	Other	Paper	Porcelain	Total
Shank	5	56	1	4	2	-	3	1	72
Stud	-	71	-	10	1	-	-	1	83
Holes	8	71	5	6	19	7	12	99	227
Total	**13**	**198**	**6**	**20**	**22**	**7**	**15**	**101**	**382**

Table 34 Type of button by material

No. of holes	Copper alloy	Porcelain	All other materials
1	8	1	2
2	62	8	36
3	1	16	0
4	-	74	19
Total	**71**	**99**	**57**

Table 35 Summary of the number of holes in the buttons, for all materials

Another observation recorded was the area of the skeleton that the buttons were found in (Table 36). There is a clear pattern overall that buttons were located on the chest, exactly 50% of the buttons were found there. If including the shoulders and wrists (261/382) the percentage goes up to 68% showing that the buttons were focused on the upper body on perhaps shrouds or shirts. The percentages for each type of button does not vary by a great amount with the exception of stud buttons where far fewer were located on the chest (34%) but were slightly more spread over the body.

	Head	Shoulders	Chest	Wrist	Pelvis	Legs	Other	Unknown	Total
Shank	4 (6)	10 (14)	39 (54)	8 (11)	5 (7)	-	-	6 (8)	72 (100)
Stud	9 (11)	13 (16)	28 (34)	7 (8)	5 (6)	-	6 (7)	15 (18)	83 (100)
Holes	4 (2)	11 (5)	124 (55)	21 (9)	9 (4)	-	19 (8)	39 (17)	227 (100)
Total	**17 (4)**	**34 (9)**	**191 (50)**	**36 (9)**	**19 (5)**	**-**	**25 (7)**	**60 (16)**	**382 (100)**

Table 36 Distribution of buttons over the areas of the body, percentages in brackets

Sample ID	Group	Location	Type	Species	Comments
12932	643	Torso	Bouquet	Unidentified	Flowers on chest
20366	1380	Body	Flowers	Unidentified	
22162	1464	Feet	Bouquet	Grass, flower stem	8 separate bouquets spread over the body of one person
22163	1464	Feet	Bouquet	Roses, Gypsophilia	
22164	1464	Pelvis	Bouquet	Grass, flower stem	
22165	1464	Torso	Bouquet	Unidentified	
22166	1464	Torso	Bouquet	Roses, Gypsophilia	
22167	1464	Torso	Bouquet	Roses	
22168	1464	Right shoulder	Bouquet	Gypsophilia	
22169	1464	Left shoulder	Bouquet	Roses, Gypsophilia	
22454	1485	Pelvis	Wreath	Pine	Cross wreath 0.42 x 0.72m
22863	1508	Legs	Bouquet	Unidentified	From one person, lying over the legs
22864	1508	Legs	Bouquet	Unidentified	
22865	1508	Legs	Bouquet	Unidentified	
200378	271	Torso	Bouquet	Holly, cedar/cypress	Possibly in hands
200379	157	Torso	Bouquet	Unidentified	
200380	15	Legs	Bow	Straw	The bow to tie the bouquet not the flowers themselves
200385	15	Under body	Branch	Pine, Gypsophilia	Inside coffin, under the body. Together with bow 200380
200382	258	Body	Bouquet	Roses, Gypsophilia	
200383	156	Body	Bouquet	Holly	
200384	356	Body	Bouquet	Unidentified	
200523	474	Inside coffin	Branch	Holly, cedar or cypress	
200773	740	Torso	Branch	Palm	2 branches held in hands and extended to the head
201130	813	Legs	Bouquet	Unidentified	Large enough to cover the entire left leg
202208	595	Body	Leaves	Box	
F200681/ 202218	648	Torso	Wreath	Holly, Red cedar	Cross of leaves and wreath of holly
F201654	1192	Body	Plastic bags		5 flower wrappings
F201667/ 202219	1160	Unknown	Leaves	Box	
F201672	1156	Body	Ribbon		Raffia flower ribbon
F202036	1359	Torso	Flower tags	None	Two plastic tags
F202340	1132	Pelvis	Ribbon	None	Plastic ribbon
F202341	1132	Body	Plastic bag		Flower wrappings
F202342	1132	Body	Plastic bag		Flower wrappings
F201448	518	Body	Plastic bag		Flower wrappings
F203442	518	Torso	Bouquet	Unidentified	

Table 37 Summary of plant material identified during analysis from Samples and Finds, Personal Finds

Flowers and organic finds

Flowers and plant material that represent Personal Finds are those found inside the coffin, related to the body. The majority of the flowers were not recorded as Finds but as samples. The results are presented together to allow an overview of the ten Finds and 27 Samples which were taken from 22 different inhumations (Table 37). Three inhumations contained both flower arrangements externally as funeral finds and also inside the coffin as personal finds. The majority of flower and plant arrangements were not registered as finds therefore these totals are only a small fraction of what was excavated.

Most arrangements were bouquets (19 items) and presented a small range of flowers used, generally roses and Baby's Breath *(Gypsophila paniculata)* with some examples of holly. One particular individual (SB22152, G1464) had eight bouquets placed over the body, another had three bouquets (SB22861, G1508) placed between the legs. There was also an example of palm branches placed over the hands and covering the body (SB14043, G740). Many of the flowers were too decayed to be sampled and it is likely there were many more. A deposit of branches was found underneath one body, possibly as some mattress padding. They were mixed with Baby's Breath so there is an element of special treatment and not just practicality. There were also remains of plastic bags or wrappings from flowers and ribbons for tying bouquets that had survived when the flowers had decayed, some tied into knots or bows. There were also two plastic tags (F202036) with the address of the florist: *Blomsternielsen, Strandvej 159, H.E. 1001-1032* and *Georg I. Christensen, H.C Andersen Boulevard 33, TLF: 14 77 28.*

Religious items

There were only four religious related items that were not also pieces of jewellery. A larger cross on a chain and a rosary and cross were identified as jewellery. Three hymn books were located inside the coffin, although none could be read as the paper had decayed, one had Psalm book embossed on the outer spine in gold leaf. An unusual religious find was a ceramic statue of Jesus, based on the Danish sculptor, Bertil Thorvaldsen's Jesus figure. It was a plain, hollow mould, white ceramic with no inscription or maker's mark (F202601) (Fig 40).

Fig 40 Statuette based upon Bertil Thorvaldsen's Christ (F202601) (Statuette baseret på Bertil Thorvaldsens Kristus (F202601)).

Medical related items

There were 12 items that could be related to a medical function or in relation to healthcare. There were seven pink rubber surgical tubes and one of other material found *in situ* within the body from five people. One individual had three tubes including one with a designed front piece (F200778). The other tubes had cut edges, probably by scissors (Fig 80). Some had intact fittings indicating drainage use and one had a safety pin attached to it. One item was interpreted as a diaper; it consisted of a fragment of textile around the pelvis held together with a safety pin. There was also newspaper packed into the autopsied skull cavity (F200777), it was unwrapped and revealed as the *Berlingske Aftenavis*, from 29th November 1934. This similar to another find of textile and paper in the autopsied skull (see Fig 119). A grey/white rubber buckle was found in association with a skeleton, it is interpreted as some form of buckle for a body bag or other wrapping around the body; there were remains of soft tissue around the buckle (F202080).

A single pair of dentures was registered as a find; all other dentures were recorded as part of the osteological recording however one pair was unusual enough to be registered in detail (F201938, see Fig 51). They consisted of two separate plates of thin sheet swagged gold, which had spikes on them where the ivory teeth slide on. There are two bronze coloured (alloy?) springs which kept the two plates together. Overall it reflects high quality craftsmanship which has taken account not only of aesthetics for the person and others seeing them but also for comfortable fitting onto the gums and strong resemblance to genuine teeth. Considerable expense and care went into the design and creation of them and there were also signs of repair on the plates indicating a long period of use. Similar examples have been dated to the late 18th to mid 19th century in Christ Church and St George-the-Martyr in London (Molleson et al. 1993; Boston et al. 2009). The dating is suggested by the full covering of the hard palate, common from 1835 and limited by the use of ivory instead of porcelain which was generally available from 1845 (Cohen 1975), so the dentures are suggested as from this period.

A single bullet (F201380) was located within the skull cavity of one individual (Fig 41). This was examined by Per Agner Bach Stougaard, a consultant for the Danish Police, Criminal Technology Centre who concluded that it was a deformed bullet either from a pistol or a revolver but the precise calibre or type of gun could not be identified (KTAR-83990-00018-10(1), July 2010).

Fig 41 Detail of bullet (F201380) (Detaljefoto af patron fra et håndskydevåben (F201380))

Unusual items

There are a total of 63 unusual items that could not be classified and were made of varied materials; many are plastic, identified as flower wrappings, or gift wrappings. There are also a few items of paper, either used for practical wrapping or possibly some form of letters or notes for the person. Other items seem to represent specific gifts for the individual such as the toy ball, or vases (Table 38).

ID	Name	Material	Description
200577	Urine bottle	Other	White enamel urine bottle made of 3 separate sections, found between the legs of a skeleton. Overall profile is rounded with a single flat long side and rounded end, so that the bottle sits on its long side, not on the end. There are no maker's marks, stamps or decoration on the bottle.
200774	Paper	Paper	Small fragments of thin paper, averaging 26mm wide and 1mm thick. Degraded pieces of paper, *c* 6 of them, obviously from one piece of paper or page. There is print on both sides, which cannot be read. There is no binding or sufficient quantity to constitute a book. Perhaps a printed leaflet or prayer.
201285	Gaming piece?	Bone	Circular object with hole in the centre, diameter 10mm. Machine turned and polished with a rounded face with 3 circles around it.

			The back is flat but polished.
201448	Plastic bag with ribbon	Plastic	Clear plastic bag with no markings and no way of sealing up at the top. Found with shiny blue paper ribbon wrapped around it and tied into a loose bow. Originally sealed with shiny grey tape at the top - however there is a large tear in the centre of the bag indicating something was taken out. Nothing was found in the bag.
201654	Plastic bags	Plastic	Two clear plastic bags, no seal at the top, one split open down the centre. One clear sheet of plastic which could have been an opened bag. This contains fragments of newspaper with some print still readable but had no date or enough text to identify the script. Appears to be from the small advert section. One mid greenish clear plastic sheet, 0.44m x 0.48m, also containing similar fragments of newspaper. One mid greenish clear sheet tied together to create a waterproof container for flowers. Several decaying flower stems are held *in situ* tied together with a white plastic (raffia) string. A separate fragment of the same string was tied into a bow but is not definitively associated with this plastic.
201660	Pink dye?	Unknown	Small remnants of some bright (artificial) pink colour were collected on lumps of soil. There are small textile imprints when examined under the microscope; this and the bright unnatural colour suggest a fragment of textile dye.
201661	Newspaper	Paper	A wedge of newspaper fused together with some visible print but not identifiable.
201668	Toy ball	Other	Small hollow rubber ball flattened. Parts of the ball have clearly disintegrated and cracked but red and white areas can be seen showing a white stripe in the centre, *c* 25mm wide.
201672	Paper ribbon	Paper	Mass of raffia gift ribbon, no indication of flowers found.
201810	Wig	Organic material	Wig of human hair, rich brown in colour with some long strands of hair. The hair has been fitted into a cloth cap which fitted into the skull. The wig had been braided and twisted at the top and held with tortoiseshell clip. Small ribbons of twisted wool held the wig into place, presumably by twisting around the skull and tied into place at the nape of the neck.
201950	Photo in frame	Paper	Photograph in rectangular wooden frame which was painted white. Located under the lower legs. Thin fragments of light brown paper were stuck onto the glass; there was a clear corner and edges suggesting pieces of paper placed on top - letters, or notes? The clear glass was *in situ* and had preserved the photograph underneath but it had been broken. Identified as *'baryt papir'*, used before modern photographic paper. It was possible to see some form of a person in a three quarter length pose. Possibly a female profile with white face and curve of neck, and possible darker areas of hair and shoulders.
202034	Memento	Paper	A rosette or medallion primarily made of paper or thin card, attached to a flower bouquet. Shaped as a circular badge with paper ribbon tassels hanging down from the base which are attached to the back of the card with two copper alloy discs or tokens were attached. Inside were locks of human hair, straight and a red-brown. There were also clearly layers of paper with typed writing on them. Only one word was visible 'Frimæ_[possibly an r] ker'. There were likely other words but they were unreadable.
202341	Plastic bag	Plastic	Small plastic bag, clear with no markings.
202342	Plastic bag	Plastic	Opaque light blue plastic, possibly a bag, perhaps a sheet. Plain with no markings.
202463	Decorated cover?	Plastic	Rectangular thin 'leaf' of unknown material but probably some form of plastic. Reddish brown with rounded corners, discoloured at the edges to a darker brown. Elaborate decoration of flowers and leaves made by a mould or stamp as the flowers are raised on the front and hollow on the reverse. Suggested as part of a book

			binding, or perhaps a cover for a photograph or letters that were bound onto it. Although there is no corresponding back cover and no sign of any other material.
202657	Shell	Organic material	Thin fragments of shell, stained brown and with a lot of soil adhering to them. Possible egg shell.
203867	Hoof bones	Bone	Two intact hoof bones (right and left distal phalange) from an adult deer, probably a medium size deer. There is a small chance that it was a deliberate deposit as it was placed by the knees of the individual and was thought to be intentionally deposited by the excavator. It is also possible that it was residual but it cannot be determined with certainty, a potential gift for the person - perhaps some kind of hunting trophy or reminder?
201492	Small flower pot	Ceramic	Little flower pot only 66mm high, plain light brown/cream colour, with hole in centre of base.
201503	Doll	Ceramic	Porcelain doll, of separate pieces including the head and shoulders, arms and legs which would have been joined by a textile body which did not survive. The face is painted and there were no signs of clothing.
200520	Glass bottle	Glass	Dark brown hand blown glass bottle. Single string rim, flattened sides and shallow base.
202140	Glass container	Glass	Complete clear glass container, reconstructed as a straight cylinder with no decorations.
202403	Glass vase	Glass	Transparent glass vase. Decoration is of coloured glass stripes running through the whole design of white and light blue, twisting around the vase and thinning and widening at different areas due to the spread and thickness of the glass.
201166, 201681, 201687, 202329	Coins	Copper alloy	5 coins found in 4 separate contexts
200366	Leather	Leather	Fragment of leather with no clear details. The edge is preserved at one of the sides.
201344	Epaulette?	Leather	Leather fragment with some metal fixings - perhaps an epaulette or some type of clothing decoration.
15 finds	Unidentified	Metal	Items from 6 contexts, some thought to be tokens, others are unidentified items.

Table 38 Details of unusual finds classified as Personal Finds

Residual, cemetery related finds

There were a total of 215 finds from unstratified, residual contexts that are definitively related to cemetery activities. Gravestones and miscellaneous subclasses contain the largest amounts of finds; however a large deposit of conch shells found skew the results (Table 39).

Subclass	No. Reg	Total	Weight	Comments
Button	13	20	21	Examples of standard types found in the cemetery inc. copper alloy, porcelain and plastic
Ceramic	1	1	20	One cremation tag (F201123), no identification
Gravestone	43	73	0*	None weighed
Jewellery	9	10	71	
Metal	10	16	5237.5	
Other (Miscellaneous)	7	95	36522	Conch shells from one deposit
Total	**83**	**215**	**41871.5**	

Table 39 Summary of Residual, cemetery related finds by subclass

Many fragments of residual gravestones were found, within topsoil, disuse phases of backfill, inside a well structure in the south of the site or within vaults. However there were many small pieces without inscriptions that were not recorded. Those recorded were the complete stones or ones with significant, identifiable inscriptions. A total of 73 were registered as finds and of these 19 were found either intact or complete but in several fragments. The earliest date of death recorded was 1821 and the latest 1943. A complete list of inscriptions is in Appendix 5. Seven gravestones were reused to form part of structures or foundations, four in unidentified structures (G21, G118) in the gravediggers' garden, another for the gravediggers' greenhouse and two as part of drainage repair to the gravediggers' house.

A total of 10 jewellery items were found in residual contexts, not directly related to a skeleton but often from a grave deposit. Some of these items are likely to have been disturbed and could be related to either charnel bones or *in situ* but disturbed graves (Table 40). For example, the fob watch (F202328) was found slightly above a skeleton but could not be definitively associated with it, although it is quite likely to be originally deposited within that grave (Fig 42).

Fig 42 Detail of fob watch (F202328) (Lommeur, detalje (F202328))

ID	Name	Material	Type	Number	Description
200531	Buckle	Iron	Buckle	1	Rectangular belt buckle
200569	Hair accessory	Leather	Other	1	Ring, possibly made of thin suede, stuffed with hair.
201052	Earrings with red glass	Gold	Earring	2	Pair of gold earrings with red glass centre piece with many facets set in centre of gold setting. Small gold loop underneath indicates a smaller pendant (missing). Simple loop and pin and hole to open it. No maker's marks or stamps. They were found separately in the same deposit, one above the other in a very disturbed grave.
201109	Comb	Bone	Comb	1	Bone hair comb, small and slightly curved.
201495	Comb	Bone	Comb	1	Horn core comb with broken teeth. Curved slightly, the body has rounded edges.
201717	Hair comb	Bone	Comb	1	Small straight hair comb, possibly horn. Would have had 4 long teeth (2 broken and missing).
201718	Ring	Gold	Ring	1	Plain gold ring with no stamps or inscriptions. Made by creating a loop of metal and twisting it. The lines can be seen twisting around the ring.
201802	Bead and setting	Glass	Bead	1	Clear glass squared bead set within a coil of thin metal wire, no sign of chain or other attachment. The bead is domed on the front, but pointed on reverse.
202328	Fob watch	Metal		1	Glass faced fob watch with copper alloy chain, visible hands and Roman numerals in gothic font. Hands pointing at 4:05. 'Paris' written in the centre of the clock where 'V' is. Rear of watch did not show any surviving details of workings when x-rayed. Chain was in fragments but on x-ray a long thin section, a ring for attachment to the watch and several small chain fragments were revealed.

Table 40 Details of unusual finds from Residual, cemetery related finds

The 16 metal finds were mostly of iron. The finds include various types of coffin furniture and grave decoration and two examples of tools (Fig 43), probably belonging to gravediggers (Table 41).

Fig 43 Grave digging tools: the shovel (F202308) (Graverens arbejdsredskab: en skovl (F202308))

ID	Name	Material	Type	Number	Description
200389	Iron cross	Iron	Nail	1	Iron object in the shape of a cross, possibly coffin decoration or hinge
200688, 200689	Coffin handle	Iron	Handle	2	Two D-shaped handle with a centre decoration shape. The finials are curved upwards to meet the attachments. There are two zinc decorative attachments at the attachment ends. Both are circular rings that the iron nails and hinges use to attach to the coffin. Identical one found in SD7263, F200689
202120	Coffin stud	Copper alloy		1	The button of an originally upholstered coffin stud
202121	Coffin stud	Copper alloy	Button	2	The buttons of an originally upholstered coffin stud
202308	Shovel	Iron	Other	1	Blade of shovel with intact handle grip. Fragments of decayed wood handle still *in situ*. Found within a grave deposit
202313	Grave railing?	Iron		1	Hollow band of iron in rectangular shape around an object, similar to pieces of grave railings that can be seen in the cemetery
202494	Lump hammer	Iron	Hammer	1	Head of lump hammer or hand mattock with no handle. Found within a grave deposit
202655	Coffin fittings	Iron	Mount	2	Fragments of coffin mounts
203434	Coffin nails	Iron	Nail	5	Decorative coffin nails

Table 41 Details of metal finds from Residual, cemetery related finds

The remaining materials are dominated by the recovery of Queen Conch shells (*Eustrombus gigas*), particularly from the disuse deposit of a water drainage shaft. Coffin wood was also recorded when it was interpreted as secondary deposit with a deliberate intention (Table 42).

ID	Name	Material	Number	Description
200355	Conch shell	Organic material	1	Queen conch shell found in topsoil of Area 2.
200356	Conch shell	Organic material	1	Queen conch shell found in gravediggers' garden
201029	Coffin remains	Wood	1	Coffin wood and nails laid about 0.3m above an intact coffin. Possibly used as a grave/coffin marker and for easy disposal of moved remains.
201086	Coffin remains	Wood	1	Coffin wood remains used as a marker.
202306	Coffin wood 'marker'	Wood	10	Coffin wood and nails placed approx. 0.5m above the underlying coffin along with deliberately placed human bones, particularly skulls. Possibly a marker for the location of the underlying coffin.
203428	Denture	Plastic	1	Upper set of dentures, pink vulcanite rubber with all teeth missing, found in a deposit, not from the skeleton as it already had a full set.
203429	Conch shells	Organic material	80	Originally recorded as three conch shells found in upper layers of a drainage shaft for water supply. Later *c* 80 more were found in lower layers, only three were retained.

Table 42 Details of Residual, cemetery related, other finds

Residual or non-cemetery related finds

There were a total of 812 finds that could not directly be associated with cemetery activity. Many of these items could relate to the activities of visitors to the cemetery or the gravediggers but they cannot be attributed with certainty (Table 43). The material is dominated by ceramic pieces; many of these are from unstratified contexts, found within topsoil or cemetery soil. Some are considered residual pieces that have been retrieved from grave deposits. However there are some finds that derive from stratified contexts that are uncertainly related to cemetery activity, such as finds from the deposit of one rubbish pit (SD19000).

Subclass	No. Reg	Total	Weight	Description
Bone	4	98	5014	Animal bone
CBM	4	5	101	Pieces of roof tile, possibly from the gravediggers house or residual
Ceramic	121	497	11399.5	
Copper alloy	13	13	74.5	
Glass	27	113	5709,5	
Iron	1	1	10	
Lead	1	1	206	
Metal	2	2	9	
other	3	4	263	Oyster shells and one possible piece of rubber fixture
Tobacco pipe	25	75	153	
Plastic	1	1	11	Piece of electrical insulating wire, 20th century
Stone	1	1	2000	Natural glacier driven stone, registered because it forms part of a grave cut
Textile	1	1	800	
Total	**204**	**812**	**25750.5**	

Table 43 Summary of Residual or non-cemetery related finds by subclass

The animal bones consisted mostly of waste material which may have resulted from rubbish deposition related to the manuring of the fields prior to the cemetery or even during the active use of the cemetery. Small quantities of animal bone were retrieved from the topsoil but not quantified. A larger quantity was collected from the area of the gravediggers' garden (40 fragments) and these are thought to represent domestic waste from the gravediggers. They consisted purely of domestic animals, primarily cow and sheep/goat bones. A handle of a brush was also located and assumed to be a loss of a personal item or domestic waste. The beak bone of a small parrot was found within a disturbed grave fill (F201019).

An unusual find was of a deposit of articulated horse bones (F203432), 58 pieces), this lay close to the cemetery wall of Nørrebrogade about 0.5m below ground level. The bones were from two different horses, with the leg bones still articulated. There was no obvious sign of butchery. The deposition was not within a pit cut. It is not thought to be cemetery related but a deposit of domestic waste.

There are no ceramic finds indicating activity between the prehistoric period and when the cemetery was established in 1760. From the broad dating it is suggested that the finds are concentrated to the first half of the 19th century. A few finds might even suggest a dating (TPQ) of the graves, for example porcelain from 1820-50 found in the deposit for inhumation (G386). The larger sherds are found in clusters in the rubbish pits and the smaller ones as individual pieces in the deposits. The majority are sherds of flowerpots and general storage vessels but there are a small number of bowls and plates with occasional teacups showing an average range of domestic types (Table 44).

Ceramic types	No. Reg.	Total
Bowl	13	42
Flowerpot	19	116
Jar	2	4
Jug	1	1
Lid	2	3
Plate	19	71
Sherd	28	46
Vessel	25	197
Unknown	12	17
Total	**121**	**497**

Table 44 Summary of types of ceramic found in residual, or non-cemetery contexts

There are fragments of Chinese export porcelain – dating to 18th century or later – and also early Danish Royal Copenhagen porcelain which is produced from 1775. The patterns are Blue Flower and Blue Fluted. One has a stamp that is used from around 1820-1850. Two unusual finds are those of plain white glazed toy saucers (F2022236, 202236). These are too small for ordinary use and are interpreted as children's toys, found in unstratified deposits. Most of the tin-glazed fragments cannot be specifically dated or identified. There are sherds of English creamware from 1762-1820 and a piece of tin-glazed stamped "Sewell" – which is from St. Anthony's pottery in Newcastle-on-Tyne, which was taken over by Joseph Sewell in 1804. There are different kinds of redware from the 18th or 19th century, but it is not possible to identify the majority of the pieces. Some of it is probably Dutch (cow-horn decoration). Jydepotte, the black pottery from Jutland was exported from Jutland to Zealand from the late 16th century onwards. It varies little over the years and was used in the household as basic pottery. There are also many flower pot sherds. They are all unglazed and simple in their design.

The sherds are from bottles and window glass. They are probably all locally manufactured in Denmark. There are mainly two kinds of bottles, the cylindrical type with a sway or the hammered *bouteille*. The first kind was manufactured around 1800 and the second was manufactured from around 1825. The bottles appear as a testimony to the change in technology in the beginning of the 19th century. The bottles were usually used for beer or wine, but could also be used as more general containers. A single cylindrical bottle is manufactured from the 1750s. There is also a complete medicine bottle (F202134) of green-blue glass. The window glass is of different colours, both greenish and clear. There is little to identify them. An unusual find was a bead or clear glass prism from a chandelier (F202131) found within the destruction deposit of a vault.

There were a total of 17 items of metal; the majority of these comprised copper alloy coins from residual topsoil deposits indicating casual loss, some are likely to be øre coins. Only one could be identified and was Swedish, dated to the reign of Gustav Adolphus IV, from 1803 (F202117). A token (F202119) was found, with the inscription 'Britain' and the Britannia figure on the one side and on the reverse an incused H. This is interpreted as a token or commemorative coin. The remaining metal items were unidentifiable fragments but with one exception: from a rubbish pit came a heavy lead item (F202122) interpreted as some kind of stamp. It was rectangular with a handle but had lost the rubber plate which would have formed the stamp.

Fragments of tobacco pipe were found, mostly from grave deposits; 75 items in total. The clay pipes are mostly stems – there is only one bowl. The shape of the bowl, the stamps on the heel and bowl and the inscriptions on the stems all indicate that the pipes are from the late 18th century until the late 19thcentury. By this time other types of tobacco pipes became predominant. There is also an example of a porcelain pipe looking like a clay pipe. Despite there being production of clay pipes in Copenhagen from 1773, these examples all appear to be from Gouda, Netherlands. The size of the finds suggests residual deposition. A few stamps or makers' names were seen (Table 45), some pipes were rilled around the edges and the bowl found was smoke blackened.

ID	Makers' stamps
202223	P.P Hamer
202097	MARIE
202099	Milkmaid stamp and Gouda quality stamp
202101	IN GOUDA
202102	IN GOUDA
202093	IN GOUDA
202103	RORZELD

Table 45 Ceramic tobacco pipes with stamps or maker's marks (n=7)

A unique find in the upper layers of cemetery soil, close to the wall by Nørrebrogade was a late 20th century artificial fibre jacket (F200929). It is yellow with black dots, collar-less and waist length with two round yellow plastic buttons on the left side (Fig 44). The lining is slightly torn and of yellow polyester. On the left side is a metal clip for a badge, on the top right (by the shoulder) is a white string with a small key. On the top right shoulder are also three staples indicating other that other features were present but are now missing. Three silver coloured shiny plastic studs are on each shoulder, all are square shaped with a raised star form, and one stud on the left shoulder is rounded but the same material. On the right pocket is stapled white fabric with writing. On the back is also another area of staples and a patch of white fabric partly torn off.

A label on the inside left, states a brand name of 'CASABLANCA', this has a name 'Julian' written above it and an extra 'S' added onto Casablanca.

The jacket has many inscriptions and slogans written in Danish, English and Swedish both in the interior and exterior in black felt-tip pen and biro plus symbols which refer to the clash between authorities and political activists concerning the ownership of *Ungdomhuset* (the Youth House) on Jagtvej 69. *Ungdomhuset,* which borders the north-west of the site, was demolished in March 2007.

Fig 44 Yellow jacket from the 20th century (F200929) (Gul jakke fra det 20. århundrede (F200929))

Charnel groups and disarticulated human bone

All human bones that were not defined as *in situ* skeletons from graves were registered as finds within soil deposits. There were a total of 432 deposits that contained human bones. Defined charnel deposits accounted for 198 deposits and stratified deposits (grave fills) accounted for 234 deposits. Specific locations were not recorded for unstratified human bones but related only to topsoil. Definitions are discussed in the Methodology chapter. All bones, including those from general unstratified contexts were registered. The overall number of bones was not registered for the unstratified deposits, only the MNI (minimum number of individuals). This has a count of 183 individuals, mostly adults. There were more adults identified compared to subadults in all types of context (Table 46) with overall a total of 903 adults and subadults. More detailed information was collected for charnel deposits and stratified deposits and these form the basis for the results.

Human remains recovered	MNI adults	MNI subadults	Total MNI
Charnel groups	360	54	414
Stratified deposits	268	38	306
Unstratified finds (machine)	170	13	183
Total disarticulated/charnel	**798**	**105**	**903**
Total (including in situ analysed skeletons)	**1433**	**224**	**1757**

Table 46 Summary of human bone finds

Overall there is more bone represented in charnel groups – 5700 bones, from a total of 198 registered deposits, with an average of 28.79 bones in each deposit (Table 47). Most deposits contain a range between 8 and 30 bones but there appears to be no real pattern in the number of bones found. Only eight deposits contained over 100 bones. The highest amount in a charnel deposit is 360, the lowest five, which is the lowest number that could be defined as constituting a charnel deposit.

There are proportionally less bones found within the deposits that contained only disarticulated human bone – 1049 bones with an average of only 4.48 bones in each deposit. The highest amount of disarticulated bone from a deposit is 24 bones which were all small fragments. Overall 21% of the deposits contained only one piece of bone (Graph 1). Most deposits contain a range between one and six bones. This is a strong pattern which however is derived from and limited by the operational definition of a charnel group.

		Total no. of bones	Adult MNI	Subadult MNI
Charnel groups	Total	5700	360	54
	Average per deposit	28.79	1.82	0.27
Stratified deposits	Total	1049	268	38
	Average per deposit	4.48	1.15	0.16

Table 47 Summary of human bones found within charnel (n=198) and stratified deposits (n=234)

Age

There is more evidence for adult skeletons than subadult skeletons and more found per deposit regardless of the interpretive definition used (charnel or stratified deposit). However there is slightly more evidence for juvenile skeletons found within charnel deposits than in stratified deposits.

Sex

A total of 59% (255) of all deposits with human bone in them had no data for sex (n=432). Of the remaining 41% (177), 127 were charnel deposits and 50 were stratified deposits (Table 48). Attribution of sex was derived from individual bones based upon the morphological variations of the pelvis and skull. No attempt was made to combine this data. The figures show that there is a much greater chance of identifying some form of data on sex attribution from human bones found within charnel deposits.

	Total contexts	Total without sex data	Total with sex data	% with sex data
Charnel groups	198	71	127	64.1
Stratified deposits	234	184	50	21.3
Total	**432**	**255**	**177**	-

Table 48 Comparison of available sex data from types of interpreted context

Areas of the body

		Skull	Arms and hands	Torso and pelvis	Legs and feet
Charnel groups	Total	155	191	178	189
	%	*78*	*96*	*90*	*95*
Stratified deposits	Total	105	135	107	157
	%	*45*	*58*	*46*	*67*

Table 49 Comparison of areas of the skeleton represented in charnel (n=198) and stratified deposits (n=234)

Charnel groups contained a higher level of representation from all areas of the body compared with stratified deposits. The percentage represented varied in charnel groups from 78% to 96%. In stratified deposits it was from 45% to 67% (Table 49). This is expected simply due to the relative number of bones. Both types of contexts had the lowest levels for the skull, followed by the torso and pelvis. Stratified deposits then contained more bones from arms and hands followed by bones from legs and feet. In charnel groups, arms and hands, and legs and feet were represented almost equally, with only 1% difference, showing a consistent level of collection of types of bones.

Osteological results

During the excavation 854 *in situ* skeletons were excavated in addition to a significant amount of disarticulated human bone. The following analyses by Marie Louise S. Jørkov

are focused on the skeletons, not the disarticulated remains. The charnel and disarticulated remains are discussed as finds. A total of 338 individuals (39.6%) underwent full osteological analysis, 111 individuals (13%) underwent low resolution osteological analysis in the laboratory, whilst 405 individuals (47.4%) underwent a less detailed assessment in the field (Table 50). The results of the different methods are combined for this report, and only presented and discussed separately where relevant. The different degrees of accuracy in the approach are acknowledged.

Human remains recovered	MNI adults	MNI subadults	Total MNI
Full analysis	255	83	338
Low resolution analysis	97	14	111
Field assessed	383	22	405
Total analysed	***735***	***119***	***854***
Total disarticulated/charnel	**798**	**105**	**903**
Total (analysed and disarticulated)	**1433**	**224**	**1757**

Table 50 A summary of all human remains recovered

Preservation and completeness

Of the 854 skeletons only 713 had preservation registered. A total of 360 individuals (42.2%) scored as “good”, 254 (29.7%) as “moderate” and only 99 (11.6%) as “poor” (Fig 45). The first field assessed skeletons did not have preservation or completeness registered by the osteologists. However, changes in the recording procedure included this detail for later field assessed skeletons. The majority of the skeletons with unknown preservation and completeness are the field assessed skeletons. The missing data can be supplemented from IntraSIS, as the archaeologists always recorded preservation and completeness in the field.

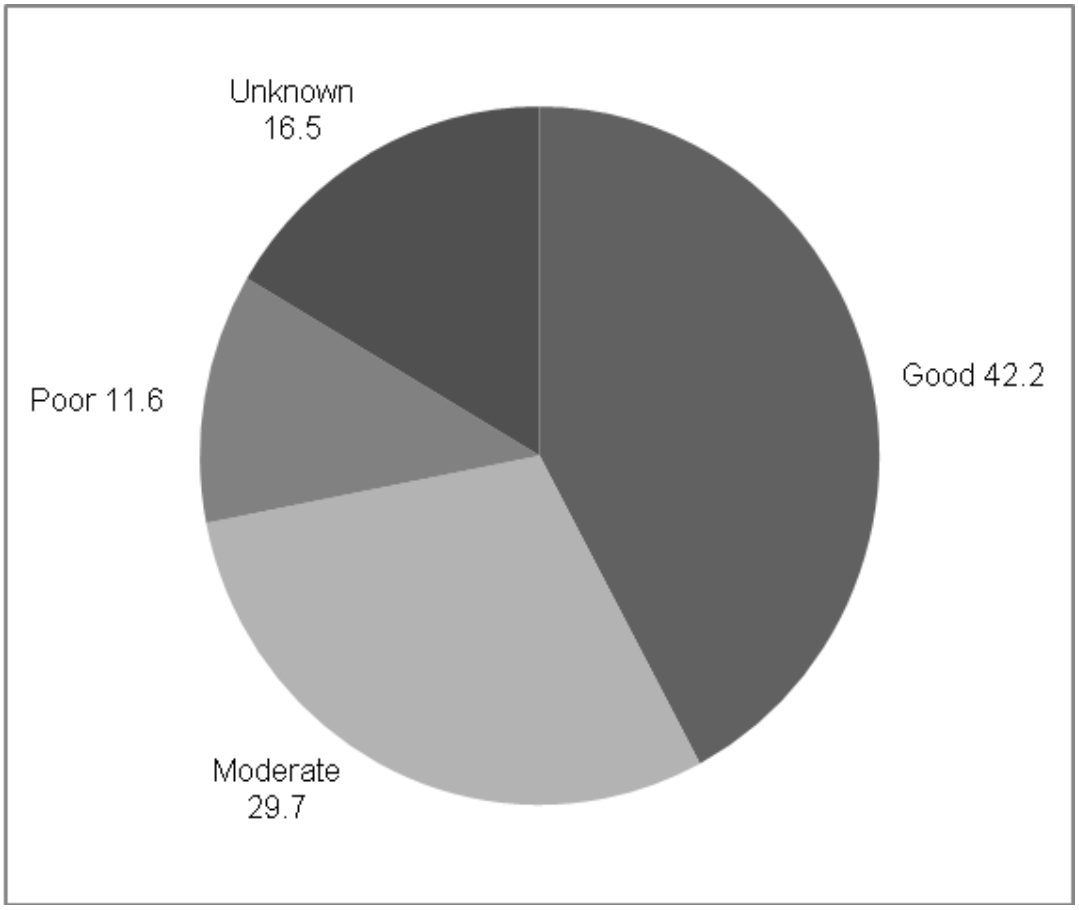


Fig 45 Preservation status for all data (N=854) (Bevaringstilstand for det samlede materiale (N=854))

The completeness was registered in 5% increments (5-95%), but for the purpose of simplicity when representing the results, these have been pooled into four categories: Group 1 =<25%, Group 2 = <50%, Group 3 = <75% and Group 4 = <95%. Of the assemblage 11% (n=94) was 50% complete or more, 54.6% (n=466) was up to 95% complete (Fig 46, Table 51). The remaining 141 cases (16.5%), the majority of which were field assessed, did not have their completeness registered. In the initial stages of the project, it was agreed that all field assessed skeletons had to be less than 50 % complete and did, therefore, not have their completeness registered. The skeletons of unknown completeness are therefore likely to be less than 50% complete.

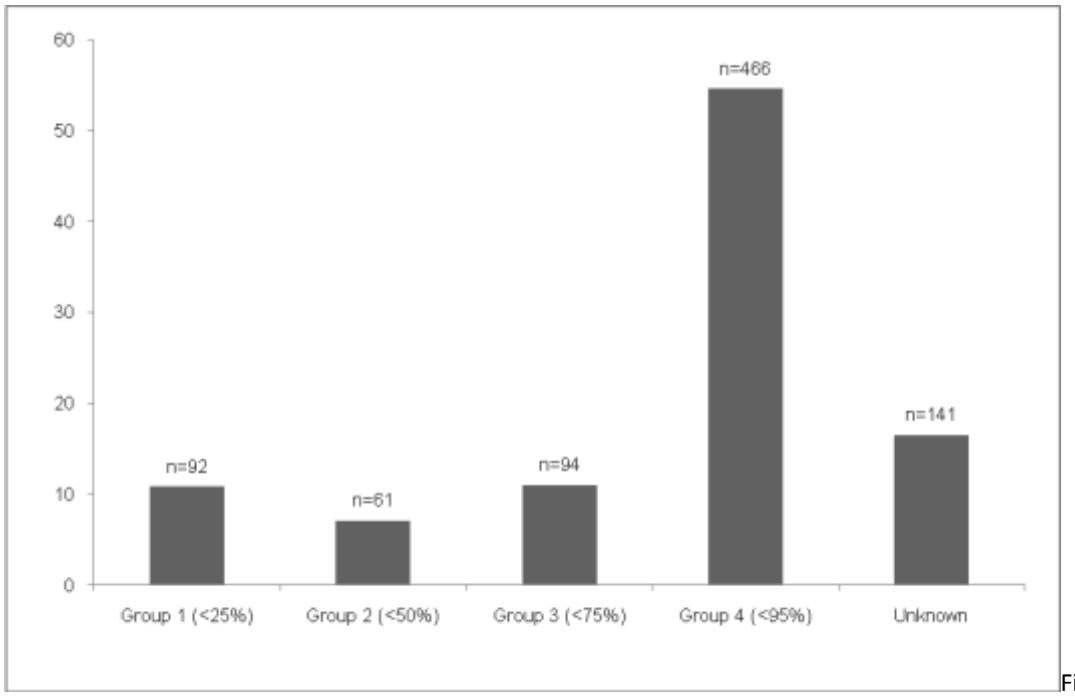


Fig 46 Completeness for all data (N=854) (Samlet angivelse af bevaringsgrad (N=854))

	Preservation									
	Good		**Moderate**		**Poor**		**Unknown**		**Total**	
Completeness	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Group 1 (<25%)	18	19.6	42	45.7	32	34.8	0	0.0	92	10.8
Group 2 (<50%)	19	31.2	16	26.2	26	42.6	0	0.0	61	7.1
Group 3 (<75%)	33	35.1	45	47.9	16	17.0	0	0.0	94	11.0
Group 4 (<95%)	290	62.2	151	32.4	25	5.4	0	0.0	466	54.6
Unknown	0	0.0	0	0.0	0	0.0	141	100.0	141	16.5
Total	**360**	**42.2**	**254**	**29.7**	**99**	**11.6**	**141**	**16.5**	**854**	**100**

Table 51 Summary of completeness and preservation

Details on preservation and completeness for the separate groups (i.e. full analysis, low resolution analysis and field assessed skeletons) can be found in Appendix 6.

Hair, either facial or head was recovered from 81 individuals (9.5%). A distinction between facial or head hair has not been made here (Table 52). Where possible brief notes were made on hairstyle, colour and the presence of wigs. These details can be found in the archive. Nails from either hands or feet were recovered from 26 (3.0%) individuals.

	Male		**Female**		**Unsexed adult**		**Subadult**		**Total**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Hair	26	32.5	35	43.2	10	12.4	10	12.4	81	9.5
Nail	10	38.5	8	30.8	4	15.4	4	15.4	26	3.0

Table 52 Frequency of hair and nail preservation according to sex

Varying quantities of dried soft tissue and or adipocere adhered to elements in 81 individuals (9.5%), with the chest being the most common site (2.9%, n=25), followed by pelvis in 2.8% (n=24), legs in 1.5% (n=13), arms and legs in 0.8% (n=7) and head in 0.8% of cases (n=6) (Table 53).

	Male		Female		Unsexed adult		Subadult		Total	
Soft tissue	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Head	5	71.4	1	14.3	1	14.3	0	0.0	7	0.8
Chest	7	28	9	36.0	7	28.0	3	12.0	25	2.9
Pelvis	8	33.3	7	29.2	6	25.0	3	12.5	24	2.8
Arms	2	28.6	1	14.3	2	28.6	2	28.5	7	0.8
Legs	5	38.5	4	30.8	2	15.4	2	15.4	13	1.5

Table 53 Preservation of soft tissue according to anatomical area and sex

Staining on the skeleton from iron nails in coffins or copper buttons from clothing was seen in 58 individuals (6.8 %) (Table 54). The staining was often positioned on the sternum, anterior portion of vertebral bodies (thoracic vertebrae), on lower arms and lower legs. A more detailed anatomical position of the staining can be found described in the archive data. Dark pink staining was noted on the facial skeleton of one individual (SB3990), which has been associated with chemical erosion of iron nails and fittings or the result of yeast colonization as seen at Christchurch, Spitalfields (Molleson et al. 1993: 13).

	Male		Female		Unsexed adult		Subadult		Total	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Staining	20	34.5	30	51.7	4	6.9	4	6.9	58	6.8

Table 54 Frequency of staining from iron nails or copper buttons from clothing according to sex (Hyppigheden af afsmitning fra jernnagler eller kobberknapper fra tøj, relateret til køn)

Demography

Demographic analysis of past populations often concentrates on mortality since, in the absence of historical records, fertility and migrations can only be inferred from the osteological data. The relatively modern date of this assemblage means that it is possible to obtain documentary sources on the individuals buried here. However, the results presented here are purely based on the osteological examinations, as further work needs to be undertaken to identify individuals archaeologically.

Sex

Of the 642 adults that could be sexed, 321 (50%) were sexed as male or possible male and 321 (50%) were sexed as female or possible females (Fig 47). This gives a male to female ratio of 1:1. When sub-grouping sex attribution 249 (38.8%) were sexed as males, 72 (11.2%) as possible males, 84 (13.1%) as possible females and 237 (36.9%) as females. A total of 99 adults could not be sexed, of whom 40 (40.4%) were noted as ambiguous sex and 59 (59.6%) as unsexed adults. Six of the subadult individuals from the adolescent age group had developed significant sexually morphological traits to suggest sex; one as male, one as possible male and four as female.

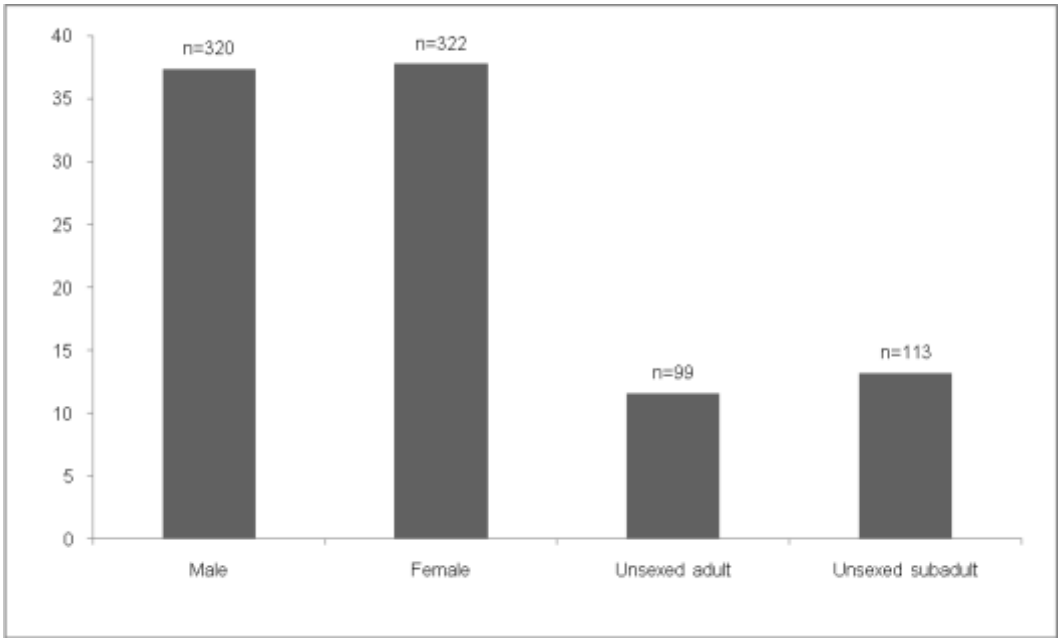


Fig 47 Distribution of sex for all data (N=854) (Den samlede kønsfordeling (N=854)

Age

The adult individuals significantly outnumbered sub-adults. The adults comprised 735 (86.1%) of the assemblage compared to 119 (13.9%) sub-adults. Of the adults, 90 individuals (12.2%) could not be aged to any degree of precision, but merely categorized as adults. Mortality increased with age, with 192 individuals (26.1%) reaching old adult age (56+ years).

In this assemblage, 51 (6.0%) individuals did not survive the first year of life (≤36 gestational weeks (gw)->1y) (Fig 48, Table 55). Almost the same number of *in situ* skeletons 52 (6.2%) were found of children aged between 1 to 11 years. In late childhood the immune system is fully developed, therefore, if a child survives the first critical years of life, the likelihood of surviving into adulthood is high. Only 13 (1.5%) individuals died in an adolescent age (between 12-17 years). In the young adult age group accounting for 25 individuals (2.9% of the total assemblage), 14 were males and 11 were females. For females, the young adult age is said to be the prime child bearing age. The mortality between males and females in the middle aged category is nearly equal, but again with highest prevalence found among males (25.2%, n=81 versus 23.4%, n=75 females). There is a lower longevity among the male population in the mature adult age group with a mortality of 23.4% (n=75) compared to the female group of 17.4% (n=56). However, more females than males lived to reach old age (34.6% versus 24.6%, respectively).

When data of the skeletons that underwent full analysis and low resolution analysis are pooled the number of individuals is 443 (353 adults and 90 subadults). The demographic distribution of these individuals is presented in table 56. There is an overrepresentation of females (n=181) compared to males (n=162).

Details of demographic distribution between methods can be found in Appendices 7 – 10.

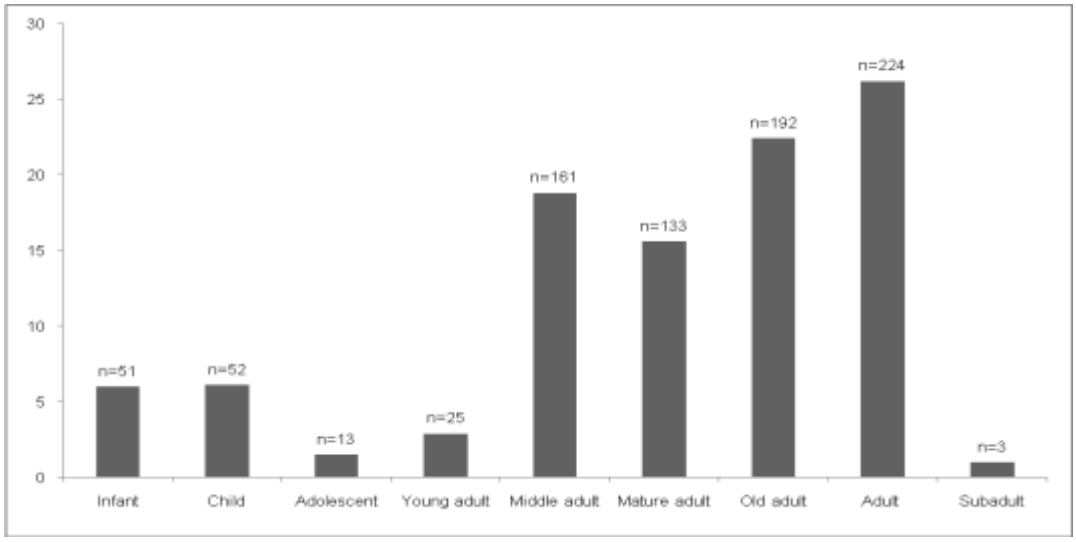


Fig 48 Distribution of age for all data (N=854) (Samlet angivelse af aldersfordeling (N=854))

		Male		Female		Unknown sex		Total	
Age group	**Years**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Infant	≤36gw-<1	0	0.0	0	0.0	51	23.4	51	6.0
Child	1-11	0	0.0	0	0.0	52	23.9	52	6.1
Adolescent	12 - 17	0	0.0	0	0.0	13	6.0	13	1.5
Young adult	18 - 25	15	4.7	10	3.2	0	0.0	25	2.9
Middle adult	26 - 45	81	25.4	75	2.4	5	2.3	161	18.9
Mature adult	46 - 55	75	23.5	56	1.8	2	0.9	133	15.6
Old adult	56+	78	24.5	112	35.3	2	0.9	192	22.5
Adult	18+	70	21.9	64	20.2	90	41.3	224	26.2
Subadult	<18	0	0.0	0	0.0	3	1.4	3	0.4
Total		**319**	**37.4**	**317**	**37.1**	**218**	**9.5**	**854**	

Table 55 Demographic distribution of all data with pooled sex categories (N=854)

		Male		Female		Unknown sex		Total	
Age group	**Years**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Infant	≤36gw-<1	0	0.0	0	0.0	41	41.0	41	9.2
Child	1-11	0	0.0	0	0.0	44	44.0	44	9.9
Adolescent	12 - 17	0	0.0	0	0.0	5	5.0	5	1.1
Young adult	18 - 25	11	6.8	7	3.9	0	0.0	18	4.1
Middle adult	26 - 45	34	21.0	46	25.4	0	0.0	80	18.1
Mature adult	46 - 55	47	29.0	36	19.9	0	0.0	83	18.7
Old adult	56+	57	35.2	77	42.5	2	2.0	136	30.7
Adult	18+	13	8.0	15	8.3	6	6.0	34	7.7
Subadult	<18	0	0.0	0	0.0	2	2.0	2	0.5
Total		**162**	**36.6**	**181**	**40.9**	**100**	**22.6**	**443**	

Table 56 Demographic distribution of skeletons being fully analysed and those that underwent low resolution analysis (N=443).

Living stature

Stature is the only dimension included in this report. An equation for stature estimation was calculated in cases where intact femora or tibiae were available for measurements of maximum length. Although stature estimation may possibly be based on other limb bones, the lower limbs are recommended as the highest accuracy can be obtained from here (Buikstra & Ubelaker 1994). The femur has been preferred in order to obtain as large and uniform a material as possible.

The living stature was estimated for 183 adult males and 185 adult females out of the total assemblage (Fig 49). The estimated adult male stature ranged between 1.59m and 1.84m with a mean stature of 1.72m (±5.6 SD). Adult female statures ranged between1.46m and 1.76m, with a mean stature of 1.61m (±5.7 SD). Thus, males were on average 0.11m taller than females. The range of 0.30m in female stature is slightly larger than the 0.25m for males. Further analysis on stature can be found in Jørkov (2015).

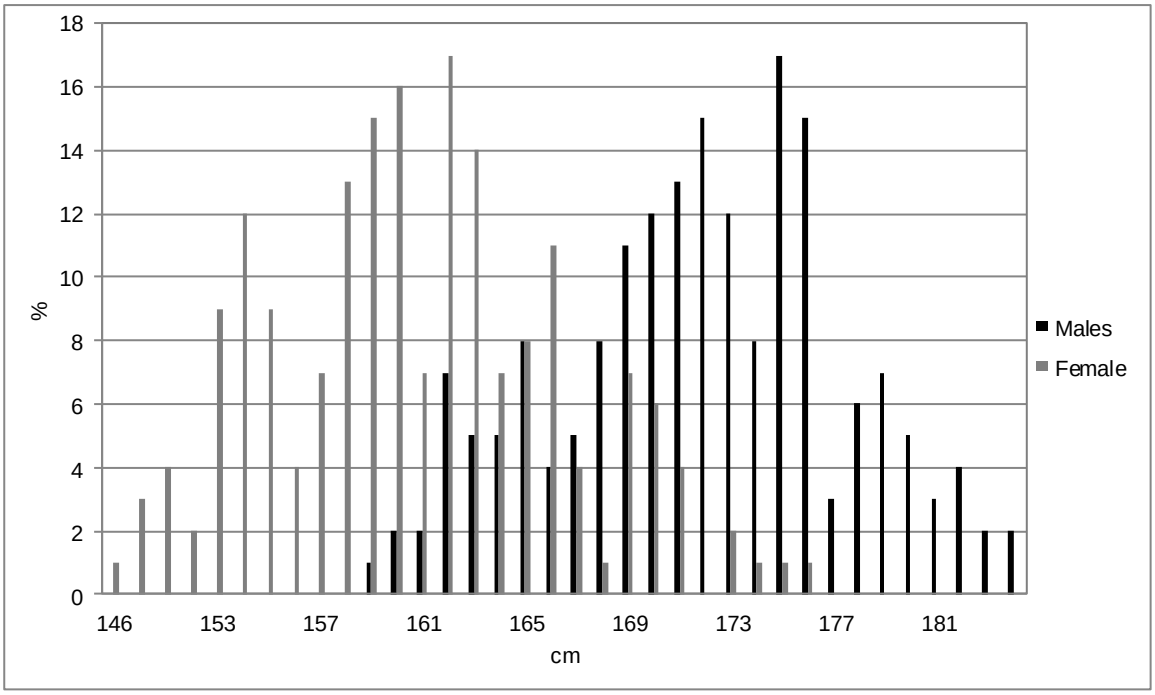


Fig 49 Stature among males (n=183) and females (n=185) based on maximum long bone length (Legemshøjde for mænd (n=183) og kvinder (n=185) baseret på den maksimale længde af lårbensknoglen).

Further data, which has been recorded, but are beyond the scope of this report, include metrical data and non metric traits. Detailed metrical data on skull and long bones was performed on the fully analysed skeletons. The data is useful when analysing ancestry, genetic variations, and robusticity and sex differences. Metrical data from skeletons of low resolution analysis and selected field assessed skeletons can be obtained from radiographs in the archive.

It was never the intent to fully document non metric traits on this assemblage. This was mainly due to time limits. However, some traits were noted when observed. The results of these can be found in the pathology section.

Pathology overview

A wide range of pathologies was observed in the Assistens assemblage, many of them age-related. They include dental pathologies and skeletal pathologies. Also observed were surgical interventions.

The data presented in the following sections was obtained from the fully analysed and from the low resolution analysed skeletons in the laboratory (N=443). For the purpose of simplicity when representing the frequency of the data, the sex and age groups have been pooled (see methodology section for specification). Only crude prevalence rates are presented (i.e. summary data) as a more detailed analysis of the data is beyond the scope of this report. However, the crude prevalence rates should be seen as indicator of the potential of the assemblage. Full details on pathology of each individual can be found in the archive data.

Dental health and disease

Dental diseases are among the most common conditions seen in human remains. The long-term presence of microorganisms in dental plaque deposits in the mouth gives rise to a range of conditions such as caries, periodontal disease and ante mortem tooth loss. Plaque-related disease is in turn strongly related to the progress of dental wear, and to the remodelling of the jaws taking place independently, in response to changing mechanical forces. Dental pathology rates are outlined below (Table 57).

The presence or absence of teeth was recorded in a coded system following Connell & Rauxloh (2003) and Powers (2008). A total of 70.7% (313/443) of the individuals had one or more teeth present. Of these, 39.6% were males (n=124/313), 35.5% females (n=111/313), 0.6% (n=2/313) were unsexed adults and 24.3% (n=76/313) were subadults.

	Male		Female		Unsexed adult		Subadult		Total	
	n	%	n	%	n	%	n	%	n	
Teeth present	124	39.6	111	35.5	2	0.6	76	24.3	313	70.7
AM tooth loss	113	54.3	91	43.8	2	1.0	2	1.0	208	66.5
Edentulous	22	13.6	66	36.5	1	10.0	0	0.0	89	20.1
Caries	98	46.5	90	42.7	2	1.0	21	10.0	211	67.4
Calculus	82	66.1	79	47.9	2	1.2	2	1.2	165	52.7
Abscesses	38	54.3	32	45.7	0	0.0	0	0.0	70	15.8
PD	83	58.0	57	39.9	2	1.4	1	0.7	143	45.7
EH	20	41.7	23	47.9	0	0.0	5	10.4	48	15.3
Full dentures	5	22.7	17	77.3	0	0.0	0	0.0	22	24.7
Partial dentures	9	29.0	22	71.0	0	0.0	0	0.0	31	9.9
Fillings	12	36.4	21	63.6	0	0.0	0	0.0	33	10.5
Pipe notch	0	0.0	1	100.0	0	0.0	0	0.0	1	0.3

Table 57 Summary with crude prevalence rates of dental pathology and interventions observed

Ante-mortem tooth loss

Ante-mortem (AM) tooth loss is regarded as a degenerative disease where the main contributory factors are old age and poor oral hygiene. Teeth may be lost due to periodontal disease, severe caries lesions or from periapical abscesses, which form through the exposure of the pulp cavity as a result of caries or excessive attrition coupled with localised resorption of the alveolar margin. The AM tooth loss is recorded on the basis that one or more teeth have been lost AM. If an individual only has a single tooth remaining in the jaw, this individual is recorded as having AM tooth loss. Individuals with complete AM tooth loss were recorded as edentulous. Individuals with only a maxilla or mandible preserved, and this being edentulous, were recorded as being edentulous. A significant number of individuals with observable dentition had lost

one or more teeth during life (66.5%, n=208/313). Males accounted for 54.3% (n=113/208) and 43.8% (n=91/208) were females. A notable difference between sexes was seen for the complete edentulous individuals. Overall 89 individuals (20.1%) were edentulous. Females were toothless in 36.5% cases and 13.6% of the males were toothless

Caries

Dental caries involves destruction of the enamel surface, the dentine (underneath the enamel) and/or the cementum (the outer layer of the root) (Hillson 1996: 269). Caries was recorded at individual tooth level. The location and severity of each carious lesion was classified according to Buikstra & Ubelaker (1994: 55) and Powers (2008: 23). A carious lesion was recorded when a clear cavity was present. Pigmentations of the enamel were not considered caries. For the purpose of this report, the crude prevalence of caries is presented per individual and not per tooth. The results showed that 67.4% (n=211/313) had one or more caries lesions, 46.5% (n=98/211) were male, 42.7% (n=90/211) were female, one was of unsexed adult and 10% (n=21/211) of the subadults had one or more caries lesions.

Calculus

Calculus consists of mineralised plaque composed of microorganisms that accumulate in the mouth and become embedded in a matrix of protein and saliva. There are two types of calculus: supragingival calculus found above the gum line and subgingival calculus found below the gum line on exposed roots (Roberts & Manchester 2001: 55). The deposits can irritate the soft tissue and the underlying bone, which can lead to the reduction of the bone (periodontal disease) and ante-mortem tooth loss (Roberts & Manchester 2001: 45). Sugar and starchy foods accelerates this process (Hillson 1996: 254). Calculus deposits were recorded by tooth and by location on the tooth. The severity of calculus was recorded as slight, medium or considerable deposition following Brothwell (1981: 155). In this report the prevalence of calculus is presented per individual with teeth present showing evidence of calculus. Calculus deposits were observed in 52.7% of the individuals (n=165/313). Calculus was slightly more prevalent among males (49.7%, n=82/165) than females (47.9%, n=79/165). Two unsexed adults and two subadults also displayed calculus. Regular tooth brushing removes plaque deposits and thereby prevents the formation of calculus. It is however, unlikely that these individuals brushed their teeth regularly.

Peri-apical abscesses

There are many factors that influence the development of periapical abscesses (pus draining sinuses) in the alveolar bone. An abscess indicates pulp chamber inflammation. The bacteria may enter the pulp cavity through dental caries, due to excessive attrition or due to trauma to the crown. An abscess can also develop as a consequence of periodontal disease. When a periodontal pocket is formed by the accumulation of bacteria within the pulp cavity the infection can track down to the root apex. As the pus accumulates within the dental socket and surrounding alveolar bone, local pressure builds and eventually precipitates the formation of a hole or sinus in the jaw. The pus drains out of the sinus into the overlying soft tissues of the gums. The recording of presence and location followed Buikstra & Ubelaker (1994: 55). A total of 70 individuals (22.4, n=70/313) had one or several abscesses in the alveolar bone resulting from infection in the apical tissues. The majority of these individuals, 54.3% were males (n=38/70) versus 45.7% females (n=32/70).

Periodontal disease

There is a strong link between the increase of age and the increase of the prevalence of periodontal disease in modern populations, which is also the case with archaeological populations. However, the aetiology is multifactoral with genetic predisposition, environment, diet and hygiene all being predisposing factors in the development of the disease. Periodontal disease is a chronic bacterial infection that affects the gums (gingivitis) and alveolar bone supporting the teeth (periodontitis). It begins when the bacteria in plaque (calculus) causes the gums to become inflamed. The gums separate from the teeth, forming pockets that become infected. With time, the inflammation spreads below the gum line and is transmitted to the alveolar bone itself. As the disease progresses, the pockets deepen and more gum tissue and bone are destroyed. Often, this destructive process has very mild symptoms and the minor degrees of infection may only involve the soft tissues (Brothwell 1981: 156). Eventually, teeth become loose and or fall out. The first stage affecting the soft tissue (gingivitis) cannot be observed in skeletal remains.

The severity of periodontal disease was recorded using the grades slight, medium and considerable, set out by Brothwell (1981: 155). Periodontal disease was observed in 45.7% of the individuals (n=143/313) of which 58% were males (n=83/133) and 39.9% were females (n=57/133). The severity ranged from slight to considerable. Notes on severity can be found in the archive. The prevalence of periodontal disease does not include edentulous individuals as the reason for antemortem tooth loss is multifold.

Defects in the enamel of the tooth crown

Enamel hypoplasia (EH) is a disturbance in the mineralization of the enamel. The defects are observed as lines, pits or grooves on the enamel surface and usually more easily observed on the buccal side of incisors and canines. There is a whole range of factors that may disrupt crown development. These include nutritional deficiency, childhood fevers (e.g. measles) and major infections (Hillson 1996; Goodman & Rose 1990) and are often termed as indicators of stress. Since the defects only occur while the teeth are developing (i.e. during childhood), they remain as a permanent record into adulthood. The enamel hypoplastic defect was represented in 48 (15.3%) of the individuals; 20 males ,23 females and 5 subadults.

Dental interventions

Given the date of the assemblage, evidence of dental treatment was expected, though it would have largely been dependent on economic circumstances. At Assistens 24.7% (n=22/89) of the edentulous individuals had a complete set of dentures (i.e. full prosthesis in maxilla and mandibula). They were most prevalent among females with 77.3% (n=17/22) compared to 22.7% males (n=5/22). The material of the full dentures often consisted of red vulcanite rubber (*kautsjuk*) with porcelain teeth (Fig 50). However, one set of dentures was more elaborated (Fig 51).

Partial dentures, defined as a prosthesis containing a single or several teeth in the maxilla or mandible, was seen in 9.9% (n=31/313) of the individuals. Again, females had the highest prevalence (n=22) compared to males (n=9). The prosthesis was usually of porcelain teeth on a supported gold/copper alloy or other metal fitting that encircled a present tooth or teeth and kept the denture in place, the fitting could also be made of vulcanite rubber. The quality of the modelling of the teeth varied considerably.

Fig 50 Full set of dentures made of vulcanite rubber and porcelain teeth (SB53924) (Helt gebis lavet af kautsjuk isat porcelænstænder (SB53924))

Fig 51 Full set of dentures made of swagged gold and ivory teeth (F201938) (Helt gebis lavet af valset guld isat elfenbenstænder (F201938)

Fillings

Thirtythree of the 313 individuals (10.5%) with present teeth had one or more fillings observed in their dentition. All were identified in adults. None were observed among the subadults. The fillings were either made of amalgam, gold or silica - a tooth coloured filling used prior to plastic fillings (Table 58 and Fig 52).

	Males		Females		Total	
	n	%	n	%	n	%
Fillings (no of individuals)	12	36.4	21	63.6	33	10.5
Amalgam filling	11	39.3	17	60.7	28	84.9
Gold filling	3	60.0	2	40.0	5	15.1
Tooth coloured filling	2	15.4	11	84.6	13	39.4
Root filling	1	100.0	0	0.0	1	3.0
Gold crown	1	50.0	1	50.0	2	6.1
Veneers	2	100.0	0	0.0	2	6.1

Table 58 Crude prevalence rates for type of fillings and veneers observed among individuals with teeth present (N=313). None were observed among the unsexed adults and subadults

Fig 52 Occlusal view of maxilla. Extensive dental work including amalgam, tooth coloured fillings, veneers and gold crowns (SB53910) (Okklusalfladen i overkæben. Der ses omfattende tandarbejde, inklusiv amalgamfyldninger, tandfarvede fyldninger, porcelænsfacader og guldkroner (SB53910)).

Pipe notch

One mature adult female displayed wear pattern to the surface of the left mandibula canine tooth (Fig 53). The wear was formed as a smooth circular groove a 'pipe notch'. Such grooves, often smooth and rounded, have been related to long term pipe smoking. They may develop over several years suggesting that smoking could have been taken up at a younger age.

Fig 53 Pipe notch in canine (tooth 33) observed in mature adult female (SB51223), buccal view and lingual view (Hul til pibe i hjørnetand (tand 33), observeret hos en voksen kvinde (SB51223), set fra den faciale og linguale side)

Other dental features that were noted include the presence of staining or other miscolouration of teeth, dental fluorosis and dental occlusions. It has not been possible to systematically quantify dental staining resulting from smoking, at this stage, but descriptive data on staining can be found in the data archive.

Skeletal pathology

Observation of skeletal pathology was limited by the variable preservation as well as analysis procedure. Most diseases affect the soft tissue and it is only the chronic diseases that can be observed on the skeleton. The recorded pathologies fall into the following broad categories: infectious disease, metabolic disease, joint disease, trauma, congenital disorders, neoplastic disease, circulatory disease and miscellaneous diseases. An additional unspecified group called "individual other" contained a number of individual anomalies, unidentified pathologies or surgical interventions (See table 74). Only crude prevalence rates are presented (Table 59). Full details on individuals can be found in the data archive.

		Male		Female		Unsexed adult		Subadult		Total	
Disease category	**Sub group**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Infectious disease	NSI	55	34.0	49	27.1	1	10.0	6	6.7	111	25.1
	SI	2	1.2	1	0.6	0	0.0	0	0.0	3	0.6
	OI	5	3.1	4	2.2	0	0.0	0	0.0	9	2.0
Metabolic disease		3	1.9	38	21.0	2	20.0	17	18.9	60	13.5
Joint disease	JD	118	72.8	115	63.5	3	30.0	0	0.0	236	53.3
	JOA	42	25.9	66	43.7	1	10.0	0	0.0	109	24.6
	VOA	56	34.6	66	43.7	2	20.0	0	0.0	124	28.0
Trauma	Fracture	37	22.8	30	16.6	1	10.0	1	1.1	69	15.6
	Autopsy	7	4.3	11	6.1	1	10.0	1	1.1	20	4.5
Congenital		28	17.3	32	17.7	1	1.0	8	8.9	69	15.6
Neoplastic		1	0.6	9	5.0	0	0.0	1	1.1	11	2.4
Circulatory		6	3.7	4	2.2	0	0.0	0	0.0	10	2.3
Miscellaneous		16	9.9	23	12.7	1	10.0	16	17.8	56	12.6

Table 59 Crude prevalence rates of skeletal pathology categories observed among 443 individuals (162 males, 181 females, 10 unsexed adults and 90 subadults . NSI=Non specific infection, SI=Specific infection, OI= Other infections, JD=Joint disease, JOA=Joint osteoarthritis, VOA=Vertebral Osteoarthritis

Infectious disease

Infectious disease can be broken into two broad groups: specific infection and non-specific infection. A third group "other infection" was added. This group include pathological changes that are infectious, but cannot be placed into a specific or non specific classification (Table 60).

			Male		Female		Unsexed adult		Subadult		Total	
Infectious disease	**Sub group**	**Pathology code**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Non specific infection (NSI)	Periosteitis	211	43	26.5	44	24.3	1	10.0	6	6.7	94	21.2
	Maxillary sinusitis	21	2	1.2	2	1.1	0	0.0	0	0.0	4	0.9
	Osteomyelitis	212	4	2.5	1	1.1	0	0.0	0	0.0	5	1.1
	Osteitis	214	3	1.9	1	1.1	0	0.0	0	0.0	4	0.9
	Unidentified NSI	215	12	7.4	11	6.1	0	0.0	1	1.1	24	5.4
Specific infection (SI)	Tuberculosis	221	1	0.6	0	0.0	0	0.0	0	0.0	1	0.2
	Venereal syphilis	222	0	0.0	1	1.1	0	0.0	0	0.0	1	0.2
	Brucellosis	224	1	0.6	0	0.0	0	0.0	0	0.0	1	0.2
Other infection (OI)	Septic arthritis	232	3	1.9	1	1.1	0	0.0	0	0.0	4	0.9

Table 60 Crude prevalence rates of infectious diseases (N=443; 162 males, 181 females, 10 unsexed adults, 90 subadults)

Non specific infection

Non specific infection is an inflammation of the periosteal membrane that covers the bone. This inflammation may lead to new periosteal bone formation. Infection may be introduced directly as a result of trauma, develop in response to an adjacent soft tissue infection or spread via the blood stream from foci elsewhere in the body. It is often difficult to detect the causative factors involved in individual cases and the lesions are commonly classified as indicative of a non-specific infection. The manifestation of periosteitis, maxillary sinusitis, osteitis, and osteomyelitis are all caused by an unspecified micro-organism.

Periosteitis

Periosteitis is an inflammation of the periosteum and usually arises secondary to an infection of the overlying soft tissue. Periosteitis is also used as a descriptive term for bony change when the change forms part of the diagnostic criteria of a specific condition (for example an infectious disease or trauma), but is also used to describe lesions that are not pathognomonic of a specific disease for example, maxillary sinusitis. It may be associated with local haemorrhage due to trauma, certain metabolic disorders (scurvy or excess vitamin intake), and chronic skin lesions but can also accompany neoplasms, physiological stress and degenerative changes (Aufderheide & Rodríguez-Martín 1998: 179). In this study periosteitis as a pathognomonic term, was observed in 94 (21.2%) individuals. Males were affected in 26.5% of the cases (n=43), females in 24.3% (n=44), one of the unsexed adults were affected and 6.7% of the subadults (n=6) were affected. True prevalence by element is reported in the archive data.

Maxillary sinusitis

The aetiology behind maxillary sinusitis is multifactoral and may be caused by allergies, smoke, house dust and upper respiratory tract infections (Roberts & Manchester 2001: 131). It can also occur due to spread of an infection from internally draining dental abscesses. Its presence among the assemblage would not be unexpected due to the smoky environments and polluted air of 19th and early 20th century Copenhagen as well as poor dental hygiene. The vast majority of crania from the analysed sample were intact, and hence could not be examined. Maxillary sinusitis is therefore likely to have been considerably under recorded in this sample. New bone formation was observed within the maxillary sinuses in four adults (0.9%), two males (one mature and one old adult) and two females (both middle aged adults).

Osteomyelitis

Osteomyelitis is an inflammation of the bone cortex and bone marrow and is almost always caused by pus-producing microorganisms. The infection may be spread through the blood (haematogenous spread), by direct spread from an infection in an overlying or adjacent organ or by direct implantation by penetrating wound or following compounded fractures or surgery. The bacteria staphylococcus aureus are responsible for the greatest number of infections (*c* 90% of cases today) (Waldron 2009: 85), which spreads through the blood stream and causes localised skin infections. Malnutrition and decreased immune system may play a part in the pathogenesis. It would have been painful, causing fevers and limiting mobility (Ortner 2003). If left untreated it could be lethal. In this assemblage, five individuals (1.1%), four males (two mature adult and two old adult) and one female (middle aged adult) had osteomyelitis.

Osteitis

Osteitis is an inflammation of the bone cortex. It generally causes the bone to hypertrophy (swell) with the cortex becoming thickened and the medullary cavity eventually obliterated. It always produces plaque-like periosteitis, but can be distinguished from osteomyelitis by not having pus drainage holes (cloacae) (Ortner 2003: 51). Four individuals (0.9%) had skeletal changes consistent with osteitis, one was an old adult female and three were males (one old adult and two aged as adult).

Further 24 individuals (5.4%) displayed possible pathological characteristics of a non specific infection seen as proliferative reactions both healed and active that could not be identified further.

Specific infection

Infectious diseases (bacteria and viruses) account for the majority of deaths in the past (pre-antibiotic times). The majority of infections were spread by faeco-oral route due to unclean water. Infants and children were highly vulnerable to acute gastrointestinal and respiratory infections (Lewis 2007). The infection seen in bone is associated with the pathological process of inflammation. Most infectious diseases primarily affect the soft tissues and are therefore rarely seen in the skeleton. However, some soft tissue infections may cause change to bone if the periosteum, the lining of the bone, is involved. The changes can occur as part of another disease, for example leprosy, or alone (lower leg periosteitis). New bone formation, however, does not always occur due to inflammation. Three diseases classified as infectious were identified among the Assistens skeletons: tuberculosis, veneral syphillis and brucellosis.

Tuberculosis

Tuberculosis is a chronic infection caused by the bacteria Mycobacterium Tuberculosis and Mycobacterium Bovis, both of which may infect humans. They can affect the soft tissue as well as the skeleton. The infection can occur as a result of infected food, for example milk or meat (M. Bovis) and affect the stomach and intestinal tract, or by means of droplet infection from infected individuals (for example coughing) (M. Tuberculosis) and develop in the lungs (Aufderheide & Rodríguez-Martín1998: 118; Waldron 2009: 90). As a result, tuberculosis is more prevalent in areas with high population densities (Roberts & Manchester 2001: 137). Only one individual a middle adult male (SB22417), showed lytic lesions on the thoracic vertebrae, which could be related to tuberculosis.

Fig 54 Caries sicca lesions on frontal and parietal bones characteristic of venereal syphilis (SB18682) (*Karies sicca*-læsioner på pandebenet og issebenene, hvilket er karakteristisk for syfilis (SB18682))

Venereal syphilis

Venereal syphilis is caused by the bacteria Treponema, and is sexually transmitted. It is associated with inflammatory changes in the soft tissues, which at a later stage affects the bones (Roberts & Manchester 2001: 151). The skeletal changes involve considerable periosteal new bone formation, especially on the tibia, frontal bone and ribs, but can involve other skeletal elements. Gumma lesions (a granulomatous appearance of nodlar foci) are formed in the bone and the bone become necrotic (caries sicca) (Aufderheide & Rodríguez-Martín 1998: 278). Skeletal lesions consistent with venereal syphilis were present in one individual, a middle adult female (Fig 54, SB18682). The individual displayed healed and active caries sicca lesions on the frontal, the parietal bones and the left zygomatic bone. Healed striated periosteitis was observed on both tibiae. No other pathological changes related to venereal syphilis could be observed.

Brucellosis

Brucellosis is a disease that is spread from animals, most often cattle, goats, pigs or dogs. In northern Europe most infections originate from cattle, *Br melitensis*, especially from handling infected blood or meat (Waldron 2009: 96). Brucellosis was diagnosed in one individual a middle adult male, *c* 32 years old (Fig 55, SB55172). Multifocal lytic lesions with smooth margins and lamella bone were seen on both sacrum and

right auricular surface. The same type of multifocal lytic lesions with rounded margins was seen on the lower thoracic vertebra. There was no collapse of vertebrae. Non specific sclerotic lesions were seen on both humerii and on the vertebral bodies of thoracic vertebrae. Differential diagnosis is tuberculosis, osteomyelitis, malignant neoplasm or mycotic infection. Sclerotic bone formation, however, is seen around and beneath lesions differentiating it from tuberculosis, which is mainly destructive in nature (Pourbagher et al. 2006; Waldron 2009: 96).

Fig 55 Thoracic vertebrae (T10 inferior view, T11 superior view). Body of T10 has a severe lytic lesion with smooth margins characteristic of brucellosis (SB55172) (Brystryghvirvler (T10 underside, T11 overside). Kropsdelen af T10 har alvorlige lytiske læsioner med bløde kanter, hvilket er karakteristisk for brucellose (SB55172))

Other infection – Septic arthritis

Septic arthritis is most commonly caused by the bacteria *staphylococcus aureaus* as osteomyelitis and is spread via the blood stream to joints. The synovium becomes swollen and inflamed, the articular cartilage is destroyed and erosions form within the joints. If left untreated, it can cause fusion of joints, immobility and pain (Ortner 2003: 222). In the Assistens assemblage septic arthritis was identified in four adults (0.9%): three old adult males and one old adult female.

Joint disease

Joint diseases are commonly associated with degenerative diseases affecting the skeleton. They comprise most of the evidence for disease in past population groups apart from dental diseases (Roberts & Manchester 2001: 100). Similar lesions – osteophytes and other forms of new bone development, and micro- and macro-pitting – may form in response to one of several different disease processes, some also occurring as lone lesions largely reflective of age-related wear-and-tear. Many of the conditions increase in frequency and severity with age, though factors other than the age of the individual are frequently involved

and the aetiology of some conditions is not clearly understood. The joint diseases affect one or more joints of the body and are characterized by formation and destruction of bone. For summary see Table 61.

Degenerative joint disease

Extra spinal joints

Degenerative joint disease (DJD), identified by the presence of porosity and osteophytosis on the joint surfaces and vertebrae were recorded. A total of 141 adult individuals (39.9%): 75 males (46.3%) and 64 females (45.9%) and 2 unsexed adults showed degenerative changes in the extra spinal joints.

		Male		Female		Unsexed adult		Total	
Joint disease	**Pathology code**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Joint DJD	345	75	46.3	64	35.4	2	20.0	141	39.9
Vertebral DJD	346	50	30.9	56	30.9	1	10.0	107	30.3
RCD	342	37	22.8	30	16.6	2	20.0	69	19.5
IVD	343	75	46.3	94	51.9	3	30.0	172	48.7
Joint OA	311	42	25.9	66	36.5	1	10.0	109	30.9
Vertebral OA	311	56	34.6	66	36.5	2	20.0	124	35.1
DISH	341	11	6.8	6	3.3	0	0.0	17	4.8
Ankylosing Spondylitis	321	4	2.5	0	0.0	0	0.0	4	1.1
Rheumatoid arthritis	331	1	0.6	5	2.8	0	0.0	6	1.7
Gout	332	0	0.0	1	0.6	0	0.0	1	0.3
uSpA	351	5	3.1	3	1.7	0	0.0	8	2.3
Psoriatic arthropathy	323	0	0.0	1	0.6	0	0.0	1	0.3
Unid.Erosive arthropathy	33	1	0.6	0	0.0	0	0.0	1	0.3
Joint other	350	3	1.9	4	2.2	0	0.0	7	2.0

Table 61 Crude prevalence rates of joint diseases in adults (N=353)

Joint disease in the vertebral column was recorded at the joint interface level. If any of the small joints were affected in an opposing pair of vertebrae, the presence of joint disease was scored for that interface. The degenerative joint changes was observed as macroscopic changes to the zygoapophyseal joints (facets) and scored following Sager (1969) in Brothwell (1981: 150).

The degenerative changes were not recorded for costovertebral or costotransverse joints. The marginal osteophytes (OP) on the vertebral bodies were also recorded at the joint interface level after Sager (1969) in Brothwell (1981: 150). Osteophytes are growths of new bone which arise around the margins of vertebral bodies and facets and can vary in size. Where changes could be definitely associated with a specific condition (for example DISH, ankylosing spondylitis) these were described separately under the specific pathology condition. Marginal osteophytes are most likely not pathological if there are no other abnormalities observed in the skeleton. Their appearance is also related to ageing in both spine and other synovial joints. DJD affecting the spine was noted in 107 adults (30.3%) : 50 males (30.9%) and 56 females (30.9%) and one unsexed adult. The severity of DJD on specific joints can be found in the archive.

Rotator cuff disease

Rotator cuff disease (RCD) is related to the rotator cuff muscles, which are the muscles that stabilise the shoulder joint. It can arise due to trauma (for example from falling and injuring the shoulder or from repetitive overhead motions), inflammation or degeneration. The disease is common and increases markedly with age. Features such as rotator cuff enthesophytes on lesser and greater humeral tuberosity, on the coracoid process of the acromion, along the bicipital groove as well as lipping around the glenoid rim are indicators of this pathology. A total of 69 individuals (19.5%) had skeletal changes consistent with RCD. Males were affected in 22.8% of the cases (n=37) while RCD could be observed in 16.6% of the females (n=30). A further two cases were observed in unsexed adults.

Spinal joints - intervertebral disc disease

Intervertebral disc disease (IVD) or degenerative disc disease is seen as pitting on and around the centrum of the vertebra (vertebral body). It is the result of dehydration of the nucleus pulposus in the disc, which causes premature hardening, rupturing and herniation of the disc. The diagnosis of IVD followed Rogers & Waldron (1995: 26) and was recorded by the location on the centrum. It was observed in 124 of the adult individuals . The results show that intervertebral disc disease is most severe in the cervical and lower thoracic and lumbar region. Furthermore, females are more affected than males. Specifications can be found in Appendix 12.

Schmorl's nodes

Schmorl's nodes (SN) are a result of intervertebral disc pressure on the superior or inferior surface of the vertebral body (Rogers & Waldron 1995: 27). They are seen as outlined depressions in the body of varying size and are commonly associated with degenerative changes of the spine. They have also been linked to physical activity (Resnick & Niwayama 1988: 1530) and to acute trauma (Fahey et al. 1998). The recording of Schmorl's nodes followed Connell & Rauxloh (2003: 18). The prevalence of Schmorl's nodes was recorded and the results show that the majority of Schmorl's nodes are concentrated around the mid and lower thoracic vertebrae (T5-T12) and that males are more frequently affected than females (Appendix 13).

Osteoarthritis

Osteoarthritis (OA) is the most commonly occurring joint disease (Roberts & Manchester 2001: 105). It is a disease of the articular cartilage which breaks down as the disease progresses. It is related to age, but also genetic disposition, obesity (which leads to stress on the joints), activity/lifestyle (mechanical stress) and environmental factors such as climate may all contribute to its development. Osteoarthritis produces the same features seen in joint diseases (osteophytes, porosity, joint change), but can only be diagnosed with certainty if eburnation is present (Waldron & Rogers 1995). The diagnosis of OA in the Assistens sample is based on this definition.

Joint osteoarthritis

OA in extra spinal joints (in one joint or several) affected 109 adult individuals with females being most affected. The distribution of OA in the joints across the skeleton indicated that the right knee joint (femoro-patella) was the most commonly affected, followed by the left knee joint (femoro-patella) and the right hip (acetabulum and femur head). Males suffered more from OA in the shoulder joints (acromio-clavicula) while females have the highest frequency of OA in knees and hips. For both sexes the right side seems to be

Joint		Male		Female		Total no of joints with OA			
		R	L	R	L	R		L	
		n	n	n	n	n	%	n	%
Jaw	Cran TMJ	0	1	3	1	3	1.2	2	0.8
Shoulder	Clav acro-clav	5	4	2	1	7	3.3	5	2.6
	Scap acro-clav	4	4	1	2	5	2.6	6	3.1
	Hum glen-hum	1	2	5	2	6	2.8	4	2.0
Elbow	Hum dist capitate	4	1	5	4	9	3.7	5	2.1
	Rad prox head	6	1	5	5	11	4.9	6	2.7
Wrist	Rad dist rad-uln	0	1	2	3	2	0.9	4	1.8
	Rad rad-scaphoid	3	4	1	2	4	1.8	6	2.7
	Uln dist rad-uln	0	0	4	3	4	2.1	3	1.5
Hip	Pelvis acetabulum	3	1	7	5	10	4.0	6	2.5
	Femur fem-head	3	1	5	7	6	3.9	10	2.4
Knee	Femur fem-pat	4	2	12	12	16	6.6	14	5.8
	Femur fem-tib-med	0	2	4	2	4	1.7	4	1.7
	Patella fem-pat	4	2	7	8	11	5.6	10	4.9
	Tibia fem-tib-lat	1	0	2	1	3	1.5	1	0.5

Table 62 Summary of OA prevalence in most affected extra spinal joints in males and females

Vertebral interface	Total no. of vertebrae registered	Males		Females		Unsexed adults		Total no. of vertebrae with OA	
	N	n	%	n	%	n	%	n	%
C1-C2 atlas	272	3	42.9	4	57.1	0	0.0	7	2.6
C1-C2	274	6	46.2	7	53.8	0	0.0	13	4.7
C2-C3	266	23	57.5	15	37.5	2	5.0	40	15.0
C3-C4	264	23	45.1	26	51.0	2	3.9	51	19.3
C4-C5	266	18	48.6	18	48.6	1	2.7	37	13.9
C5-C6	268	12	54.5	9	40.9	1	4.5	22	8.2
C6-C7	261	11	68.8	5	31.3	0	0.0	16	6.1
C7-T1	260	9	47.4	10	52.6	0	0.0	19	7.3
T1-T2	256	8	53.3	7	46.7	0	0.0	15	5.9
T2-T3	253	13	52.0	11	44.0	1	4.0	25	9.9
T3-T4	247	13	56.2	10	43.5	0	0.0	23	9.3
T4-T5	239	10	55.6	8	44.4	0	0.0	18	7.5
T5-T6	259	8	66.7	4	33.3	0	0.0	12	4.6
T6-T7	243	3	37.5	5	62.5	0	0.0	8	3.3
T7-T8	245	3	50.0	3	50.0	0	0.0	6	2.4
T8-T9	246	0	0.0	1	100.0	0	0.0	1	0.4
T9-T10	247	0	0.0	1	100.0	0	0.0	1	0.4
T10-T11	245	2	66.7	1	33.3	0	0.0	3	1.2
T11-T12	254	1	33.3	2	66.7	0	0.0	3	1.2
T12-L1	265	20	52.6	18	47.4	0	0.0	38	14.3
L1-L2	265	2	40.0	3	60.0	0	0.0	5	1.9
L2-L3	264	2	20.0	8	80.0	0	0.0	10	3.8
L3-L4	263	3	7.7	10	76.9	0	0.0	13	4.9
L4-L5	260	9	28.1	22	68.8	1	3.1	32	12.3
L5-S1	257	11	25.6	32	74.4	0	0.0	43	16.7

Table 63 Prevalence of spinal OA seen in adults at the vertebral interface level

the dominating side. The elbow joint is equally affected between the sexes, again with right side dominating, followed by the wrist joints. For details see Table 62, and Appendix 15. OA in the hands and feet have not been analysed for this report, but can be found in the archive data.

Vertebral osteoarthritis

Osteoarthritis in the spine was identified from eburnation only after Waldron & Rogers (1995). OA in spinal joints was present in 35.1% of the adult individuals. Again females were slightly more affected than males with 36.3% (n=66/181) compared to 34.6% (n=56/162), respectively. Two unsexed adults also had changes consistent with spinal OA. As can be seen from Table 63, the joint interface C3-C4 is the most affected area for both sexes with 19.3%, followed by L5-S1 with 16.7%, C2-C3 with 15.0% and T12-L1 with 14.3%.

Other joint diseases

Diffuse Idiopathic Skeletal Hyperostosis (DISH)

DISH also affects the spine and is characterized by bony proliferations on the margins of the vertebral bodies that fuse together causing the spine to become stiff. The most characteristic feature of DISH is blocks of ankylosed (fused) vertebrae that have the appearance of melted candle wax dripped down the right side of the bodies (Fig 56). Ossifications can also occur elsewhere in the skeleton at sites of ligament and muscle attachment (Aufderheide & Rodríguez-Martín 1998: 97; Rogers & Waldron 2001; Waldron 2009: 74). DISH predominately affects older individuals, usually over 50 years, and it far more common in males than in females (Resnick & Niwayama 1988). The exact cause is unknown, but it has an association with obesity and late-onset diabetes (Julkunen et al. 1971; Waldron 2009). It has also been associated with abnormal vitamin A metabolism (Abiteboul & Arlet 1985). DISH was diagnosed when at least four vertebrae were fused with disc space preserved and follows the criteria by Rogers & Waldron (1995). There were 17 (4.8%) individuals: 11 (6.8%) males and six (3.3%) females, with appearances which matched the criteria for DISH. It is evident that the majority were males. Furthermore, the affected individuals were aged as mature adults (46 years+) or older.

Fig 56 Fused thoracic vertebrae in right side of bodies characteristic of DISH (SB52421) (Sammenvoksede brystryghvirvler i højre side karakteristisk for DISH (SB 52421))

Ankylosing Spondylitis

Ankylosing Spondylitis (AS) is a progressive inflammatory disease which affects entheses (tendon insertions) with erosions and bony ankylosis. It is more common and more severe in males than females and has a peak onset in the early 20s (Ortner 2003: 571). The aetiology is still not clearly understood, but has been associated with the antigen HLA-B27 (Rogers & Waldron 1995: 64). The disease most often begins with fusion of the sacroiliac joint. The fusion is symmetrical. The spine may also fuse (Waldron 2009: 59). The costo-vertebral joints may be involved, fusing ribs to the vertebrae (

Fig 57). As a result, the spine may become fused into a single unit and become rigid. The process of fusion of the spinal segments is accompanied by pronounced osteoporosis of the vertebral bodies. Four males (2.4%), three aged as middle adults and one as mature adult, had bony ankylosis of the sacro-iliac joint and spine characteristic of AS.

Fig 57 Complete fusion of thoracic vertebrae and right upper ribs related to ankylosing spondylitis (SB22861) (Komplet sammenvoksning af brystryghvirvler samt øverste højre ribben, relateret til ankyloserende spondylitis (SB22861))

Rheumatoid arthritis

In contrast to ankylosing spondylitis, Rheumatoid arthritis (RA) is a chronic and erosive inflammatory disease of connective tissue. The erosive lesions predominately affect the knuckles of the hands and fingers (the metacarpo-phalangeal joints and proximal interphalangeal joints) and feet (the metatarso-phalangeal joints) (Aufderheide & Rodríguez-Martín 1998: 99). The cause of RA remains unknown, although is known to be associated with genetic factors. As the disease progresses, the hands and feet may become deformed with deviation of the fingers at the knuckles (metacarpo-phalangeal joints). Erosions in the joints are characterized by destruction of the dense bone (cortex), exposed trabeculae, sharp ridges and scooped floor (Waldron 2009: 51). Six individuals (1.7%), five females (2.7%) and one male (0.6%) had erosive lesions in the metacarpo-phalangeal joints which were attributed to RA.

Gout

Gout is a joint disease which occurs due to a disturbance of the purine metabolism. This is in part due to kidney failure, where there is a reduced excretion of uric acid or may be due to an excess of uric acid causing high levels of blood uric acid (Ortner 2003: 583). Urate crystals are formed and appear in the synovial fluid of joints, which leads to inflammation and erosion of the cartilage and bone (Roberts & Manchester 2001: 122). Gout is most commonly found after the age of 40 years and is predominately seen among males. It mostly affects the joints of the extremities, especially the metatarso-phalangeal joint of the big toe. The most characteristic changes are the scooped out erosions on the metatarso-phalangeal and interphalangeal joints of the toes located near the margin of the articular surface. The urate crystals are sometimes present and seen as small salt-like white crystals in the lesions (Doherty & Dieppe 1986). A

middle adult female (SB50587) had erosive lesions with overhanging margins both in right and left first metatarso-phalangeal joint (big toes). There were, however, no small embedded crystals present (Fig 58).

Fig 58 Lytic scooped out lesions observed on disto-medial side of right first metatarsal, possibly related to gout (SB50587) (Knoglelnedbrydende/lytiske læsioner observeret på den disto-mediale side af højre første mellemfodsknogle, muligvis relateret til urinsyregigt (SB50587))

Undifferentiated Spondyloarthropathy (uSpA)

Individuals that could not fulfil the criteria for any of the main categories of spondyloarthropathies (e.g. due to incomplete skeletons or poorly preserved skeletons), but who shared many of the pathological characteristics of spondyloarthropathy, were diagnosed with Undifferentiated Spondyloarthritis (uSpA).
Eight individuals (2.3%) were noted for this category, five are males (3.0%) and three are females (1.7%).

Other joint diseases found, includes a case of inflammatory osteoarthritis observed in one old adult female (SB23913). The right talo-navicula joint was affected showing severe marginal osteophytes, macro porosity and contour change was observed in and around joint surface and woven periosteitis was affecting the navicular joint surface.
A mature adult female was affected by possible psoriatic arthropathy (PsA). This was diagnosed based on resorption of distal phalanges observed in the hands, resulting in pencil shaped phalanges. Lytic lesions with rounded margins were seen on the margins of carpals. Most of the extraspinal joints were affected by DJD including moderate lipping around the joint margins of the sacroiliac joint. Healed periosteitis was found bilaterally on the medial side of the tibial shafts which could be related to skin ulcers in psoriasis.
An unidentified erosive arthropathy observed bilaterally in the tarsal bones (navicular and cuboid) was observed in a mature adult male. Further eight individuals had an unidentified joint disease, which could not be categorized further.

Trauma

Trauma in one or more elements was seen in 69 individuals (15.6%, n=69/443). One of the most commonly recorded conditions that could be placed in the category trauma is fracture. Fractures are the most obvious of trauma recorded in skeletal material and are either caused by an acute injury to the bone, repetitive stress or an underlying disease (Roberts & Manchester 1995: 68). Since accidental injuries can produce similar features to those that would be sustained in interpersonal violence, a distinction between the two

has not been attempted in this report. The examination of fractures was aided by radiographic images. There is a range of other indicators of trauma such as dislocations, soft tissue injuries, surgical interventions (for example autopsy and prostheses) and ballistic injuries, that it is possible to record (Table 64). The type of trauma suffered may be related to lifestyle and occupation, as fractures can also have a pathological cause. Trauma may also be inflicted on the skeleton after it is buried. The weight of soil during burial tends to flatten the skeleton so that the rib cage, pelvic girdle and the skull may be fragmented (post mortem fractures).

		Male		Female		Unsexed adult		Subadult		Total	
Trauma	**Pathology code**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Fractures	420	22	13.6	13	7.2	1	10.0	0	0.0	36	8.1
Dislocation (Subluxation)	422	0	0.0	3	1.7	0	0.0	0	0.0	3	0.7
Compression fracture	424	6	3.7	8	4.4	0	0.0	0	0.0	14	3.2
Soft tissue trauma (myosteitis ossificans)	425	7	4.3	2	1.1	0	0.0	0	0.0	9	2.0
Sharp force trauma (unhealed)	435	0	0.0	1	0.6	0	0.0	0	0.0	1	0.2
Blunt force (unhealed)	434	1	0.6	0	0.0	0	0.0	0	0.0	1	0.2
Projectile injury	435	1	0.6	1	0.6	0	0.0	0	0.0	2	0.5
Unidentified trauma (healed)	436	4	2.5	2	1.1	0	0.0	1	1.1	9	2.0
Amputation	412	2	1.2	0	0.0	0	0.0	0	0.0	2	0.5
Craniotomy	413	0	0.0	1	0.6	0	0.0	0	0.0	1	0.2
Prosthesis (hip)	Other	0	0.0	1	0.6	0	0.0	0	0.0	1	0.2
Autopsy	415	7	4.3	11	6.1	1	10.0	1	1.1	20	4.5

Table 64 Crude prevalence of trauma types between adults, subadults and sexes (N=443; Males=162; females=181; unsexed adults=10; Subadults=90)

Fractures

Antemortem fractures were seen in 8.1% (n=36/443) of the adults; in 22 of the males (13.6), 13 (7.2%) of the females and in one unsexed adult. The majority comprised fractured ribs, followed by nose and fibula fractures (see Appendix 16). While the males had most fractures concentrated on ribs, nose and lower limbs (Fig 59 and Fig 60), the females were most affected in the arm bones (humerus and radius) and the femur. The fractures of the radii were Colle's fractures. These types of fractures often occur as a result of a backwards fall, where the arm is used to "catch" the fall and are often associated with osteoporosis. The results further indicate that males were more affected by fractures than females. The right side limbs were more frequently affected for males, while the females had right limb fractures on the lower arm (radius and ulna), while the humerus and femurs were affected on the left. Most fractures recorded in the bones from Assistens were simple, closed fractures. The majority of these fractures were well healed, with no evidence of infection. However, all but one showed indications of not being treated properly with malalignment.

Fig 59 Oblique fracture of distal left tibia and fibula shaft with mal-aligned fusion, anterior view, with corresponding radiographic image (SB22843) (Oblik fraktur af venstre, distale skinneben og lægben med skæv opheling. Set forfra og med tilhørende røntgenfoto (SB22843)

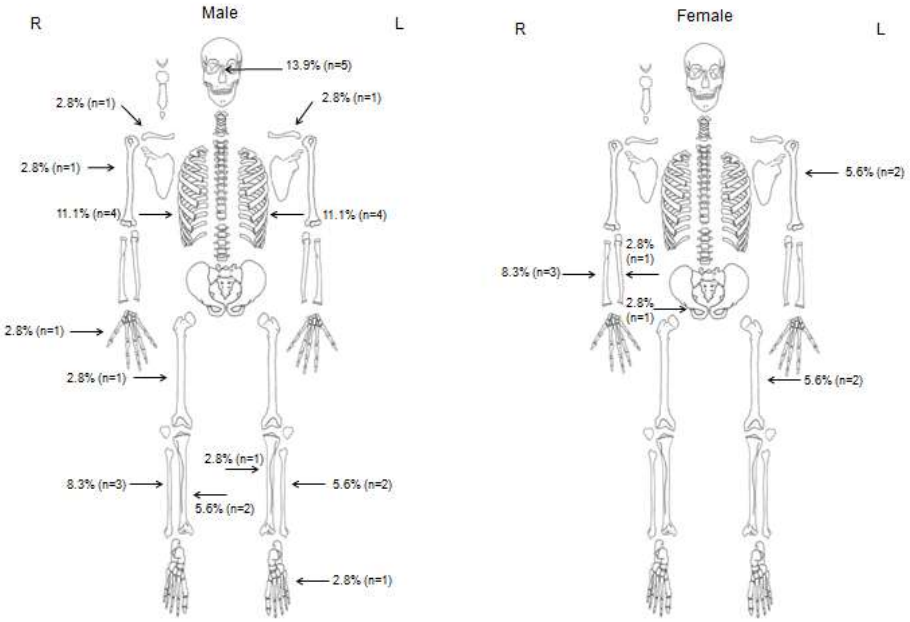


Fig 60 Skeletal sketch with prevalence rates of trauma affecting individual elements in males and females (Skelettegning med fordelingen af traumer i de individuelle elementer hos mænd og kvinder)

Dislocation (Subluxation)

Dislocation of a joint was observed on three adult females, all of which affected the hip joints. One female, a mature adult (SB15162), had a superior displacement of the right femur head following trauma of the femoral neck (Fig 61). A second female, aged middle adult (SB54910), had a superiorly oriented displacement of left femur with subsequent mushroom shaped femoral head. A third female, aged adult (SB4450), had a bilateral dislocation of the hip joint. All three individuals had osteoarthritis in the affected hips as a secondary consequence of the dislocation.

Compression fracture

Compression fractures are the result of sudden excessive impaction and are observed in the spine (the vertebral body). It may be associated to stress on bone (be pathological), but can also be a consequence of a traumatic injury (from a fall). Fourteen adults (3.2%), six males (3.7%) and eight females (4.4%) had compression fractures in one or more vertebrae. The fractures were all located in the thoracic or lumbar region. Six of the individuals were affected by osteoporosis. The compression fractures observed on these individuals are, therefore, likely associated. All but two females were aged as old adults (56+ years). One female was aged as a mature adult and had osteoporosis, while the other female, aged as middle adult, did not. The compression fractures observed in the individuals without osteoporosis could likely be related to accidental injury fracture. However, at this stage this is purely speculation and would need further analysis.

Fig 61 Fractured femoral neck with subsequent dislocation of femoral head and secondary osteoarthritis (SB15162)
(Brækket lårbenshoved med efterfølgende dislocation af lårbenshovedet forårsagende gigt (SB15162)

Traumatic myositis ossificans

On some occasions, damage to soft tissues can result in tearing of ligaments and tendons, or a localised haematoma (blood clot). Under these circumstances, the heamatoma or other soft tissue can become mineralized (the periosteum can stimulate the bone forming cells, osteoblasts) (Aufderheide & Rodriguez-

Martin 1998). This results in an irregular mineralized lesion known as myostitis ossificans traumatica. Possible cases of this condition was observed in nine individuals (2.0%), seven males (4.3%) and two females (1.1%) with the interosseous membrane between tibia and fibula being the most common element involved (Fig 62), followed by muscles and tendons in the hip.

Blunt and sharp force trauma

A possible case of blunt force trauma was observed in one adult male (SB9094). However, due to radiating fracture patterns related to a projectile injury on the same individual, it is at this stage uncertain if the presumed blunt force fracture lines are in fact heaving fractures related to the projectile injury (see below). Trauma to the nasal bones, presented in the section of fractures by element (Appendix 16), can also be considered blunt force trauma, but will not be discussed any further in this report. Sharp force trauma refers to an injury induced by a sharp instrument (e.g. knife, axe, pick). A sharp force puncture wound was observed on the right anterior arch of the atlas of a middle adult female (SB22913) with no signs of healing (Fig 63). A differential diagnosis is post mortem damage resulting from excavation. The top of the calvarium had been truncated by a sheet pile but this could not have caused this small trauma. If such an injury was induced perimortem causing the death of the individual, it is likely to assume that the person would undergo an autopsy prior to burial. This was not the case.

Fig 62 *Myostitis ossificans* traumatica observed on right distal tibia and fibula with callus formation (SB50719)
(*Myostitis ossificans*-traumer observeret på højre distale skinneben og lægben med opheling (SB50719)

Fig 63 Possible puncture wound or post mortem damage on right anterior arch of atlas (first cervical vertebra) (SB22913) (Mulig peri-mortel læssion eller post mortem skade på forsiden af højre atlas (første halsryghvirvel) (SB22913)

Ballistic injuries

The analysis of ballistic or projectile injuries is an important aspect of forensic anthropology and pathology, but is rarely found in archaeological material. The damage caused by bullets or other fired projectiles depends on the weight and velocity of the projectile. The bullets that enter the skull leave an entry wound and almost always an exit wound as well. Projectile injuries to the skull were observed in two individuals; one middle adult male (SB9094) and one young adult female (SB15123). Neither of them exhibited evidence of healing indicating that the cause of death is likely to have been by gunshot to the head.

The male had been autopsied. Radiating fracture lines were seen from both the entry wound in the right temporal and from the exit wound in the posterior portion of the left parietal (Fig 64). Concentric heaving fractures (a result of the kinetic energy from the entering bullet) were present around the calvarium intersecting the autopsy incisions. Further comminuted fracture patterns were observed in the right side of the skull (on sphenoid and temporal) with radiating fracture lines. These fractures could not be linked with any certainty to the heaving fractures. They were therefore recorded as unhealed blunt force trauma (see section on blunt force trauma above). This is to be investigated further in future study.

The female had a double entry wound into the left temporal, but only one exit wound. There was no evidence of autopsy. A radiographic image of the cranium revealed a bullet still attached to remains of brain tissue. The bullet was removed after being photographed and radiographed *in situ* and examined by ballistics experts at Kriminal Teknisk Center, the crime scene department of the Danish National Police.

Fig 64 Projectile injury to skull. Exit wound in posterior left parietal with radiating fracture lines. Calvarium has been sectioned during full post mortem autopsy (SB9094). (Projektilskade på kranium. Kuglens udgangshul ses på den bagerste del af venstre issben med udgående frakturlinjer (SB9094))

Unidentified trauma

A further nine individuals had trauma recorded which could not be identified into a specific category. All of them were healed. One individual in particular, a mature adult male (SB57805) showed trauma to the hand and foot, which looks like an accidental amputation of the third to fifth right finger and fractured right first metacarpo-phalangeal joint. This could possibly be a work related injury (Fig 65). The remaining cases of unidentified trauma will be analysed and discussed in future study.

Fig 65 Unidentified healed trauma to right hand. Possible accidental amputation of middle third to fifth finger and fractured first metacarpal-phalangeal joint with healing but mal-alignment (SB57805) (Uidentificeret ophelet traume ved højre hånd. Amputaion af midterdelen af tredje til femte finger og beskadiget led mellem første mellemhåndsknogle og finger. Muligvis som følge af arbejdsulykke. Efterfølgende skæv opheling (SB57805))

Amputations

Two males, both old adults, each had their leg amputated shortly prior to their death. One male (SB16864) had the right femur amputated at mid shaft with no macroscopic evidence of healing of the bone edges (Fig 66). The second male (SB52727) had his right femur amputated at mid shaft a few weeks or months prior to death, as there were signs of new bone formation on the edges. His left tibia and fibula had also been amputated. However, there were no macroscopic signs of healing on these elements. The amputated tibia and fibula were articulating and had been placed in the left side of the torso, while the left foot, which was also articulating, was placed in the right side of the torso. The lack of remodelling on the tibia and fibula indicate that amputation took place shortly prior to death. It is likely that the patient died from complications related to the second amputation.

Fig 66 Right femur with distal half amputated (SB16864) (Højre lårben, hvor den distale del er blevet amputeret (SB16864)

Fig 67 Possible case of mastoidectomy of right temporal bone (SB4253) (Tegn på mulig mastoidektomi ved højre tindingeben (SB4253))

Craniotomy

A possible case of mastoidectomy, a surgical intervention of the mastoid process, was observed on a mature adult female (SB4253). A large lytic lesion with smooth edges was observed on the right temporal bone at the junction between the mastoid process and the external acoustic meatus (Fig 67). A differential diagnosis could be an ear infection of the right ear (a mastoidit, atresi or cholesteatoma).

Prosthesis

A hip prosthesis was recovered *in situ*, inserted into the left femur of a middle adult female (SB22913), severely affected by osteoarthritis through the extraspinal and spinal joints. The bone surrounding the prosthesis did not seem to have healed, indicating a recent operation prior to death. The prosthesis carried the serial number: P0624 (Fig 68).

Fig 68 Hip prosthesis in left femur (SB22913) (Hofteprotese i venstre lårben (SB22913))

Autopsy

Post mortem examinations (autopsy) may be either partial or complete. In a partial autopsy the viscera in the abdomen and/or chest are examined, but the skull is not sectioned, whereas it is when the autopsy is complete. Where the autopsy was confined to an examination of the abdomen only, there would often be no signs on the skeleton. The prevalence of autopsies is therefore confined to include the complete autopsies (

Fig 69). Complete autopsies were identified in 20 cases (4.5%) of which seven were males (4.3%), 11 were females (6.1%), one was an adult of unknown sex and one was a subadult. Besides a horizontal cut of the calvarium observed in all of the individuals, individual SB8944, an old adult female, displayed cut of columna and cut marks on sternal ends of ribs and clavicles. These incision wounds on the ribs and clavicles are characteristic of incisions made when opening the torso during autopsy. The cut of the columna may in some cases be made during the autopsy procedure in order to analyse the bone marrow (Hansen 2010 pers. comm.).

Congenital defects

Congenital and developmental defects in the axial or appendicular skeleton are malformations that occur during foetal development, and are observable at birth or as the skeleton matures. Most of the congenital abnormalities are due to genetic defects that may be hereditary (Barnes 1994: 2). Environmental influences, for example drug effects and maternal infections such as rubella, can also cause foetal malformations including cleft palate, spina bifida and microcephaly (Roberts & Manchester 2001: 32). See Table 65 for a summary.

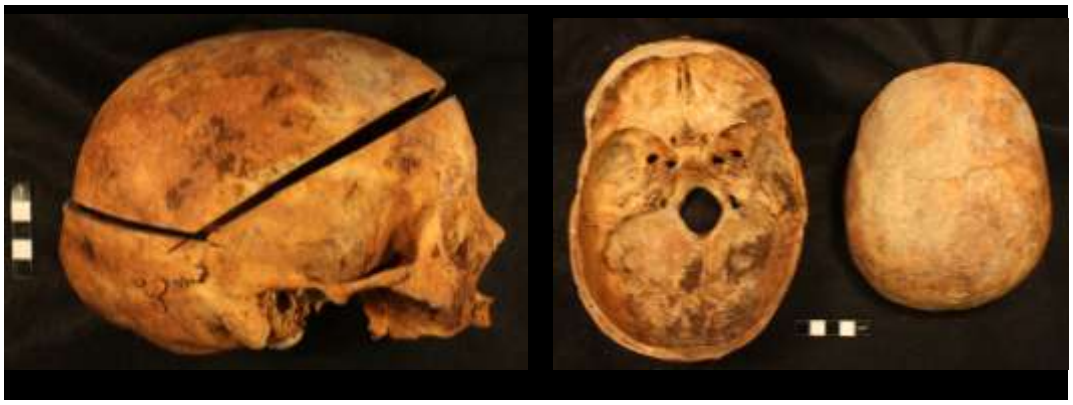


Fig 69 Sectioned skull (right profile and endocranial view) related to a full autopsy (SB11636) (Overskåret kranium (højre profil samt kraniets indre), relateret til en komplet obduktion (SB11636)

		Male		Female		Unsexed adult		Subadult		Total	
Congenital disorder	**Pathology code**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Skull malformation	120	0	0.0	1	0.6	2	20.0	0	0.0	3	0.7
Bathocrania	125	1	0.6	2	1.1	0	0.0	0	0.0	3	0.7
Scoliosis	131	4	2.5	3	1.7	1	10.0	0	0.0	8	1.8
Kyphosis	132	1	0.6	2	1.1	0	0.0	1	1.1	4	0.9
Segment failure	134	8	4.9	9	5.0	0	0.0	0	0.0	17	3.8
Spina bifida occulta	1341	3	1.9	2	1.1	0	0.0	0	0.0	5	1.1
Spondylolysis	1511	0	0.0	2	1.1	0	0.0	0	0.0	2	0.4
Os acromiale	160	4	2.5	1	0.6	0	0.0	0	0.0	5	1.1
Upper limb aplasia	1420	0	0.0	3	1.7	0	0.0	0	0.0	3	0.7
Lower limb aplasia	1430	0	0.0	1	0.6	0	0.0	0	0.0	1	0.2
Hallux valgus	161	0	0.0	1	0.6	0	0.0	0	0.0	1	0.2
Congenital other*	160	13	8.0	15	8.3	0	0.0	6	6.7	34	7.6

Table 65 Crude prevalence rates of congenital disorders between sex, adults and subadults observed among the analysed samples (N=443). *Specifications for congenital other are presented below

Skull malformation

Individuals displaying congenital malformation of the skull, which could not be specifically diagnosed, were classified as general skull malformation. Two individuals showed such cranial deformities. An infant (SB17538) had very large skull bones compared to limb bones. One mature adult female (SB13841) had asymmetrical distortion of maxilla and posterior part of the skull. Such asymmetrical shape could be attributed to plagiochephaly. However, plagiochephaly is most often found among infants. The unusual head shape in plagiochephaly is caused by pressure in the womb giving a "diamond" shaped head when seen from above. In pronounced cases there may be flattening of one side of the head as well (Barnes 1994). The distortion did not seem to be caused by postmortem pressure, although it cannot be ruled out completely.

Crouzon's syndrome

A third individual, an adolescent *c* 15 years old (SB9265) had cranial deformations with synostosis (the abnormal fusion of bones) characteristic of Crouzon's syndrome. Crouzon's syndrome is a genetic disorder known as a branchial arch syndrome or craniofacial dysostosis that affects the first branchial (or pharyngeal) arch, which is the precursor of the maxilla and mandible. It is a rare condition. The most notable characteristic of Crouzon's syndrome is cranial synostosis (premature fusion of sutures). It is usually recognized by frontal bossing with steep forehead, short calvarium and flat occipital (Barnes 1994). The person could appear as having a short and broad head (
Fig 70).

Fig 70 Cranial synostosis with frontal bossing and steep forehead seen in a subadult, *c* 15 years old. The changes are possibly related to Crouzon's syndrome (SB9265) (Kraniesynostose med udvoksning på pandebenet og stejl pande hos en subadult, ca. 15 år gammel. Forandringerne er muligvis relateret til Crouzons syndrom (SB9265))

Bathocrania

Bathocrania is a synostosis of the posterior part of the skull. The posterior portion of the parietal slopes inferiorly and the occipital protrudes superiorly (Jane et al. 2000). Three individuals (0.7%, n=3/449), one male and two females had the protruding or bossing occipital bone, characteristic of a bathocranic shape.

Vertebral anomalies

Scoliosis

Scoliosis refers to the lateral curvature of the spine. There are often two curves, enabling the cranium to be maintained in the mid-saggital plane. In addition there is often also rotation of the vertebrae. The ribs are often thinner than normal and the vertebrae are wedged towards the concave side. As a consequence, osteophytes are often present together with osteoarthritis of the costo-vertebral joints. There are several causes of scoliosis and may accompany other spinal malformations, such as hemi-vertebrae and transitional vertebrae (Aufderheide & Rodríguez-Martín 1998, 66) The idiopathic form is the most common type, with a prevalence rate of 80% of all cases (Waldron 2009: 215). Eight adults (1.8%), four males (2.5%), three females (1.7%) and one unsexed adult had slight scoliosis. In one case, (SB56352), a mature adult male, the ribs were thinned.

Kyphosis

Congenital kyphosis is an abnormal forward bending of the spine (Ortner 2003: 463). It should not to be confused with anterior collapse of vertebrae, also causing kyphosis, but may be due to a variety of diseases. Congenital kyphosis was observed in four individuals (0.9%), of which one was a middle adult male, two were female: a young adult and a mature adult. The fourth was of an unsexed adolescent. The latter is likely Scheuermann's disease, the juvenile version of congenital kyphosis (Ortner 2003: 463-64).

Spina bifida occulta

Spina bifida occulta is a mild congenital defect, which is characterised by fusion failure of the sacral neural arches. The defect is usually asymptomatic, as the area of non-union on the posterior side of the sacrum is bridged by membrane, thus protecting the spinal cord. Spina bifida occulta is a common condition affecting between 5-25% of modern populations and has been associated with a deficiency in maternal folic acid in early pregnancy (Aufderheide & Rodríguez-Martín 1998: 61). In this sample five individuals (1.1%), three males and two female, had spina bifida occulta with all five segments affected, while one female had partial open sacral canal.

Spondylolysis

Spondylolysis is a defect of the vertebrae in which the lamina and spinous process are separated from the vertebral body, transverse process and inferior articular processes and usually occurs in the fourth and the fifth lumbar vertebrae (Aufderheide & Rodríguez-Martín 1998: 63-64). It appears to be caused by a genetic predisposition or due to repetitive stresses rather than acute trauma. The condition is said to be more common in males than females (Merbs 1995). Nevertheless, in the Assistens sample, spondylolysis was found in two females (one young adult and one old adult).

Extra spinal anomalies

Os Acromiale

Additional developmental anomalies were seen in five individuals (four males and one female) in the form of os acromiale, i.e. non-fusion of the acromion process to the spine of the scapula. This condition is believed to be caused by severe stress on the rotator cuff muscles, which hold the shoulder in place, during adolescent growth and development (Coughlan & Holst, 2007: 73). The stress is thought to prevent the acromion process from fusing to the spine of the scapula. In one individual (SB9221), a mature adult male, os acromiale was bilateral, while it was present on the left scapula in one individual (SB23097), an old adult male.

Aplasia

Limb deformities are described and broadly classified as aplasia or hypoplasia (an underdevelopment (Barnes 1994). An abnormal shortening or shape of the limbs, either upper, lower limbs or both was observed among three females. One female had an abnormal shortening of the left radius and ulna, while another female had hypoplasia of a distal first hand phalanx. The third had hypoplastic shortening of the right femoral neck as well as malformed styloid on right radius.

Hallux valgus

Hallux valgus –bunion - is a medial deviation of the first metatarsal and lateral deviation and/or rotation of the hallux, with or without medial soft-tissue enlargement of the first metatarsal head. The condition can develop as a result of numerous different factors including biomechanical, traumatic and metabolic factors. It usually leads to painful motion of the joint and difficulty with wearing footwear. A possible case of Hallux valgus was seen on a first metatarsal of a mature adult female (Fig 71).

Fig 71 Possible case of Hallux valgus (SB13708): Right and left first metatarsals and phalanges. Proliferation and smooth edged lytic lesions on the medial side of the proximal head of the metatarsals. Phalanges of the big toe point laterally (Tegn på mulig Hallux valgus (SB13708). Højre og venstre mellemfods- og tåknogler. Knogledannende og knoglenedbrydende læsioner med afrundede kanter på den mediale side af mellemfodsknoglernes proximale ledende. Storetåens tåknogler peger lateralt).

Other slight developmental anomalies were observed in the spine, ribs and limbs, but will not be discussed any further in this report. None of these would have caused any problems during life. For specification see Table 66.

		Male	Female	Unsexed adult	Subadult	Total	
Congenital other	**Observation**	**n**	**n**	**n**	**n**	**n**	**%**
Spine	C1 fused to occipital	1	0	0	0	1	0.2
	Fusion failure of axis	0	0	0	1	1	0.2
	Fused C3-C4	0	1	0	0	1	0.2
	C7 missing	1	2	0	0	3	0.7
	11 thoracic vertebra	0	1	0	1	2	0.5
	Supernum. thoracic	3	1	0	2	6	1.3
	Supernum. lumbar 6	2	3	0	0	5	1.1
	Sacralised lumbar	0	3	0	0	3	0.7
Ribs	13 ribs	2	1	0	1	4	0.9
	Bifucated rib	2	1	0	1	4	0.9
	Fusion of two ribs	0	0	0	1	1	0.2
	Abnormal flattening of ribs	1	0	0	0	1	0.2
Torso	Sternal foramen	1	0	0	0	1	0.2
Limbs	Patella cubiti	1	0	0	0	1	0.2
	Malformation of ulna-conoid	0	1	0	0	1	0.2
	Depressed smooth lesion in femur heads	1	0	0	0	1	0.2
	Fusion failure of cuneiforms	0	1	0	0	1	0.2

Table 66 Other congenital observations (N=443)

Metabolic diseases

Metabolic diseases are medical conditions characterized by problems with an organism's metabolism (i.e. interference in the normal uptake of specific nutrients). They comprise a wide range of conditions that are caused by a disruption of bone formation, mineralization or remodelling, or a combination of these processes (Brickley & Ives 2008). They include vitamin deficiencies such as rickets, osteomalacia, scurvy and osteoporosis and provide valuable information on socio-economic aspects of life. See Table 67 for a summary.

		Male		Female		Unsexed adult		Subadult		Total	
Metabolic disease	**Pathology code**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Rickets	511	0	0.0	0	0.0	0	0.0	4	4.4	4	4.4
Osteomalacia	512	0	0.0	2	1.1	0	0.0	0	0.0	2	0.6
Scurvy	521	0	0.0	0	0.0	0	0.0	14	15.6	14	3.2
Osteoporosis	531	3	1.9	37	20.4	2	20.0	0	0.0	42	9.5

Table 67 Crude prevalence rates of metabolic diseases (N=443). Since rickets can only affect subadults, the total number for rickets is based on total number of subadults (N=90). The total number for osteomalacia is based on the total number of adults (N=353)

Vitamin D deficiency

Vitamin D is essential for proper mineralization of newly formed bone (Steinbock 1993: 978). A failure of bone mineralization can result in skeletal changes indicative of a state of deficiency, termed rickets in juveniles and osteomalacia in adults. During growth, bone with insufficient mineral content is unable to support the biomechanical function and deformities start to occur (Ortner 2003: 393). If the deficiency is prolonged after bone growth has ceased or the deficiency arises during adulthood the continuous remodelling of bone that takes place can also result in deformity as the mineralized bone is replaced by unmineralized bone cells.

The primary source of vitamin D is the exposure to sun and secondly through dietary sources such as fish oil and egg yolks (Brickley & Ives 2008: 90; Fraser 1995). The deficiency has been linked to air pollution and factors that lead to reduction in the amount of sunlight available (Steinbock 1993: 979). Studies on post-medieval skeletons have showed high prevalence of Vitamin D deficiency among individuals living in urban areas with high concentrations of industry, particularly in those areas that produced high levels of particulates and material that blocked the sunlight (e.g. Molleson et al. 1993; Brickley et al. 2006).

Rickets

Rickets resulting from vitamin D deficiency affects the skeleton, but has no direct mortality (Ortner 2003: 393). The typical skeletal changes of rickets in infants and children were identified following Ortner & Mays (1998) and Ortner (2003). It rarely begins before the age of three months (Brickley & Ives 2008: 90) because vitamin D passes from mother to foetus through the placenta and is stored in the liver of the infant (Ortner 2003: 393). According to Ortner (2003), the highest frequency is observed between six months of age and two years. The changes typical of rickets are earliest seen and mostly marked on the rapidly growing areas of the skeleton. These include the rib ends (seen as rounded nodular swelling) and the metaphyseal areas of the long bones with flaring and flattening (distal femur, tibia, radius and ulna and the proximal humerus) Ortner (2003: 394). The cranial bones are also involved with characteristic porotic hyperostosis on frontal and parietal bones. Furthermore, rickets can lead to retardation of growth.

Rickets was observed in four subadults (4.4%). Trumpeting of the diaphyseal ends of long bones and sternal rib expansion were seen in all four cases. Three of the individuals affected were aged between one month and two years. The fourth was aged nine years. No evidence of resolved rachitic changes was observed in the adults, perhaps indicating that those affected did not survive childhood, or that environmental circumstances had changed between generations.

Osteomalacia

Osteomalacia is the adult version of rickets and has the same aetiology as rickets (Brickley 2000: 189). The increased percentage of osteoid (bone cells) and poorly mineralized bone occurs at a slower rate among mature individuals than in younger individuals. There is therefore a less pronounced bowing of the adult long bones. Two possible cases of osteomalacia were observed in a mild form in two females (one mature adult and one old adult). The left tibia of the old adult female was curved slightly anterio-posterior, while the mature adult female displayed a medio-posterior curvature of both femora. Osteomalacia is often

present in individuals who have suffered age-related bone loss and the combination of these two conditions makes these individuals particularly prone to osteoporosis-related fractures (Steinbock 1993: 980). Only the mature adult female was affected by osteoporosis as well.

Scurvy (vitamin C deficiency)

Scurvy is the result of a dietary deficiency of vitamin C (ascorbic acid), which can be found in fruit, vegetables or diets fortified with vitamin C (Bradley & Parish 2009). A deficiency can result in defective collagen, bone cell (osteoid) synthesis and capillary blood vessels with consequent haemorrhaging into subperiosteal areas and skeletal growth retardation (Aufderheide & Rodríguez-Martín 1998: 310; Maat 2004). Children between eight and ten months of age are most commonly affected by scurvy, but it can occur at other ages (Ortner et al. 1999; Ortner 2003: 384). In 14 cases at Assistens, all of them subadults, a number of bones were affected across the skeleton. Most notably the long bones with porotic bone formation on diaphysis and flaring metaphyses, new bone formation and porosity on the scapulae, expanded and porous rib ends, new bone formation on the sphenoid as well as on the alveolar bone of the maxilla or mandible (Fig 72 and 73). These markers are all consistent with scurvy as described by Ortner (2003: 376-87). The majority affected (n=10/14), died in infancy. The remaining four died between the ages one and five years. Scurvy would have resulted in affected infants failing to thrive, and as a result of the deficiency they would have been prone to contracting infections secondary to the condition (Resnick & Niwayama 1988: 3095).

Two infants had indications of both rickets and scurvy.

Fig 72 Porosity in the left scapula fossa in infant with scurvy, superior view (SB8787) (Porøsitet i venstre skulderblad hos et spædbarn med skørbug, set fra oven (SB8787))

Fig 73 Trumpeting of sternal rib ends in infant with scurvy (SB8787) (Forstørrede sternale ribbensender hos et spædbarn med skørbug (SB8787))

Osteoporosis

Osteoporosis is the term used to describe bone that has undergone levels of bone loss and architectural changes that have left the bone liable to fracture (Aufderheide & Rodríguez-Martín 1998: 314). There are a number of causes of osteoporosis, and in addition to being linked to increasing age and hormonal changes (particularly in women after the menopause), characterized by trabecular bone loss with fractures of the radius and vertebrae. It can also affect both sexes above the age of 60 years with features such as loss of both trabecular and cortical bone which may lead to hip and vertebral fractures (Aufderheide & Rodríguez-Martín 1998: 314). However, the condition can also arise due to other disease processes or as a reaction to drugs (Brickley 2000: 191). The fractures related to age-related bone loss have been presented in the section on trauma, where six were recorded as having vertebral compression fractures combined with osteoporosis. The prevalence of osteoporosis, observed as loss of cortical thickness and trabecular bone in both long bones and spine was 9.5 % (n=42/443) with the majority represented by females. In addition, Colle's fractures, fractures to the distal radius, have also been linked to osteoporosis, and today are the most common fracture in Caucasian women below the age of seventy (Stevenson 1991). Only one of the females with Colle's fracture was diagnosed with osteoporosis (SB8795).

Circulatory disease

A circulatory diseases is a condition in which a disturbance in normal blood circulation to the bone has occurred which may result in bone death (osteonecrosis) (Ortner 2003: 343). Because there is a circulatory link between many diseases, a differential diagnosis can be challenging (Ortner 2003: 343). Most of the circulatory disturbances that affect the human skeleton occur in the long bones and is usually a circulatory disruption to the epiphysis and subchondral bone. The reduction or loss of blood supply to bone quickly results in bone cell death. Complete bone cell death can occur within 12-48 hours (Sweet & Madewell 1995: 3447). See Table 68 for a summary.

		Male		Female		Unsexed adult		Subadult		Total	
Circulatory disease	**Pathology code**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Osteochondritis dissicans	911	6	3.7	3	1.7	3	30.0	0	0.0	9	2.0
Femoral neck necrosis	931	1	0.6	0	0.0	0	0.0	0	0.0	1	0.2
Slipped femoral epiphysis	933	0	0.0	1	0.6	0	0.0	0	0.0	1	0.2

Table 68 Crude prevalence rates of circulatory diseases observed among the analysed individuals (N=443)

Osteochondritis dissicans

Osteochondritis dissicans (OCD) is a fracture that occurs of the osteochondrum (the joint surface), which leads to a disruption of the articular cartilage. The fractured fragment may become incompletely or completely detached. It may be caused by direct trauma or repetitive micro trauma, which may follow excessive normal compressive strain. Although the aetiology is not fully understood, the prevalence is higher among individuals engaged in sport or vigorous physical activity. The condition is more common among males than females. The peak age of onset of OCD is between 15 and 20 years. It occurs more commonly on convex than concave surfaces. The knee is the most frequent involved joint (also known as Osgood-Schlatter's disease) with the most frequent site being the lateral aspect of the medial femoral condyle (Waldron 2009: 154). However, it can arise in other synovial joints as well, but are less frequent.

Nine individuals (2%) exhibited osteochondritis dissicans (Table 69); six (3.7%) males and three (1.7%) females. All were aged as middle adults or older. Six conditions were observed in the knees (three bilateral, two in right and one in left knee), two in the acetabulum, one bilaterally in the talo-calcaneal joint (the ankle) and one was observed in the metatarso-phalangeal joint.

	Male		Female		Total	
Osteochondritis dissicans	**n**	**%**	**n**	**%**	**n**	**%**
R knee	2	1.2	0	0.0	2	0.5
L knee	0	0.0	1	0.6	1	0.2
Knee (bilateral)	2	1.2	1	0.6	3	0.7
Talo-calcaneal joint (ankle)	1	0.6	0	0.0	1	0.2
MTP joint (L)	0	0.0	1	0.6	1	0.2
Acetabulum	2	1.2	0	0.0	2	0.5

Table 69 Anatomical location of osteochondritis dissicans (OCD) observed in nine individuals (N=9). No instances were observed in unsexed adults or subadults

Femoral neck necrosis

Trauma is a common contributing factor for osteonecrosis. For a mature adult male (SB12229), a fracture to the femoral neck and surrounding arteries resulted in abruption of blood supply and led to bone death (aseptic necrosis).

Neoplastic disease

Eleven individuals (2.4%) had indications of possible neoplastic disease (Table 70). Neoplastic disease is an abnormal mass of tissue, commonly known as a tumour (Aufderheide & Rodríguez-Martín 1998: 371). It is rare in the archaeological record (Roberts & Manchester 2001), but there are some benign neoplasms that are seen more commonly. One example is dense outgrowths of bone from the outer table of the skull, often referred to as a "button" or "ivory" osteoma (Fig 74). They have no symptoms and are of little clinical significance (Aufderheide & Rodríguez-Martín 1998: 375). These were observed on four females. Possible cases of malignant neoplasms were also observed in one female (SB3990) who displayed multiple destructive lesions with only slight reactive woven proliferations. On the radiographs further translucent lesions could be seen inside the cortex, especially on the pelvis suggesting metastasis from a soft tissue tumour in the pelvic region - an osteosarcoma (

Fig 75). Differential diagnoses are metastatic carcinoma of the kidney or the gastrointestinal tract. As there were no cranial lesions multiple myeloma was not considered. Another female (SB58341) had lesions suggestive of chondroblastoma observed on the skull. Severe proliferation and poorly organised osteoblastic reaction affected the external surface of the fronto-sphenoid area. The cortex on the lateral portion of orbits and sphenoid were thickened and lamella-like formations were seen. The lesions appear radio dense (white) on the radiographic image. Seven individuals displayed a form of neoplasm, which was destructive in nature, but could not be categorised further. Details are available in the data archive.

		Male		Female		Subadult		Total	
Neoplastic disorder	**Pathology code**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Button osteoma	711	0	0.0	4	2.2	0	0.0	4	0.9
Osteosarcoma	714	0	0.0	1	0.6	0	0.0	1	0.2
Osteoblastoma	722	0	0.0	2	1.1	0	0.0	2	0.4
Bone cysts	745	1	0.6	0	0.0	0	0.0	1	0.2
Unclassified neoplasm	745	0	0.0	5	2.8	2	20.0	7	1.6

Table 70 Crude prevalence rates of neoplastic disorders observed (N=443)

Miscellaneous Diseases

		Male		Female		Unsexed adult		Subadult		Total	
Miscellaneous disease	**Pathology code**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Cribra orbitalia (healed)		7	4.3	13	7.2	1	10.0	9	10.0	30	6.8
Cribra orbitalia (active)	1001/1002	1	0.6	0	0.0	0	0.0	2	0.2	3	0.7
Cribra orbitalia (healed/active)		1	0.6	0	0.0	0	0.0	0	0.0	1	0.2
Porotic hyperostosis	1010	5	3.1	0	0.0	0	0.0	7	7.8	12	2.7
Dysplasia	104	0	0.0	1	0.6	0	0.0	0	0.0	1	0.2
Paget's	1050	1	0.6	1	0.6	0	0.0	0	0.0	2	0.4
Hyperosteosis frontalis interna	1052	0	0.0	5	2.8	0	0.0	0	0.0	5	1.1
Unidentified pathology	106	3	1.9	0	0.0	2	20.0	0	0.0	5	1.1

Table 71 Crude prevalence rate of the miscellaneous diseases observed (N=443).

Fig 74 Large button osteoma on right parietal (SB10716) (Stor knapformet tumor på højre isseben (SB10716)).

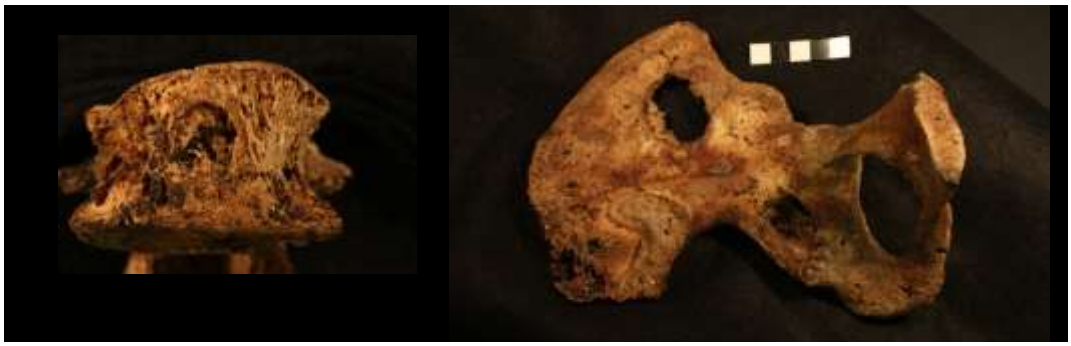


Fig 75 Lytic lesions on the anterior body of a lumbar vertebra, on the iliac blade and ventral side of ischium of a right pelvis. Lesions related to an osteosarcoma (SB3990) (Knoglenedbrydende/llytisk læsion på forsiden af en lænderyghvirvel samt på ilium og i den ventrale side af ischium i højre side af bækkenet. Læsionerne er relaterede til en osteosarcom (SB3990)).

The term miscellaneous diseases group together diseases that are poorly understood in terms of potential causes and their pathogenesis. They are therefore not easy to classify. What they all have in common, however, is that something has gone wrong with the cells or in the formation of the bone cells. The bone may react in the same way despite different pathogens. There are many diseases that fall into this category, but few have been identified among the Assistens assemblage and will be presented below. Fifty-six individuals were observed having one or several of the miscellaneous diseases. Below is a representation of the miscellaneous bone diseases (Table 71).

Cribra orbitalia

Cribra orbitalia (CO) is a descriptive term for porotic hyperostosis lesions of the orbital roof. It is identified as pitting of the compact bone of varying in size from capillary like impressions to coalescing outgrowths

(Stuart-Macadam 1991) (Fig 76). The aetiology is multifold. It has been related to stress suffered by an individual, but linking stress to specific causes is difficult (Roberts & Manchester 2001: 166-99). Anaemia is used to describe a range of conditions involving a reduction or defect in the production of red blood cells (Ortner 2003: 363), and may be linked to a range of deficiencies or genetic abnormalities, not all of which affect the bone. Nevertheless, the most commonly and considered factor in the skeletal changes observed is iron deficiency (Roberts & Manchester 2001: 166). In this study cribra orbitalia was examined macroscopically and graded according to Stuart-Macadam (1991). Information on the grades recorded for different individuals is available in the archive. The data presented here are based on the presence or absence of the changes in one or more orbits.

		Male		Female		Unsexed adult		Subadult		Total	
Age group	**Years**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	%
Infants	≤36gw-<1	0	0.0	0	0.0	0	0.0	4	36.4	4	9.8
Child	1-11	0	0.0	0	0.0	0	0.0	6	54.5	6	13.6
Adolescent	12-17	0	0.0	0	0.0	0	0.0	1	9.1	1	20.0
Young adult	18-25	4	44.4	1	20.0	0	0.0	0	0.0	5	27.8
Middle adult	26-45	1	11.1	5	83.3	0	0.0	0	0.0	6	7.5
Mature adult	46-55	0	0.0	2	100.0	0	0.0	0	0.0	2	2.4
Old adult	56+	3	33.3	5	62.5	0	0.0	0	0.0	8	5.9
Adult	<18	1	11.1	0	0.0	1	100.0	0	0.0	2	5.9
Total		9	26.5	13	38.2	1	100.0	11	32.4	34	7.7

Table 72 Individuals affected by cribra orbitalia according to age and sex. Individuals affected = individuals with cribra orbitalia in either left, right or both orbits (N=34)

A total of 34 individuals displayed cribra orbitalia in either the left (n=4), the right (n=3) or both orbits (n=27). In 30 individuals (6.8%) the lesions were healed, while three individuals (0.7%) had active (unhealed) cribra orbitalia. One individual showed mixed healed and active lesions in the orbits (Fig 76). From table 72, it can be seen that the most affected age group compared to number of individuals representing the age group are the young adults followed by the adolescents, the children group and infants group, respectively. All these individuals had healed leasions except for two children who had active leasions. All leasions in the middle and mature adult age group were healed. All leasions were healed in the old adult group except for two males having active and mixed active and healed lesions, respectively.

Porotic hyperostosis

Porotic hyperostosis (PH) is seen as thickened and coarsely porotic skull vault (Cribra cranii externa). The changes are more common in subadults than in adults. It can be a result of a healing inflammatory process of the skull bones, for example periosteitis, osteitis and osteomyelitis (Ortner 2003: 102). Haemorrhaging on the skull can also lead to PH. Subadults who suffer from scurvy tend to show a higher frequency of the haemorrhagic processes which often affect the skull vault. Rickets can also be responsible for porotic hyperostosis. It was observed in 12 individuals (2.7%), five males (3.1%) and seven subadults (7.8%).

Fig 76 Active cribra orbitalia in left orbital roof with woven new bone formation (SB18207) (Aktiv cribra orbitalia i øverste del af venstre øjenhule med ny knogledannelse (SB18207)

The porotic changes on the external surface of the skull vault are sometimes associated with cribra orbitalia, but neither is characteristic of a specific disease, but a symptom of several diseases (Ortner 2003: 102). Five of the individuals with PH also displayed CO (two young adult males and three subadults.

Hyperostosis frontalis interna

Hyperostosis frontalis interna was observed in five females (1.1%). The age distribution for the females affected was one middle adult, three old adults and one un-aged adult. It is a condition in which there is a thickening of the inner table of the frontal bone. Hyperostosis frontalis interna represents a condition generally occurring more often in females than in males (Hershkovitiz et al. 1999) although the prevalence among sex is still debated (Waldron 2009, 78). It has been associated with acromegaly, toxic goitre and diabetes (Dann 1951). However, the aetiology is still unknown. In this assemblage it should be remembered that the high proportion of complete crania has limited observation.

Paget's disease

Paget's disease is a condition of the elderly, characterized by abnormal bone formation. The bones eventually become enlarged and may fracture and the vertebrae may collapse. The growth of the bone within the spinal canal may lead to compression of the spinal cord. The cause of the disease is unclear, although it is believed that it may be due to the infection of the osteoclasts (bone eating cells) with a slow virus which prevents their taking part in normal bone remodelling (Ortner 2003: 435). Two individuals, a mature adult male and mature adult female, had the disease, but this is probably an underestimate. In the early stages of Paget's disease the bones, although perhaps heavier than normal, may appear normal. Consequently there may be no morphological clue suggesting that the condition is present. Both individuals had densification of trabeculae and cortex and the affected elements had the appearance of cotton wool when x-rayed, a characteristic diagnostic of Paget's disease (Fig 77, Fig 78). The female had densification of

the pelvis, sacrum and vertebrae, with compression fracture of the 12th thoracic vertebra (T12), while the male had densification of the cortex in pelvis and femurs with narrowing medullary cavity in the femurs.

Other pathological conditions

A number of miscellaneous or as yet undiagnosed conditions were noted (Table 73).

Concha bullosa

Concha Bullosa is an enlargement or ballooning of the nasal turbinate (Fig 79). Concha bullosa is a normal anatomic variant but occasionally can be very large and block the sinus outflow tract. In these cases, the concha bullosa interferes with normal nasal ventilation (restricts breathing) and can result in recurrent sinusitis (sinus infection). Today they are easily reduced with endoscopic sinus surgery. At the Assistens, 4.5% (n=20) had concha bullosa, the majority seen in females (n=15) compared tomales (n=3). Concha bullosa was furthermore seen in two subadults. It has been linked to sinus infection (Hatipoğlu et al. 2005) but none of the four individuals with registered sinusitis at Assistens are among the individuals diagnosed with concha bullosa.

Fig 77 Severe thickening of cortex on pelvis with Paget's disease, anterior view (SB14428) (Alvorlig fortykkelse af det yderste knoglevæv på et bækken med Pagets syndrom, set forfra (SB14428))

Fig 78 Radiograph of pelvis with Paget's disease. The image displays the cotton wool appearance characteristic of the disease (SB14428) (Røntgenbillede af et bækken med Pagets syndrom. Billedet viser sygdommens bomuldsagtige karakteristika (SB14428))

Fig 79 Bilateral expansion of nasal conchas. Concha bullosa (SB14056) (Bilateral udvidelse af næsens muslingeben. Concha bullosa (SB14056))

		Male		Female		Unsexed adult		Subadult		Total	
Individual other	**Type**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Individual other	Concha bullosa	3	1.9	15	8.3	0	0.0	2	2.2	20	4.5
	Harris lines	8	4.9	10	5.5	0	0.0	2	2.2	20	4.5
Non metric traits	Metopic suture	1	0.6	5	2.8	0	0.0	0	0.0	6	1.4
	Mandibula tori	1	0.6	1	0.6	0	0.0	0	0.0	2	0.4
	Vastus notch	4	2.5	2	1.1	0	0.0	1	1.1	7	1.6
	Unid. smooth lesions in acetabulum	7	4.3	11	6.1	0	0.0	0	0.0	18	4.1
	Unid. smooth lesions in glenoid	3	1.9	2	1.1	0	0.0	0	0.0	5	1.1
	Supra condyloid process	0	0.0	0	0.0	0	0.0	1	1.1	1	0.2
	Supra trochlea spur	0	0.0	0	0.0	0	0.0	1	1.1	1	0.2
	Pseudo joint pelvis	1	0.6	0	0.0	0	0.0	0	0.0	1	0.2
Unidentified pathology	Narrow ex acoustic meatus	1	0.6	0	0.0	0	0.0	0	0.0	1	0.2
	Unid. lytic lesions in frontal bone	0	0.0	1	0.6	0	0.0	0	0.0	1	0.2
	Thickened diplöe	1	0.6	0	0.0	0	0.0	0	0.0	1	0.2
	Unknown pathology	0	0.0	2	0.6	0	0.0	0	0.0	2	0.4
Surgical interventions	Surgical tubes in abdomen	0	0.0	2	0.6	0	0.0	0	0.0	2	0.4

Table 73 Crude prevalence rate of individual anomalies, unidentified pathological or developmental changes or surgical interventions (N=443)

Harris lines

Transverse lines or Harris lines occur in the growing bones of subadults and have been a popular indicator of physical stress in the osteoarchaeological record. The precise mechanism behind the formation of lines have been related to an episode of acute or chronic stress (for example high fever) affecting the deposition of osteoids (bone cells). The lines become visible when the osteblasts start working again after the stress period. Hence, a line is only visible if normal growth was resumed and the individual recovered from the stress period (Lewis 2007: 108). The aetiology behind Harris lines is still not fully understood, but has been associated with starvation, pneumonia, lead poisoning, rickets, congenital syphilis and scurvy (Follis & Park 1952, in Lewis 2007: 108). Although Harris lines are mainly seen in subadults, they can become permanent in “rare cases” (Wells 1964: 155). Nevertheless, it is seems that Harris lines were commonly affecting adult individuals at Assistens. Harris lines could be observed from radiographs in 20 individuals (4.5%) of whom18 were adults and only two were subadults. The lines were mainly observed on the tibia and or fibula.

Non metric traits

Non metric traits are skeletal variations that are genetically inherited but do not affect the health in any way. Non metric traits were not registered fully at Assistens; however, some were noted when observed. The prevalence is therefore likely under representative of the actual distribution. The non metric traits will not be discussed any further in this report.

Other

In five cases, all adults and only one male, surgical tubes were found in the body, all but one were made of pink rubber (Fig 80), the other wood. The tubes have possibly been left there because the patients died during, or just after, surgery. The location where they were found, in the pelvis or near the chest area indicates the uses of them.

Fig 80 Surgical tubes found in pelvic region of a female (SB13708) (Kirurgiske rør fundet i bækkenregionen hos en kvinde (SB13708))

Scientific analysis/environment

Prehistoric soil analysis

The pit samples contained very little archaeological plant material; the results are from Hald (2011). A few seeds of wild taxa were observed, primarily indeterminate *Caryophyllaceae* (carnation family) seeds, i.e. from wild flowers. A very small amount of charcoal fragments were also observed. None of these low levels of botanical components are able to throw light on the possible function of these pits.

These results are, however, based on small 100ml subsamples. The rest of the samples have been processed, but are yet to be analysed.

Plant samples from the cemetery

The plant samples contained a variety of twigs/branches, leaves from wreaths, and fragments of bouquets, all of which are very likely to have functioned as funerary decorations. Not all samples were identifiable due to their state of decay.

The most common plant found in the samples is Box (*Buxus sempervirens*). Other twigs/branches were of Holly (*Ilex aquifolium*), Spruce (*Picea* sp.), Pine (*Pinus* sp.), Palm and possibly Yew (*Taxus* sp.). Leaves of Red Cedar (*Thuja* sp.) formed the base in a wreath otherwise made from Holly in F200681. PM200382 consisted of a bouquet of wide grass/leaves wrapped around a "Baby's breath"-type plant (cf. *Gypsophila paniculata*) and possibly roses. A number of samples also contained fine dried grass, from the pillow stuffing in the coffin; it was not identified to species.

7 Cultural historical interpretation

At Assistens cemetery there are only two main phases of activity: prehistoric activity (Bronze Age – Iron Age) and the cemetery from 1806-2010. There is no archaeological evidence for the period in between these two represented phases. The small amount of prehistoric activity is described briefly but the cemetery forms the major focus of interpretation. Due to the fact that the cemetery was only active for 204 years, there is only limited ability to phase the site, but one identified difference in cemetery layout is focussed upon. This was the change from lines of single graves to a system of family plots. However in general the cemetery is treated as a single phase, though specific cultural interpretations may focus on the chronological differences where possible.

Prehistoric settlement

The prehistoric contexts were found in two different areas of the site: Area 4 and Area 6. As there are no stratigraphical relations between these two areas, it is uncertain whether the two concentrations belong to the same phase of activity or not. However, the few datable finds show that they likely belong to the same time period (see 7.3.1.), which further suggests that they are related to the same settlement phase.

A concentration of 13 pits was found in Area 4 (Fig 81). The pits were found in an area which was excavated down to one metre below the present surface only, but the pits were fully excavated. Some of the pits were truncated by a large grave plot but most of them were undisturbed. The size of the pits varied from approximately 0.90 to 4.00m in diameter and the depth from approximately 0.30 to 0.90m. Twelve of these were likely clay extraction pits considering the clayey natural geology. The extracted clay was likely used for daub for houses or perhaps for pottery, which is the most common prehistoric find in the area. Their content of various, typical settlement finds such as flint debris and pottery sherds, suggest that the pits were left open after the clay extraction and were gradually filled with different settlement waste. Some of the clay extraction pits were disturbed by later, prehistoric pits. As these did not cut the natural ground, they were obviously not for clay extraction. A likely interpretation is that they were pits dug for waste disposal. However, the content of charcoal, burnt stones and burnt finds in one (G172), might suggest that it was a cooking pit.

A single pit was found in Area 6, and this was likely also a clay extraction pit, which had been filled with various settlement waste (G395).

Fig 81 Pit concentration in Area 4 (Koncentrationen af gruber i Område 4)

A concentration of five postholes was found in the eastern corner of Area 6, outside of the grave area (Fig 82). The postholes were found less than one metre below the present surface and none of them had a stratigraphic relation to any other contexts.

The postholes were found close to each other and were relatively uniform in shape and size (approximately 0.30m wide and between 0.15 to 0.20m deep), which suggests that they belonged to the same construction. This is also indicated by the pattern that they seem to form. Three of the postholes form an east-west oriented line, slightly skewed towards the north-west, while two postholes could be the

remnants of a second posthole line parallel to the first one. The two posthole lines could be the remains of the roof-bearing posts belonging to a three-aisled house. The distance between the two lines is approximately three metres, which could match to the distance between the roof-bearing post of a small, three-aisled house; probably the home of a single family. The east-west orientation of the posthole lines also match well to the normal orientation of prehistoric houses found in Scandinavia (Ethelberg et al. 2000: 176-7; Ethelberg 2003: 183). If we are dealing with the remnants of a three-aisled house, all the holes for the wall posts and some holes of the roof-bearing posts are missing. The small depth of the registered postholes could suggest that the missing postholes have been removed with the top soil.

There were no finds to date the structure, and the outline of it does not suggest any narrow dating either. Three-aisled houses were built in a very broad period, spanning from the Early Bronze Age to the Viking Age. The closest datable prehistoric feature, a pit (G395), is found about 10 metres to the south. This is likely to date from the Pre-Roman Iron Age and, considering that most of the datable prehistoric finds on the cemetery belong to the Late Bronze Age/Early Iron Age, there is reason to believe that the house structure belongs to that period too. However, both the identification of a house structure and its possible dating is highly uncertain. Whether or not the post holes belong to a three-aisled house, the orientation of the structure strongly indicates that it is not related to the cemetery use of the area, as contexts related to the cemetery use in Area 6 generally follow a north-east/south-west orientation, which does not match to the east-west orientation of the posthole structure.

As stated before, the majority of finds belong to the Late Bronze Age and the Early Iron Age, indicating that the people were settled in the area within this time span; in calendar years *c* 1100-0 BC. However, it cannot be ruled out that some of the finds, especially the lithics, are the traces of sporadic activities, which took place in the area in other parts of prehistory.

Animal bones have been found in five of the prehistoric pits. These have been identified as belonging to cow and sheep/goat; species whose remains are commonly found on agricultural settlements. The bones likely belong to the Late Bronze Age/Early Iron Age settlement and indicate a settlement economy, which, at least partly, was based on livestock. The sheep have probably been kept for their wool and meat and cattle were likely kept for their meat too, but can also have been used as draught animals for ploughs or carts/wagons. Both species' milk production was likely utilised for dairy products (Ethelberg 2000: 77). As the economy in the Late Bronze Age to Early Iron Age was generally based on arable farming together with animal husbandry (Ethelberg et al. 2000: 233-9; Ethelberg et al. 2003: 39-42), there is reason to believe that the economy of the settlement was partly based on crops too. The clay extraction pits suggest that the domestic pottery was produced on the site, while the flint debris shows that stone tools were also produced in the area.

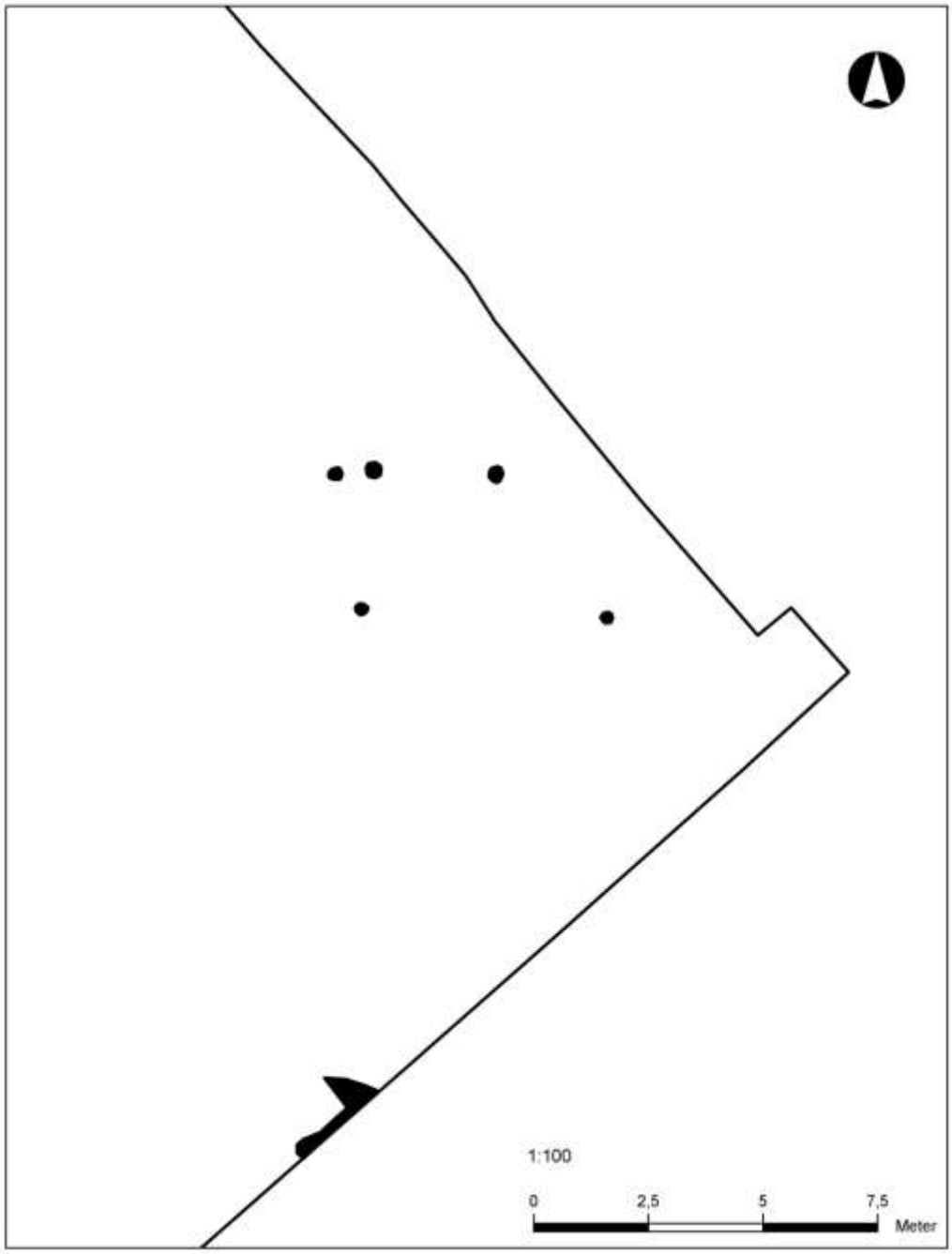


Fig 82 Posthole concentration in Area 6, which might represent some of the roof bearing posts of a three aisled house (Område 6, Stolpehullerne, repræsenterer muligvis tagbærende stolper i et treskibet hus))

Comparable finds from the Copenhagen area are very scarce. A few stray finds and a single grave from the Early Bronze Age have been found, but no Bronze Age settlements have so far been registered. Early Iron Age finds are correspondingly scarce. However, a single Iron Age house has been excavated in the Municipality of Copenhagen, in Vigerslevparken in Valby, which is situated about 6km to the south-west of the Assistens cemetery. The house was three-aisled and was dated to the Early Roman Iron Age *c* 0-200 AD (Simonsen 1994: 4).

The cemetery

The spatial organisation of the cemetery

Assistens cemetery was from the beginning organized and planned-out around overall principles regarding the acceptable burial of the dead. Area G was unusual in that it was set within the corner of the cemetery and was designed to have the gravediggers' house as a focus. The corner location enabled the placement of more of the visible and higher status lines of burial plots along the two exterior walls. Although historical records give detailed evidence for the layout of this part of the cemetery, changes have been made over time and the order and extent of these is not always clear. The archaeological evidence, therefore, has a role in unpicking the alterations made throughout its use. The data from this excavation was also examined to see if there was any evidence relating to aspects of 19th and 20th century Copenhagen's social make-up which became represented in the spatial organization of the cemetery.

General layout

The excavation data was analysed and compared with historical records to discern the general design and layout of the cemetery. This analysis reveals an ordered layout of rows of grave plots and individual graves separated by a number of pathways all surrounding the central gravediggers' house (Fig 83).

One observation is the orientation of the graves: the majority are aligned northwest-southeast, with the head of the individual oriented towards pathways. The one major exception to this is a large area of graves lying between the gravediggers' house and the main north entrance of the cemetery (Areas 3 and 4). These graves, which collectively form a rough oval shape in plan, are aligned north-south. Graves alongside walls or major pathways are also oriented towards the path rather than a specific cardinal direction. Another clear observation is that nearly all the graves are organised into long rows generally aligned northeast-southwest. Again exceptions to this are the rows along the northeast cemetery wall (parallel with Nørrebrogade) that is aligned northwest-southeast and those in Areas 3 and 4 in front of the gravediggers' house that are aligned east-west.

The rows are grouped together in blocks with little space between them. However surrounding the blocks of grave rows are areas with no graves in. Many of these areas form long straight lines that are interpreted as footpaths. These paths vary in length, width and orientation dependant on their role in the overall design of the cemetery. The largest two paths are parallel to the external cemetery walls, starting at the entrance at the north and continuing down to the southwest and southeast corners: a row of graves separates each of the paths from the outer wall itself. These two are by far the widest, at about 7m wide at the southern ends but narrowing to about 2.5m as they pass the oval area at the north of the site, and appear to extend beyond the excavated area to the south. These two paths are main thoroughfares through the cemetery as a whole. A third path seen archaeologically is about 2.3m wide and at least 28m long. It is orientated northwest-southeast and bisects an area of graves to the south of the gravediggers' house.

As well as the paths there are a number of other open areas with no graves present that indicate a planned grave-free area. The most clear of these is an area to the south of the gravediggers' house, extending about 14m south from the back wall. Within this space was located a well, the remains of a chimney and a pit of unknown use. These features point to the area having some function associated to the gravediggers' house. The well, for example, may have been situated in a back yard and the chimney would have been part of an auxiliary building. It shows that the gravediggers' house was not placed alone amongst the graves but was

part of small complex of buildings and yard space. There is also evidence of open space to the west of the gravediggers' house where the only archaeological features present were small pits, drainage ditches and an area of dark soil. The combination of a drainage system and the dark soil confirm that this area was used as a garden. However as excavation did not go beyond 1m depth in this area and often did not reveal natural undisturbed clay, it cannot be confirmed if earlier burials were present beneath. The combination of a yard behind the house, with possible out-buildings, and a garden area to the west of it imply an organised, segregated space for the use of the gravediggers to live and work in with a certain degree of privacy. The spatial layout of areas that were not fully excavated could not be confirmed; information on these areas which appear as spaces but possibly contained graves must be supplemented by the documentary data.

If these interpretations, based on the archaeology alone, are compared to the historic records they appear to correlate well. The grave rows and major paths appear to match the general design of grave plots and footpaths as shown on the historical plans. However the archaeological evidence does not show the minor pathways between rows that are shown on later historic maps as spaces; within the clusters of burials all of the space is used. However there are rows of burials present that are never reused for family plots. They range in width from 1m to 2m and allow burials which are not on the main pathways to be accessed. This is clear evidence of a change in burial layout. The maps do show that the area surrounding the gravediggers' house did have auxiliary buildings and the layout of these has changed over time and was extended to the south between 1868 and 1900. One of the new buildings is shown to truncate a number of graves. Though some early plans show these graves to be within areas used for burial there is no plan that shows any specific numbered plots in this location. Here is another change in layout.

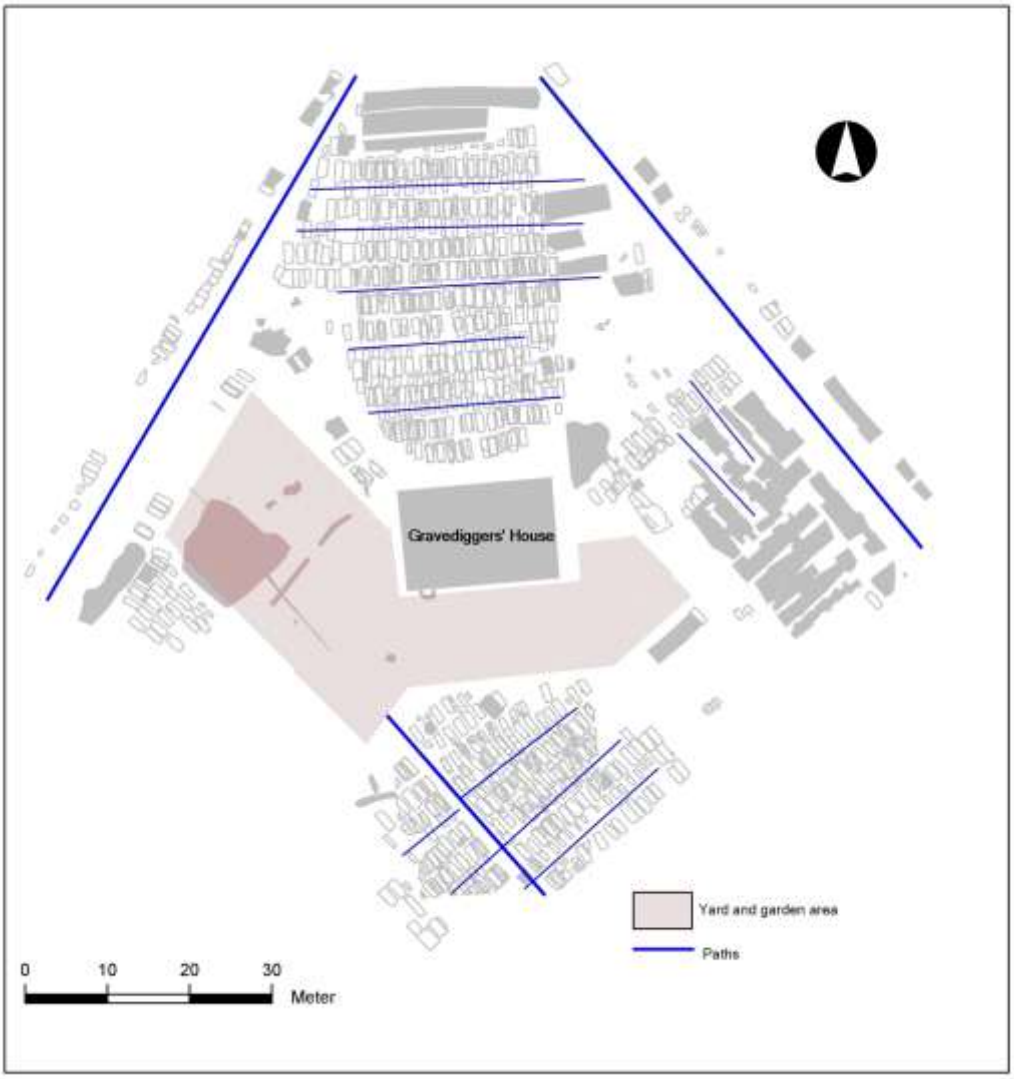


Fig 83 Plan of recorded features with location of archaeologically identified paths and yard/garden area indicated.
(Plan af indmålte anlæg med placeringen af arkæologisk identificerede stier og haveområde)

Grave plots

Grave plots are plots of land that can be purchased to accommodate multiple individuals rather than just one. Maps of Assistens are dominated by the outlines of family grave plots which are in other areas of the cemetery still visible above ground marked out by railings or a hedge. However no survey was undertaken of these boundaries prior to excavation and gravestones often do not mark out the precise location of each individual grave in the plot. However only these individual graves could be observed and recorded archaeologically because the boundaries of the plot did not extend physically below ground. Adding to this difficulty many individual graves intercut others so that there were rarely discrete clusters of burials that could directly be associated with an above ground plot boundary. This makes the process of trying to identify plots a complex task, especially when the above ground information is not available.

The vast majority of burials are clearly organised in rows reflecting the overall planning and spatial organisation of graves in the cemetery. However, within these definable rows clusters of graves often intercut one another. These groups vary in the number of graves included and their physical size. However,

what is clear from many of these groups is that there is clear spatial separation between different groups. The physical space that one group inhabits may then be defined as a grave plot. This is a definition arrived via purely archaeological means. The historical evidence shows that the cemetery was organised into rows of grave plots, each plot sold to an individual or family who then had control over who was buried in that plot. When plans of the cemetery plots are overlaid on the plans of the archaeological surveyed graves, the archaeologically defined plots appear to correspond with these rows of plots. However, many of the archaeologically defined plots cover two or more plots on the historic plans, so despite the historic maps suggesting a clean gap between them above ground, below ground the grave cuts and coffins can overlap and truncate each other. This demonstrates where the re-use of certain grave plots was more popular and so areas with high frequencies of graves indicate a particularly popular or heavily used area in which people wished to be buried. In some cases more than one archaeologically defined plot is within a plot on the historic plan. This suggests that some plots are more organised than others with care taken to avoid the disturbance of existing graves in the same plot. However, if the spatial pattern of grave cuts within an individual plot, or cluster of graves, is examined with relation to the stratigraphy a more regular pattern emerges. Frequently there are two coffins where one is placed directly on top of the other, with the lower coffin, to some extent, undisturbed by the upper coffin; this is then repeated some distance to the east and/or west. Earlier graves are more likely to be partially truncated or all but removed. This indicates that within plots there is tradition of burying two coffins in the same vertical space, with a higher and a lower one. When the space is full this may be repeated with disturbance or removal of the existing coffins, the remains of which demonstrate earlier phases of burial activity in a plot.

What this shows is that it is possible to distinguish between a plot based and an individual grave cemetery layout using the archaeological evidence. However, it is not enough, when identifying individual plots, to simply point to clusters of intercutting graves. Instead, one needs to compare the spatial and stratigraphical relationships between the graves as more complex, but meaningful, patterns may emerge. These patterns may also help to identify separate phases of activity within the plot itself. By doing this it has been possible to attribute nearly all the non-single graves excavated at Assistens to a historically defined plot, despite often large disparities in the accuracy of the historic plans.

Monument lines

Rows of plots were placed alongside the exterior cemetery walls and adjacent to the major pathways within Area G, several of these were identified but few plots were excavated. The archaeological evidence demonstrated that plots along these rows were distinctive from the rest of the plots in their use of large masonry structures. While the exact outline of most grave plots was not clear during the process of excavation, a number of family plots were enclosed by brick or stone structures. These were identified by their location as much as the foundations of boundary walls or as underground vaults. It appears that only the owners of plots along these paths were able to build structures more complex than a gravestone to mark the plot. The position of these plots along the main pathways in the cemetery would have also made them more prominent and thus more likely to be seen by people walking through the cemetery. Therefore, it is clear that there was a form of distinction made for the burial plots situated along the largest paths in the cemetery that involved a perception of heightened social prestige.

Another feature of the areas bordering these large paths was that they did not contain any traces of the single line burials. This allows for the monument lines to be contemporary with the single line graves, making them the earliest of the family plots on site.

Returning to the historic sources it can be seen that there were three specific divisions in burial type at Assistens set out in the cemetery protocols (Wiene 2010), identified by level of payment and separated spatially. The most expensive of these was monument lines, which were laid out along major pathways and besides the outer wall. These were the only place where grave plot walls or structures were allowed and it appears that the cemetery officials have been consistent in upholding this rule.

Single grave rows

A row of single graves refers to graves that have been purchased individually; there was no right to be buried with family members and no right to choose the precise location, rather than as part of a plot. This means that specific graves are less likely to be clustered together and overlapping in groups, but are more evenly spaced. During the excavation a pattern emerged, distinct from the family plots, of regularly spaced rows of individual graves.

When investigating the grave plots it was clear that there were often graves that seemed different in a number of ways from the other graves in the plot; they were either positioned a little further to the north, or to the south, than the others; their preservation was generally poorer; the backfill was more compact and less mixed; they tended to be older than the others stratigraphically, and they were not dug very deep (only to single depth). Another characteristic was that the burials themselves were limited in amounts of grave gifts and coffin decoration. These graves also appeared to adhere to their own pattern of spatial arrangement. Graves that were identified as conforming to these specifications became labelled as single graves and were thought to indicate a separate phase of burial activity. These graves formed rows of individual burials spaced roughly 2m apart. The rows followed a pattern very similar to the rows of clustered burials of family plots, but often shifted slightly to the north or south.

However, it was clear when examining the results that the strict definition excluded a number of graves which seemed to fit neatly into the distinctive rows of the single graves. These graves, which had the same alignment as the rows of single graves, did not fit the definition in some other form, most often because they were only partly excavated or because the depth was unregistered or registered as double depth. It was,

Fig 84 Distribution of the single graves. The single graves are in black, while later cuts are transparent (Kort over enkeltbegravelserne (markeret med sort) - de yngre anlæg er er uden udfyldning)

therefore, decided that they would be added to the group of single burials. The definition also included some graves that were clearly not single graves: a few were buried in single depth and cut the natural soil, but were however spatially not aligned with the rows of single graves. These graves were, therefore, not interpreted as single graves, despite their similarity to single grave characteristics.

So, although a number of different traits were used to identify the single graves, it is the spatial location and stratagraphic position that properly define this burial tradition. When completing these adjustments to

the results, a possible early cemetery layout is revealed (Fig 84). The total number of single graves based on this definition was 219. It is, of course, possible that a few graves that actually were single graves, but by coincidence had the same location as a later grave plots, have been falsely interpreted as belonging to a family plot (though these may simply have been truncated away completely).

According to the historic sources, of the three specific divisions in Assistens set out in the cemetery protocols single line graves (*linjebegravelser*) are the cheapest form and were placed between family plots. All of these graves were earth-cut, meaning they were buried within a grave cut, rather than being placed inside a structure such as a vault. There was normally no possibility of renewal of ownership and they were situated on impassable places which were often later used for family grave plots (Wiene 2010: 17). However the early date of these burials suggests that they were not necessarily placed between family grave plots but pre-date them almost entirely, so that the entire area would have been filled with line burials.

Dating the single graves

Due to the stratagraphic evidence the single graves can be ascribed to an early cemetery phase: with no exceptions all the single graves are the earliest contexts in the stratigraphies they are part of. This is not surprising considering that one of the defining traits of the single graves, is, that they are cut into natural soil. As stated, there is therefore a possibility that later single graves have not been recognised. However, obvious examples of rows of single graves truncating rows of family plots is non-existent; the uppermost graves are nearly always found in clusters, which strongly suggest that the single grave tradition is in fact of an earlier date than the grave plot tradition. The question is then, what date were the single graves established?

In general the graves are in a poor state of preservation compared to the graves in the family plots, which could be an indication of an early date of the burials; however, this is a highly unreliable indication. The grave gifts are few, and there is little to suggest a date based on these. However, the gold wedding ring found in G847 has the year 1816 (likely the year of marriage) inscribed on its inside, giving a *terminus post quem* dating of this particular grave. The individual in the grave was determined to be female and 25 years old when she died and as such, is likely to have been married only a few years by the time of her death. These few facts together suggest that the individual was buried in the early 1820s.This single piece of evidence is not enough to date the single graves as a whole, but it is, however, another hint of a possible early date of the grave type. The coffins likely contain traits which are characteristic for their time, but a coffin chronology on the material of the 19th and 20th century has not been established for this cemetery yet. Thus, the shape of the coffins does not help to narrow down the period of single graves further, but would likely be a fruitful study in future research on the subject. As there is currently no secure connection between the archaeology and the documentary data from the earliest cemetery protocols, it is not yet possible to identify the indviduals buried in the single graves or to date them precisely. However, the family plots which contain individuals identified using the grave protocols can help to narrow down the period when people were buried in the single graves. As the single graves are stratigraphically older, it is likely that they were first established in the earliest use of this area of Assistens cemetery, which began in the first and second decade of the 19th century (Fig 85). The overlying family plots with securely dated graves can tell, at least approximately, when the single burial tradition ended. However, this method, which likely would be the most fruitful in terms of dating the single graves, is unfortunately beyond the limits of the present study.

Fig 85 The northernmost excavated row of graves in Area 3, where a few widespread single burials are preserved, probably representing the remnants of a line of single graves. The single graves are in black, while the other graves are transparent (Den nordligst række af grave I Område 3, hvor der også fremkom spredte enkeltgrave som formentlig repræsenterer resterne af en gravrække. Enkeltgrave er markeret med sort og de øvrige uden udfyldning.

The lines of single burials have a similar outline as the later family plots; the rows more or less have the same orientation and length. However, some differences clearly stand out: the graves being interpreted as single burials were often found where later pathways, which existed in the area up to the time when the Metro construction work began, were present. They were also in between the younger rows of graves plots where they are often partly truncated. This suggests an earlier outline of the cemetery making the present organisation with pathways and family plots, at least partly, of a later date than the single graves, showing that the cemetery at some point was reorganised and the use of these spaces were cancelled. Furthermore, there is reason to believe that single graves were originally much more numerous, but because of their shallowness have been vulnerable to disturbance by later cemetery activities. The cemetery reorganisation meant that some single graves have been completely destroyed by the establishment of family plots.

The best impression of how the earliest organisation of the cemetery looked is seen in the four northernmost lines of graves of Area 5 to which 40 single graves belong (Fig 86). The majority of these graves are undisturbed by later burials, suggesting that the burial activity here was limited to a shorter period than in many other excavated areas. No cremations were found within the area, which suggest that the area was used for burials in an early phase of the cemetery use, as cremation was not legalised in Denmark before 1892 (Secher 1956: 54). The northernmost of the four rows seem quite clearly to be a line of single graves as all have approximately the same distance to each other, are cut into the natural ground and buried in single depth. However, in the next grave line to the south the picture gets more blurred. Here we have an almost perfect alignment of graves, but a few graves are found in clusters, suggesting that they

represent family plots. This pattern is more strongly expressed in the two southernmost lines of graves. One explanation could be that the use of the area for burials over a period of unknown length was given up. Looking at the location of the graves in reference to the map from 1800, the graves lie inside a large square immediately to the south-east of a south-east north-west oriented pathway behind the gravediggers' house. According to the 1960 map the pathway has since been moved further south, and an outbuilding has been placed on the location of the four mentioned grave lines. The two maps thus together suggest that the area originally was used for burials but at some point, perhaps gradually, was incorporated into the space belonging to the gravediggers' house. All together these graves give a snapshot of the changes in the outline of the cemetery: in an early phase the area was used for single graves placed in straight rows (the northernmost line). Over time, plots were established in the same area expressed by the well-defined clusters of graves placed side by side with the single burials (second and third northernmost grave line), while at some point plots took over completely and often destroyed the old line order (line four from the north).

Overall it is uncertain when the single grave practice ended. However, it is certain that the practice was used from the beginning of the cemetery use of the area, and is likely to have ceased early too, likely within the 19th century. Confirming the archaeological interpretation of the single graves as being line burials, historical sources state that line burials were established up to 1880, again in 1894-1900 and finally in 1918-1919 (Wiene 2010:18). These two later periods of line burial do not appear to be represented in Area G, though they may, of course, exist elsewhere in the cemetery.

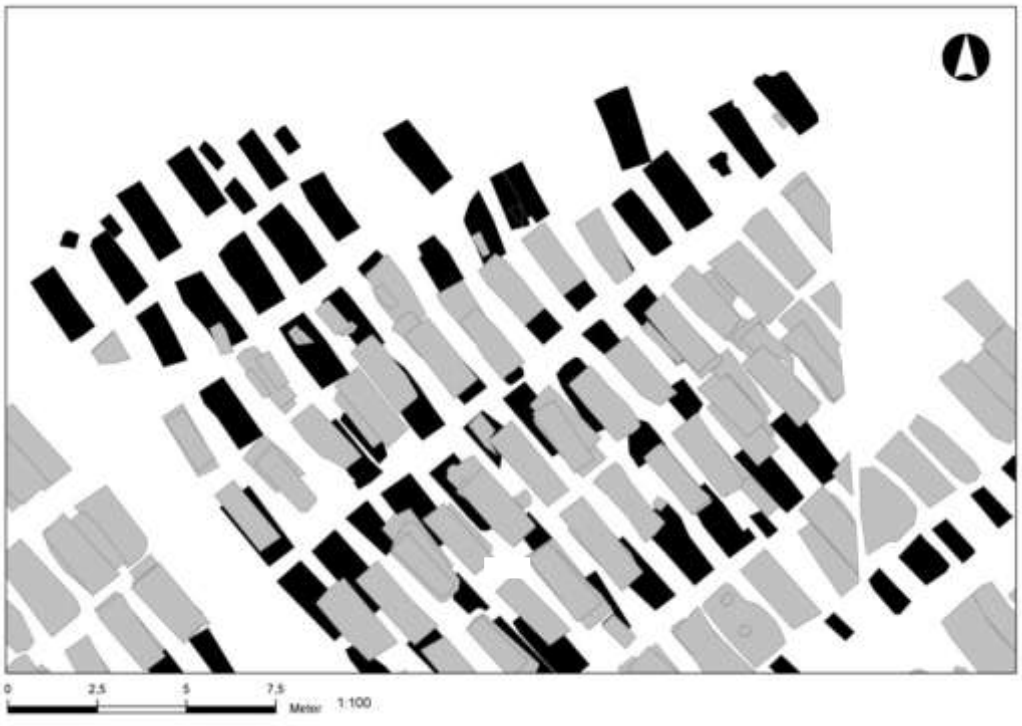


Fig 86 Overview of the northern part of Area 5. The burial use of the area likely ended in 19th century and thus leaves a glimpse of the earliest organisation of the cemetery. The single graves are black, while the later graves are grey (Kort over den nordlige del af Område 5. Enkeltbegravelser er markeret med sort, mens senere grave er markeret med grå. Formentlig ophørte man med at begrave folk i dette område i løbet af det 19. århundrede, og området giver således et fastfrosset billede af kirkegårdens tidlige organisering af)

Row of children's burials

The remains of children and infants were identified in most areas of the site. There were, however, certain locations that were used to accommodate the graves of young children. So, although there are a number of examples of children being buried in family plots, there does appear to be a tradition of spatial separation of child burials.

The most obvious area used only for child burials was a row of graves south of the gravedigger's house. This row was parallel to, and between, two rows of family plots running in a northeast-southwest orientation (Fig 87). The row contained at least 16 child single graves, but possibly includes as many as 23 child graves as the size of seven unexcavated graves further to the northeast suggest that these also contain children. The oldest of these children was 9 years old (according to osteological analysis) with all but two being aged 2 years or under.

The row of children's graves in many ways resembles the single line graves, both mainly consisting of relatively shallow graves containing poorly preserved coffins and tending not to disturb earlier burials. These similarities may indicate that the two types of burial are contemporaneous, but there are significant differences that mean such a claim must be tested. For one, unlike the adult single lines, the location of the children's line was respected by later family plots which do not truncate it. Also there is evidence of coffin decoration, such as plaster work, in a number of these children's graves (G1092, 1098, 1129, 1140 & 1170) which is absent from the adult line burials. A different, later date is also be indicated by the rubber ball found in one child's grave (G1170) that could be of a fairly recent date, perhaps from the late 19th century or the early 20th century. This confirms that the child single graves are not necessarily as old as the adult single graves. That children continued to be buried in a single-burial-like pattern into the period of family plots is supported by a family plot register from the cemetery, where it is stated that child burials were placed in children's grave lines and that these child burials were similar to family plots which could be renewed (Andersen 1991: 11). According to this, family plots separated for children were established in the cemetery, and the specific line of child graves in the southern part of Area 5 could possibly belong to such child plots. Some plots were seemingly bought just to contain a single child as only a few of the burials are cut by other child burials.

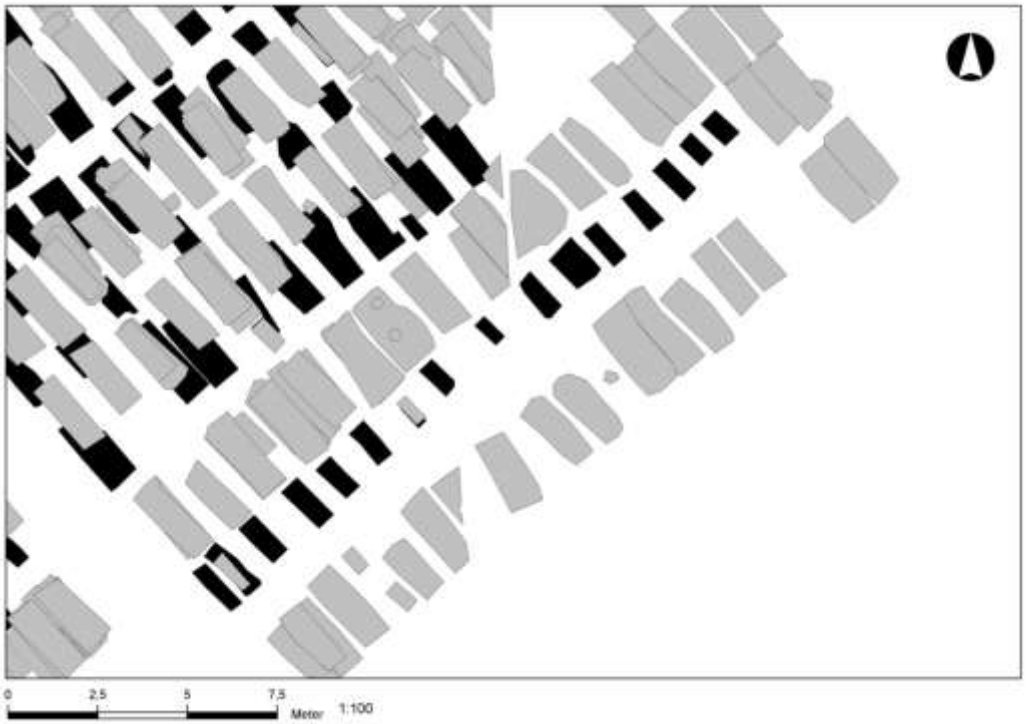


Fig 87 The southernmost row of single burials, consist of child graves only (Den sydligste række af grave består udelukkende af barnebegravelser)

The evidence from the historic plans also supports the idea that this line of children's graves is contemporary with the family plot layout: a map of the cemetery from 1880 shows small plots marked out where the line is situated (see Fig 6). However, a later map, from the 1960s has the location of the children's line covered by bushes or trees (see Fig 7), suggesting that some time prior to this inhumations ceased being placed in this line of children's graves.

So, although children are occasionally buried within family plots, there is a clear difference in the treatment of young children, as compared to adults, in the way they are buried. This demonstrates that culturally children are not simply young, but are *different* from adults.

Minor alterations

Once the family plot layout of the cemetery was established there is still evidence that minor variations to it were made. Archaeological evidence shows plots that are not marked on the historic plans, plots being removed to make way for new paths and the division of large plots into smaller ones.

Within the graves that are not defined as belonging to the earlier phase, or layout, of single graves there are several examples where it seems that plots are cancelled rather than being sold on to new owners. A cluster of three sub adult graves in Area 7 is on the same line as other designated grave plots, they appear to be organised as plots, and they could also have been part of a longer ownership of the plots that were no longer marked above ground. However, the plots do not appear on any of the historic plans. This seems to be evidence of a change in the layout where they were no longer used and have been cancelled in order to broaden a path.

In Area 2, where the targeted excavation area lies, there is evidence of changes to the general cemetery layout which affects some grave plots. The gravediggers' garden area lay to the west of the main buildings and yard and a small pathway was aligned on the far western edge. However, by 1880 plans show a small path had been made cutting between grave plots 547 and 548. The numbering on the old and the new systems suggest that there never were any burials or plots lying within this area. However, there is archaeological evidence that another set of a double line of graves was present, lying to the south, and although not excavated they were observed and surveyed as intact graves.

There was also evidence of grave plots being separated where they have been created originally as double sized plots but later, when they are sold onto another family, they have been separated creating two smaller plots. This has proved very difficult to identify archaeologically. There was also evidence of plot merging where a vault and boundary wall structure that covered two grave plots on the monument line had been merged to create a single plot twice the size. Further research into this aspect could point to changes in social topography or even the consideration that families were smaller or that the buying of a family grave plot involves less of the extended family thus requiring less space.

In general all plots in the cemetery were used but there were a few gaps in the rows where graves would be expected, but there was no trace of graves, only undisturbed natural ground. The estimated space needed for an adult grave is based upon the average size for a grave cut (2.16m x 0.85m) and there is space present in several areas where no graves were located. This may be an indication that a plot was purchased, but family circumstances changed and, therefore, the full potential number of inhumations was not utilised. It could also be a sign that plot size was important as a form of social display and not just thought of in functional terms of space for potential inhumations.

Despite the cemetery being carefully planned and laid out, it is clear that small alterations were continually being made to accommodate specific desires and needs.

Design and changes

Assistens cemetery is different from many of the other 19th century cemeteries that have been excavated. Here there is a distinctive planned layout, using a design concept that reflects the contemporary ideals of garden architecture and park planning. This excavation has shown that, despite changes to the layout, the very earliest use of Area G conformed to this concept. Although space was used efficiently, there was no presumption to use every piece of land for graves. The design was a rational and ordered layout which allowed for pathways and roads to navigate amongst the ordered rows of grave plots. Whereas earlier churchyards were centred on the church building which determined the spatial layout of graves, in the excavated Area G the gravediggers' house and associated smaller buildings formed a central focus for the area which interacts with the imposing original gate entrance to Nørrebros Runddel. It is these features that demand the arrangement of the grave plots around it. The archaeological investigation has added to the knowledge of the cemetery layout available from the historical plans. It has given a new understanding of the way a historical cemetery can change over time, often in disorderly ways that are not apparent from above ground. The earliest arrangement of single burials has been demonstrated and, when this gave way to the use of family plots, it has been shown that features such as paths were altered. The gravediggers' house, as the dominant feature in this area of the cemetery, has also undergone changes and it is possible now to see where this has affected the positioning of graves and plots. The order and organisation of the modern landscaped cemetery such as Assistens can be observed above ground in the laid-out pathways,

hedges and planting, it is through the archaeology below ground that one appreciates that, rather than being timeless, it is a changing and active space.

Plot structures and decoration

Plots are generally delineated in some form above ground and often monuments or decoration of some kind are present. A solid and enduring marker is generally used, but unfortunately due to the lack of survey or recording of the extant burial markers or grave plot decoration prior to the excavation this information was lost. The surrounding grave plots in Area G and the rest of the cemetery show a varied survival of grave markings, in some instances trees and bushes mark out the edges of the plot, in other cases gravestones are still standing. In family grave plots the gravestones are placed centrally and there is space for each new name to be added. There are also individual gravestones. If there was a difference in commemoration due to personal factors such as age, sex, or wider changes in chronology it cannot be known without further research into the original plot decoration. Similarly there is a loss of the plant decoration that formed a vital part of the symbolic reference to the family and the individuals. However, the excavation did recover many fragments and in some cases, intact gravestones in residual or re-used contexts; there was also the evidence of walls surrounding plots and the few burial vaults which were excavated.

Gravestones

Of the 43 gravestones recorded with some biographical detail surviving, so far, none has been identified to a particular grave plot or individual from the protocols consulted for this report, with only one important exception (Grave plot 611). Although the gravestones recovered during excavation have not been found *in situ*, there is some useful information available from their study. The dates of death ranged from 1821-1947. Most are commemorating several people within a family. The majority are in marble and have little or no decoration, containing simple phrases such as 'Rest in peace' rather than longer inscriptions. Only one highly decorative inset for a gravestone was found and that was in the cemetery soil and thus unrelated to any specific grave. It was copied from Bertil Thorvaldsen's 'Natten med sine børn: Søvn og død' from 1815: this employs the symbolism of angels of the night lifting baby twins up into the sky (Kragh 2003: 49). Therefore, images and symbols do not appear to be popular ways to express sentiments on gravestones with mourners preferring to rely almost exclusively on text.

Images of Area G, prior to the excavation, show that many of the stones had already been cleared and the area had become overgrown. However, there were seven examples of the below ground foundations for gravestones that were still present, five in Area 4 and two in Area 3. Four of them contained rectangular brick structures approximately 0.65m long and between 0.9 and 0.7m deep. One (G128) had been tipped over to one side but wasn't fully excavated, the tipping over is interpreted as happening when the marker or stone was removed. There were two empty pits that are related to grave markers, one was filled with broken bricks and sand, another was an emptied rectangular cut but it contained an iron reinforcement placed in the base of the cut which could have been used to support the stone, it is possible that the marker was a complete stone that did not require a separate foundation. Lastly a single concrete marker could also have been a more modern equivalent support for a gravestone.

It is then clear that at least a few plots would have had a gravestone standing within them at some stage and there is no reason to believe that the use of gravestones in this area differed significantly from the rest of the cemetery, where they are common.

Plot boundaries

Gravestones were not the only form of structure associated with the grave plots. Many of the plots were surrounded by walls, mainly of brick (Fig 88). All of these were located along the monument lines showing that their construction was strictly controlled by the cemetery authorities. Although a walk around Assistens today will reveal that plants, in the form of shrubs and bushes, are commonly used to delineate individual plots, brick or stone walls form a more permanent and psychological boundary that separate those buried inside more clearly from the rest of the cemetery. Those plant boundaries would likely also have been common in Area G, but the lack of a pre-excavation survey of the undisturbed site means that their extent is not known.

Vaults

Although there was no indication in historic maps of the presence of vaults, two were excavated (Fig 89) and there are likely to be more that are unknown and lie unexcavated.

Both the vaults lie on the monument line, where the plots were more expensive to purchase, and coupled with the cost of building the vault itself the implication is clear that the owners had access to significant wealth and were willing to create a long-term burial space for their families.

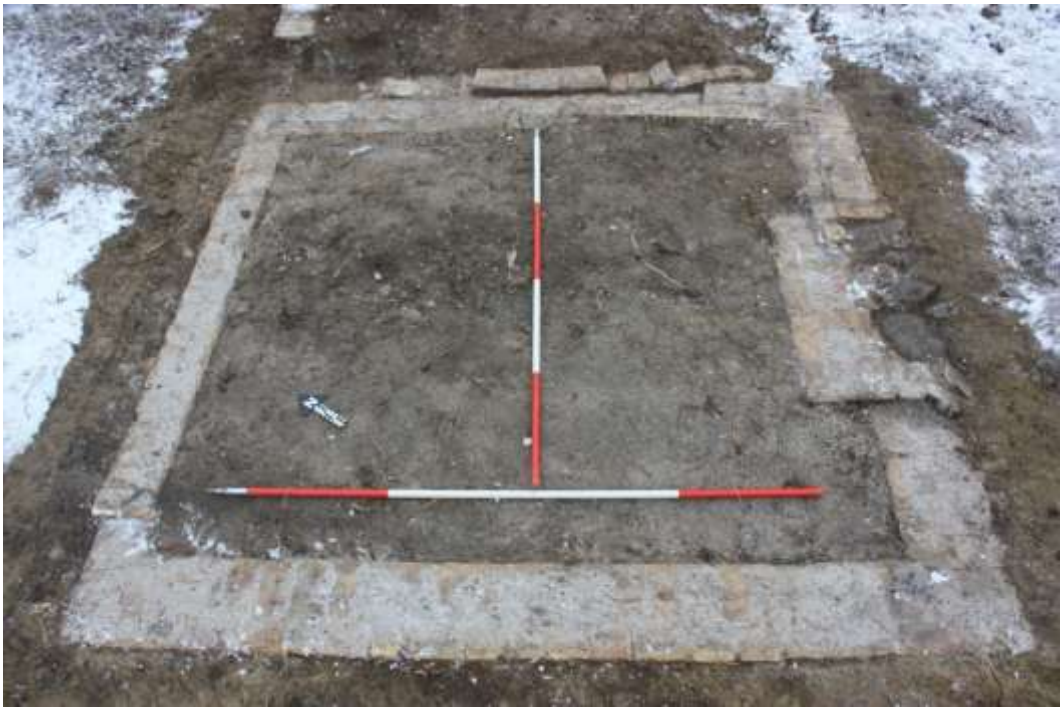


Fig 88 Typical grave plot walls in Area 2 (Typiske gravstedsmure i Område 2)

Both were relatively early in date (1815-1826) suggesting the desire, or ability to create these structures faded out over time. The creation of the vaults also meant that reuse of the plot would have been inhibited, unless they could be removed, it also shows no inclination to reuse the vault for a new family. This may also have led the cemetery authorities to discourage their construction due to perceived future difficulties in reusing a plot when the owners lease expired.

Plot Decoration

The discovery of over 80 conch shells (*Eustrombus gigas*) within a disused drainage sump (G501), gives a hint of some of the decorations that could have been put on the grave plots. It is not known when the well was filled. It is unlikely that all 80 shells came from one grave plot therefore they must have been gathered together, perhaps as suitable material for fill in the disused structure, along with many fragments of old gravestones. They could have been gathered together from all parts of the cemetery but they certainly represent a trend of decorating the graves. Queen conchs come from the Caribbean, and can be found from Florida, to as far south as Venezuela and north-eastern Brazil. Queen conchs are edible, but in Europe they're far more likely to be brought back for scientific or natural interest or for its decorative character. They were also commonly used to prevent barrels moving around in the hull of a ship. There is an intriguing connection with St John in what are now the US Virgin Islands, but was once a Danish colony, from the early 18th century until 1917. Archaeological investigations of a 19th century African-American slave cemetery in the East End Community on St John found queen conch shells marking out the graves (Armstrong 2003). They were used as a form of headstone and marker for the person buried there and it could be possible that a person buried at Assistens or their family had seen this tradition and carried it back to their native country. At least one person buried on Assistens was born in St Croix, another of the Danish Caribbean colonies and there may be links with others.

Fig 89 Empty vault with herringbone floor in monument line in Area 2 (G47) (Tom gravhvælving med teglstensgulv i sildebensmønster, Område 2 (G47))

There were few other hints in the soil deposits of how the grave plots were marked above ground. There was evidence of gravel in some of the redeposited grave fills, particularly of shallow graves and there were also residual iron objects identified as hinges or brackets that are paralleled with existing railings that mark the edge of the grave plots.

Grave plot 611

There was only one opportunity to record the connections between the above ground plot and the remains buried below. Grave plot 611 was legally not allowed to be removed or exhumed until mid way through the excavation, in June 2010. This applied to the surviving above ground decorations as well as the coffins underground and thus they were able to be archaeologically surveyed. The plot consisted of an entrance defined by a gap between hedges at the north-east end, with low box hedges continuing around the sides. There was a gravelled surface with a semi circle of rounded stones; in the centre was a smaller circle of rounded stones. Two small bushes lay on either side of the entrance. Several gravestones were present although they were lying flat (Fig 90).

Two family names are represented on the stones; the Petersen's and the Sass's. Three gravestones were present, one for the Petersen family with the earliest date of 1848 commemorating three people. The Petersen's are the registered family owners of grave plot 612 lying just to the west, it is clear that at some point this stone has been moved onto this plot. These graves were not excavated but left *in situ*. There is a possible connection between the families, both females recorded in the Petersen and the earlier Sass gravestone were born with the maiden name of Berg and could be related; it is possible, but not proven that two families bought grave plots side-by-side. The second records four members of the Sass family from 1844 to1847. It appears to commemorate a family of two parents and one child. The third stone is also for the Sass family of three people from 1917 to 1970, these could be the next generation from the earlier Sass gravestone, with Lt Colonel Edvard Sass as a potentially surviving son. The stone records his honours as knight of the Dannebrog and marks that he fought in the wars against Germany in 1864, his son Viggo, also was given an honour and was a Royal-approved ship broker.

The grave plot is in a socially prominent position; it lies directly in front of the main entrance to Assistens cemetery from Nørrebros Runddel and would have been immediately visible as well as placed prominently in front of the gravediggers' house. The social standing of both of the Sass males is marked out clearly in terms of occupation and military experience. There is some reflection between the social decorations and traditions highlighted above ground with what was found below. Two of the coffins were in elaborate metal and wood coffins, neither was investigated but immediately reburied, these were identified as Wiggo Sass and his mother Susanne. Although neither had nameplates or any decoration, good quality wooden inner shells and much decorated textile could be observed through small cracks in the coffin shell. However Edvard who had died considerably earlier was buried in a simple wooden coffin with no elaboration at all. This could have been personal preference or because he died so much earlier than his wife and son. The mother, Susanne also died just after the end of World War Two and the German occupation, an elaborate coffin and decoration would have been much more of a social statement and expense. The son died in 1970, by this period perhaps a metal coffin was an elaboration of previous burial traditions. The change between the type of traditions afforded to the elder Sass and the wife and son could be a reflection of changing ideals of display of the dead.

Patterns of burial placement

The area excavated covers only one parish, therefore no comparison between people from different parts of the city is possible. However, other factors such as age and sex can be examined to see if these affected the location of burial and the spatial arrangement.

Fig 90 Grave plot 611 prior to excavation with the intact display and marking out of the plot boundaries, gravediggers' house in background (Gravsted 611 før udgravning. På billedet ses gravstedet med intakt randbeplantning, gravsten og sti. I baggrunden ses graverbygningen)

Layout of graves according to sex categories

Within the family grave plots and the assemblage overall there seems to be no pattern or segregated areas set aside for males and females, the skeletons that were able to be categorised showed no overall pattern showing that sex was not a defining factor for grave placement (Fig 91). Due to the even numbers of males and females identified it is not thought that further identifications would have made any difference to this evenly distributed grave pattern. There were occasional clusters of each sex. Within a family grave plots there are clusters for example in the north of Area 4 (two males, G530 and G583 and two females G624 and G651). However these are still likely to represent family groups and do not seem to represent any wider social pattern of isolating graves according to sex or gender.

For the earlier phase of the cemetery, looking at the spatial distribution of male and female graves, there are no indications that specific lines or groups of single graves were reserved for either males or females as the sexes seem evenly distributed throughout the excavated area (Fig 92). This corresponds to the overall distribution of males and female graves in the excavated area. The most conspicuous pattern as regards to the sexes is that there is a great difference in the number of adult males compared to the number of females: while 78 single graves have been identified as male graves only 40 have been identified as female graves. The age distribution between the sexes is close to even, so the overrepresentation of males cannot

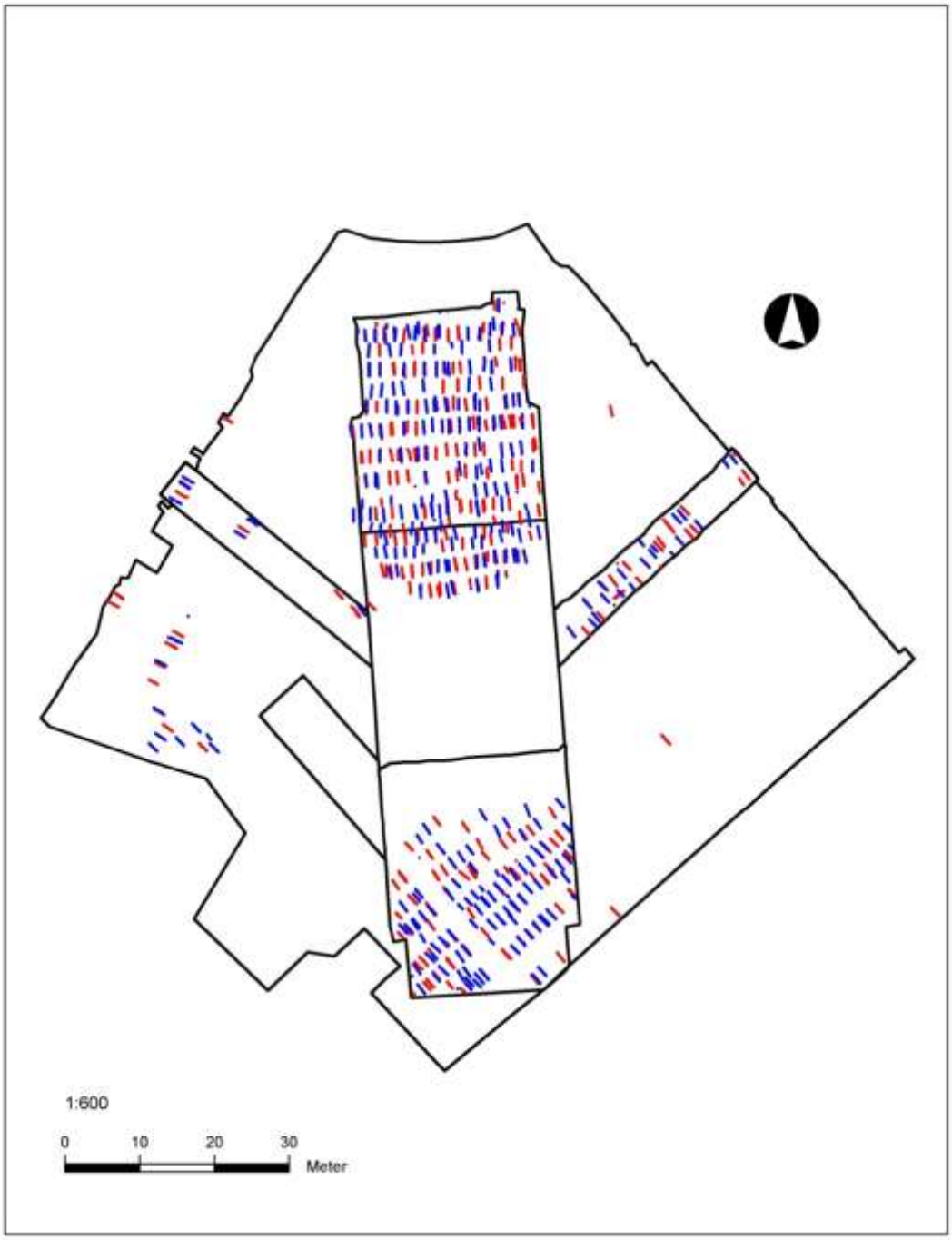


Fig 91 Distribution of sexed adults. Red = female; Blue = male (Fordeling af kønsbestemte voksne. Rød = kvinder; Blå = mænd)

be explained by an excess of a particular age category of males being buried in the lines (see Table 74). The mixed distribution of the sexes throughout the cemetery show that the pattern cannot be explained by the woman being buried somewhere outside the excavated area either. The material contains 70 graves which could not be sexed, however, the "missing" woman are unlikely to be hidden in these graves, as there is no reason to believe that there should be an overrepresentation of unidentified woman. If we accept that the buried individuals are representative for the poorer population who lived within Trinitatis parish, the

individuals in the single graves show that considerably more males than females were represented in this segment in an early phase of the cemetery; possibly the earlier part of the 19th century. The explanation of this pattern however remains an open question.

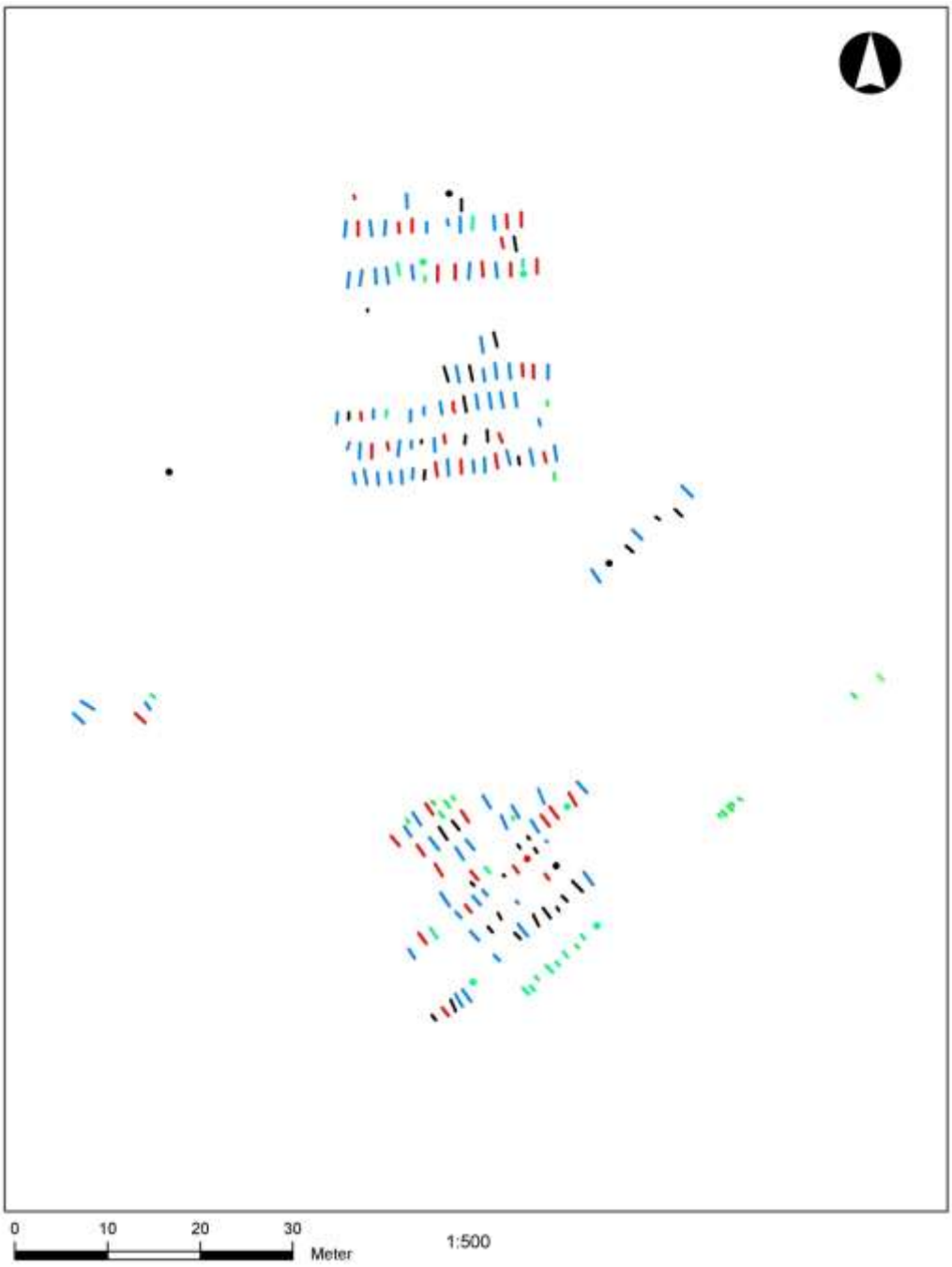


Fig 92 Overview of the different ages and sexes in the single graves. The black lines represent unspecified adults, the blue lines represent males, the red represent females, while the green lines represents infants and juveniles (Oversigt over de begravedes køn og alder. De sorte linier repræsenterer voksne, der ikke kan kønsbestemmes, blå linier repræsenterer mænd, røde repræsenterer kvinder, mens grønne repræsenter børn)

Layout of graves according to age categories

The remains of children and infants were identified in most areas of the site (Fig 93). There were, however, certain locations such as the line of single children's graves that were used specifically for the graves of young children. So, although there are a number of examples of children being buried in family plots, there does appear to be a tradition of spatial separation of child burials.

Fig 93 Distribution of subadults over the site divided into age categories. Black = perinatal; Green = Infant; Red = Child; Blue = Adolescent; Pink = Subadult ageing only (Fordelingen af subadulte på hele lokaliteten, inddelt i alderskategorier. Sort = Nyfødt; Grøn = Spædbarn, Rød = Barn; Blå = Teenager; Lyserød = Subadult)

As well as the line of children's graves in Area 4, the northern part of Area 5 contained a small cluster of child graves. Furthermore, there are a few examples where two small children were buried together in the lines of adult single burials. The shallowness of the child graves has, as other single graves, made them vulnerable to disturbance. This is shown by three graves, that because of the small size have been categorised as child graves (G393, G563 and G735), but in which no remains of bones have been found, likely because of disturbances. Shallow grave cuts seem to be a general trait for child graves in later periods of the cemetery use too, possibly because the depth of the grave cut was made in proportion to the small size of the coffin. The archaeological observations show that children, at least periodically, were treated different than adults. This can in some cases have a practical explanation: cemetery regulations from 1805 record that two children could be buried within the same amount space as one adult and the price of the child burials were therefore only half that of an adult burial (Wiene 2010: 19). The regulation could possibly explain the children buried together in pairs. However, economical considerations cannot be the reason for all of the differences, as it leaves no obvious explanation for the line of child single graves in Area 5.

Age (code and interval)	No. of males	No. of females	No. of unsexed adults	No. of unsexed children
1 (perinatal)				**7**
2 (1-6 months)				**4**
3 (7-11 months)				**3**
4 (1-5 years)				**9**
5 (6-11 years)				**4**
6 (12-17 years)	**1**	**2**		**4**
7 (18-25 years)	**5**	**3**		
8 (25-35 years)	**4**	**2**		
9 (36-45 years)	**15**	**3**		
10 (45-55 years)	**13**	**4**	**2**	
13 (56-65 years)	**1**	**1**		
14 (≥ 66 years)	**1**	**1**		
11 (>18 years)	**24**	**16**	**32**	
12 (<18 years)				**1**
15 (perinatal-11 months)				**1**
16 (1-11 years)				
17 (26-45 years)	**11**	**6**	**3**	
18 (>55 years)	**3**	**2**		
Total	**78**	**40**	**37**	**33**

Table 74 Comparison of males, females, unsexed adults and unsexed children according to the different age codes in the single burials

There is also one specific cluster in the east of the site that contains two perinatal infants, six infants and one subadult (Fig 94). These are spatially lying separately from other graves; they are not positioned within rows and are grouped around what was recorded as a tree hole. They were all shallow graves within the top 1m from the ground level and thus required excavation. Some of the graves were also intercut. They divide into two specific features: three (G57, G58, G61) are lying within an ordered layout, two were three months old, one was nine months old. These however do fit into what could be a continuation of a main grave plot line. Comparison of the positioning with the historic maps shows that in 1880 a small divided plot (grave plot 89B) that is missing in later maps.

However there is a second cluster of graves that is much less ordered, the graves are intercut and some of the bones were mixed together, only one was above a year old. The coffins, where they survived were extremely poorly preserved. They were possibly placed around a tree as the graves were disturbed by the

tree hole (Fig 95). All were very young infants or children (Table 75). There is no indication on the historic maps of any cancelled plots and no archaeological evidence to show that they were official graves. The nature of these graves suggests they were buried without knowledge of the cemetery authorities, being shallow and not lying within ordered rows and established plots. This could suggest that the gravediggers were accepting small infant burials to be placed, perhaps within plant borders for a small fee, in a small shallow grave which could easily be hidden during the routine maintenance of gardening. It is possible that these children were orphans or that the parents lacked the money for the official burial fees and did not wish their child to be placed within the paupers burial areas.

Group	Age
68	4,5 months
72	10 months
120	42 gestational weeks
123	40 gestational weeks
121	2 years
122	1 month

Table 75 Age categories of unorganised cluster of infants in Area 7

There were only two perinatal infants buried with a female, assumed to be the mother (G265; G1385, Fig 96), both in family grave plots. There are two infants who appear to be twins who are also buried together in one coffin. This does show that it is possible for people to be buried together in one coffin but appears to be restricted to younger infants as a practical consideration. There is another example of a middle age female buried with a small separate coffin of an infant placed directly on the top. These individuals have not been identified; it is possible that the mother died first as there was a layer of charcoal in the base of the coffin and was not buried if the infant was not expected to survive thus they could have had a joint funeral. There were no examples of adults placed together in the same coffin.

In comparing the patterns of adults that were aged with those that were designated as adult only there also seems to be little patterning, there were slightly less adults aged in Area 5 than 3 or 4 (Fig 97). This is thought likely to represent the osteological recording method and approach undertaken rather than any deliberate pattern of disposal (see below). There is a high degree of identification in smaller excavation areas (the small service trenches), this also reflects the osteological strategy which also concentrated on analysing skeletons from these trenches.

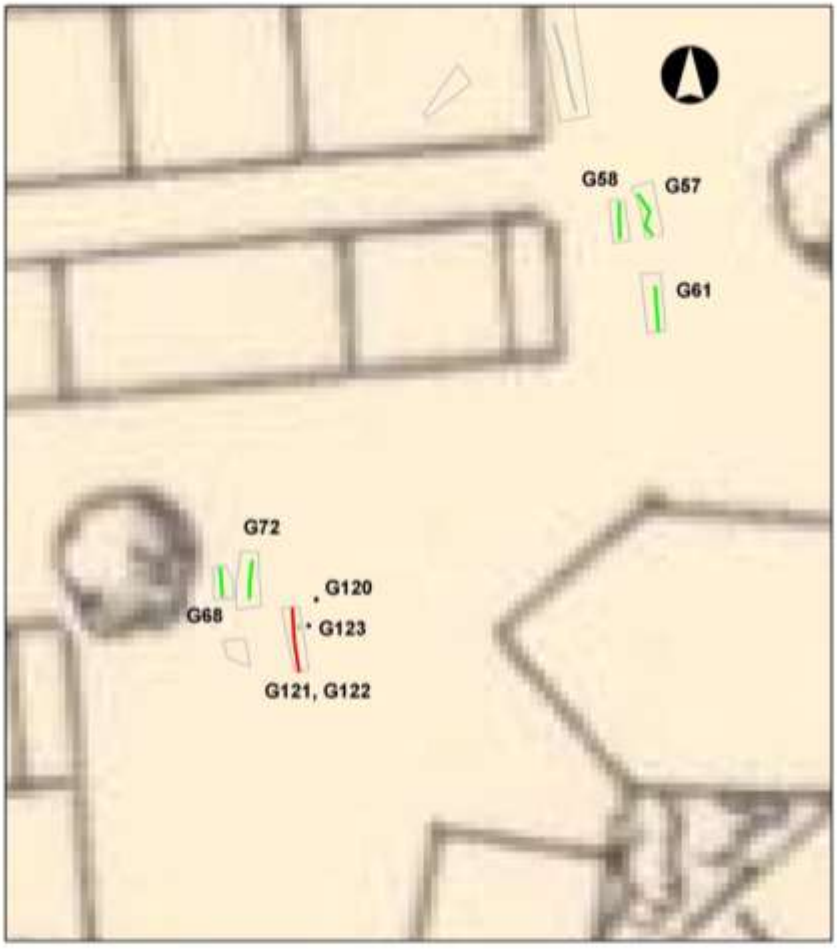


Fig 94 Detail of infant graves in Area 7, overlaid onto the historic map of the cemetery dated to the 1960s (Detalje af spædbarnsgrave i Område 7 lagt oven på et historisk kort over kirkegården fra 1960'erne)

Fig 95 Discovery of the infant graves in Area 7 (G68, G72 & G120-3) during the clearance of topsoil, the arrow shows the centre of the tree hole with the coffins grouped around it. Facing north-west (Spædbarnsgravene i Område 7 (G68, G72 & G120-3) under afrømning af det øvre jordlag. Pilen markerer trærodens centrum og kisternes placering omkring denne. Set fra sydøst)

Fig 96 Female with infant in left arm (G1385), arrow points to the infant (Kvinde med spædbarn i venstre arm. Pilen angiver spædbarnets placering)

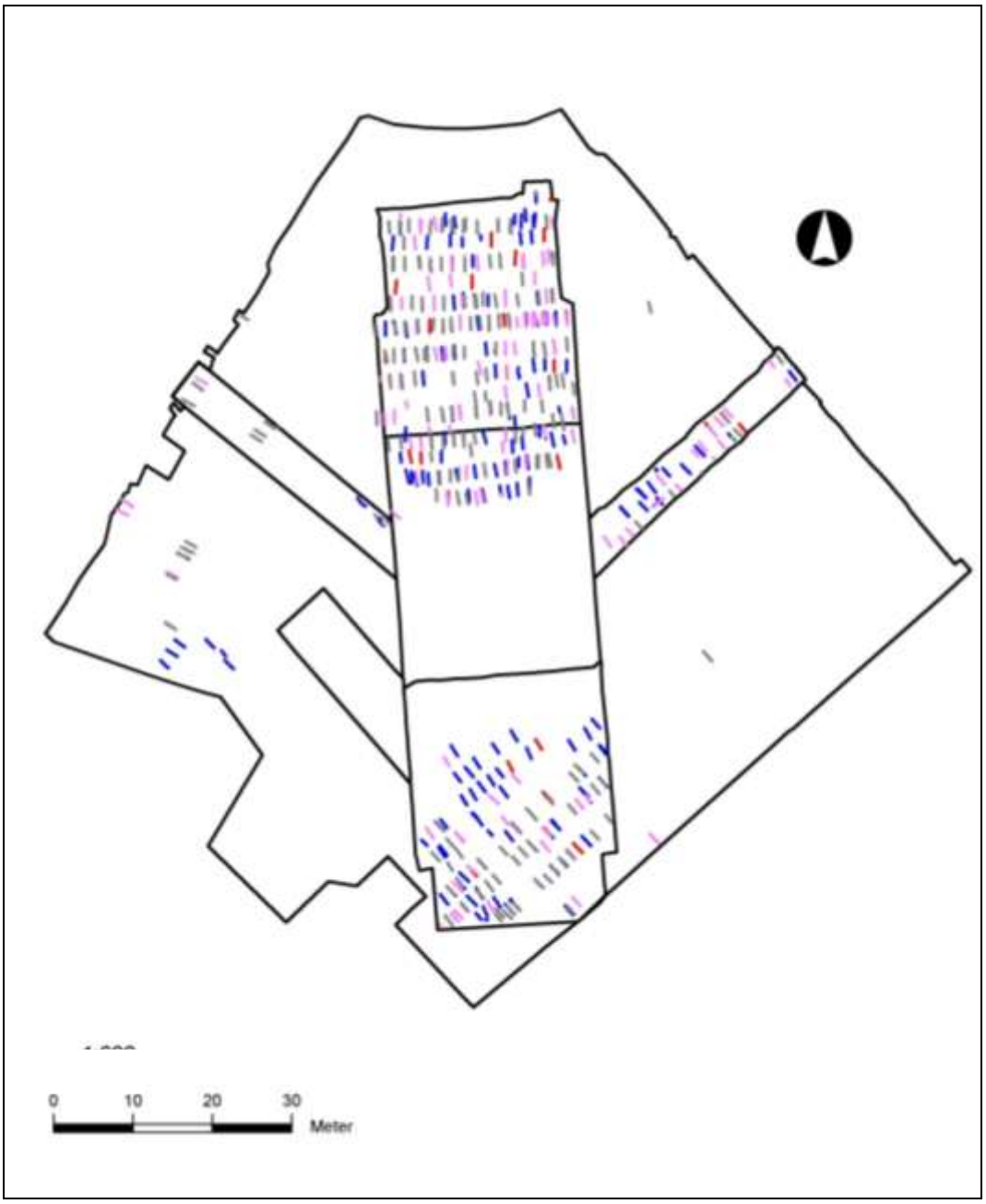


Fig 97 Distribution of all adults aged by category. Red = Young adults; Blue = Middle adults; Pink = Mature adults; Grey = Old adults (Fordeling af alle voksne individer inddelt i alderskategorier. Rød = unge voksne, blå = mellem voksne, lyserød = modne voksne, grå = gamle voksne)

Comparing the separated age categories, the spatial patterns are affected by the relatively small numbers in some categories, such as young adults (18-25 years), again there seems to be no secure trends in the overall spatial patterning with an average mix of aged adults. However there are a few concentrations where there are some categories grouped together. Along the borders of the site very few graves were excavated but these showed predominantly mature and old aged adults (9 of 10 graves). There were also a few clusters of individuals of similar age, within Area 4 there was a group of middle age and mature adults, Area 3 contained a group of middle adults and Area 5 a group of middle aged adults. This could be related to groupings where family members live to similar ages or could simply reflect random patterns within the

data. The problem of young adults being missing is not one easily solved, identification of young adults is often easier due to the incomplete epiphyseal fusion and general lack of more degenerative features on the skeleton, and therefore there is a distinct lack of this age group which affects the demographic analysis.

There is some pattern in relation to the age categories and grave placement. Subadults are present within other adult family plot clusters, especially in Area 4. However within the centre of Area 5 there is a distinct gap where there are few subadults (Fig 98), in fact the subadults present are recorded only as points indicating that they were truncated and too disturbed to be recorded as a line. Instead there is a focus on placement in the lines closer to the gravediggers' house and a clear line of subadults placed between lines of adults which seem to continue far to the northeast. Here there is a clear difference between Area 4 and 5; Area 4 contained a mix of adults and subadults whereas Area 5 had a spatial differentiation.

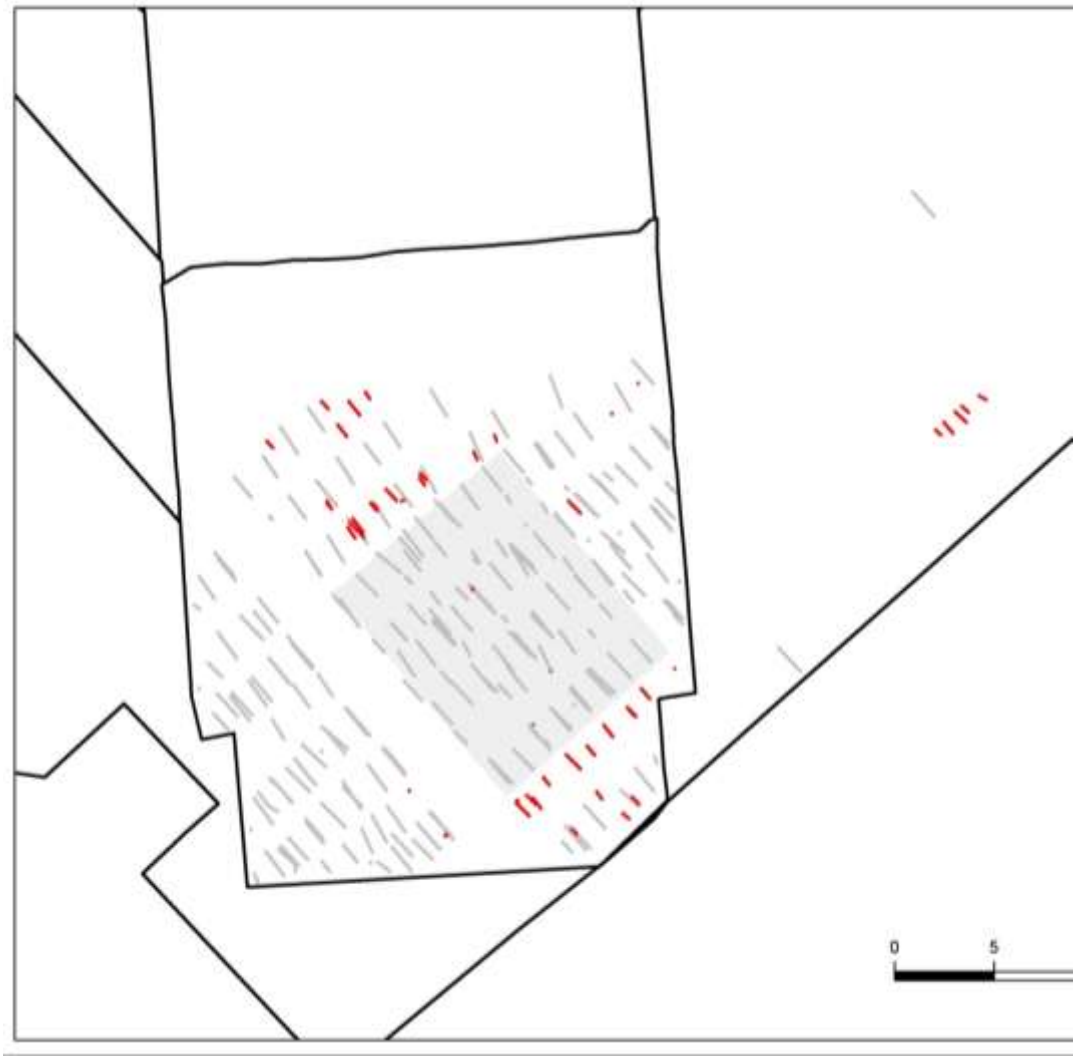


Fig 98 Distribution of subadults in Area 5, shaded area indicates significant area with no subadult graves (Fordeling af subadulte i Område 5. Det skraverede område indikerer en signifikant mangel på subadulte grave)

Why the difference? Is there a stronger desire to bury children with adults in Area 4, was it more expensive? If not more expensive perhaps it was more status driven to place the children in the family plot. Voegtly cemetery, in Pennsylvania, US, had a distinct spatial separation of adults and children with several

areas set aside for children within the ordered rows of graves (Ubelaker & Jones 2003: Fig 6). This was interpreted as having a religious separation in society where children are too young to be responsible for their own religious state and therefore are a separate category in society; this was also reflected in the decoration and type of coffin and material finds within the coffin. The authors suggest that it is a common practice in Europe and America in the 19th century (Ubelaker & Jones 2003:10). The evidence for this is scarce and little researched however.

Burial standards and the gravediggers' work

A basic standard for graves on Assistens cemetery has been identified; each grave cut was intended to contain one coffin and one person. Every excavated skeleton had a wooden coffin: there were no shroud graves. There seems to be a standard set of measurements of the grave cut to fit the coffin and naturally child graves were also smaller and could be fitted into smaller spaces. Written records suggest standardised depths (Wiene 2010) for adults and subadults which could be quite shallow. There was no deviation in this pattern for the earliest layout of the cemetery in the single lines of graves but there were non-standard patterns identified in the family plots.

Gravediggers' work life and practices

The working life of a gravedigger is one that can be examined through the direct evidence of their craft in the grave cuts and the decisions made concerning the movement and reuse of earlier coffins. There is also indirect evidence concerning their techniques and social attitudes to their work. There were historic protocols stating what should have been done but how often was this followed and how practical was it?

The choice of where to bury the dead was not given to gravediggers at Assistens, whereas in earlier cemeteries and churchyards the gravediggers (or sexton) were often given the control over the location, although people could always pay for a vault or a specific location. At Assistens the plot was bought and paid for and the exact positioning of the coffin may have also been predetermined according to the pre-existing burials. There may have been some autonomy in the placing of people in single grave lines where simply the next available space was taken and there was also the example of the unregistered infant graves in the east of the site which indicates that the gravediggers were capable of actions outside of the protocols.

The gravediggers' role included a number of different aspects. They would have to prepare and dig the grave, making sure that the depth was adequate and the sides secure from collapse. In plots with existing burials they will have had to deal with the presence of coffins and human remains already in the ground, with decisions being made about the how to treat these. Some plots may have required the taking down of an existing monument prior to the grave being dug.

Through the archaeological evidence of the graves the craft tradition of the gravediggers comes through as something that is skilled and needed to be passed onto others, yet the traditions could also adapt as new technology and new ways of thinking about graves came into use.

Orientation of the grave

Graves were often oriented north-south with the head at the north, where this was different the alignment was dictated by the location of pathways. This is an important break from the standard practice of Christianity where the grave would be oriented east-west, with the head at the west so that the person could rise to face the east on Resurrection Day. Large scale analysis of medieval monastic cemeteries in the

UK found that it was extremely rare for people to be positioned in any other alignment (Gilchrist & Sloane 2006: 152). Cemeteries in Copenhagen also mirror this in the medieval period (Jensen & Dahlström 2009), later cemeteries such as Vartov and Farimagsvejen (Mosekilde 2010; Poulsen 2006) however start to show a difference in alignment with some graves aligned north-south. It is possible that the practicalities of positioning a cemetery in an urban location restricted the possibilities and also the absence of a central church as a focus meant that a break in alignment practice seemed more possible. Despite this the commercial cemetery at City Bunhill, (Connell & Miles 2010: 7) where coffins were placed in mass graves, the coffins were all aligned west-east showing adherence to tradition. However Assistens shows a complete break in spatial orientation and alignment of people in the graves. If a grave plot was positioned so that the stone was facing out to a pathway to the north, it might be expected that the alignment of the person had the head at the south, but this pattern is not seen. There is a common pattern to the alignment which so far does not seem to be linked to a known traditions or a fixed spatial reference.

Where graves deviate from this standard we can see some unexpected individual results. There were two vault chambers that were located and able to be excavated; there had been no surviving indication of their presence above ground. They were quite elaborate in their detail showing a great amount of design, expense and effort into creating a defined and separated chamber which would not be on display. The vaults were placed on the monument line on the edge of the site, facing the pathway of Jagtvej.

There were some examples where graves were placed in unusual alignments compared to the surrounding graves. In the east of the site two coffins were placed in a southwest northeast alignment which differs from all surrounding graves (G975, G979). In Area 3 another mostly truncated coffin was placed west-east (G1576). There was only one example of deviation from this pattern, a coffin placed deliberately on its side, rather than the base (G959); it has been identified as of a female who was buried in 1912. There was no obvious reason why it should be placed like this, a previous coffin underneath was in the correct position and there was room to place the new coffin on top. There was no evidence of third, later grave either that could have caused this movement. If it was done during the committal it suggests that no family or mourners were present to observe this action.

Digging the grave

The practicalities of digging the grave cut would have required the skill and correct tools plus any knowledge of earlier graves that would require removal. Depending on the depth of the grave there may have been a need to stop loose soil falling into the grave cut. Although the natural ground at Assistens cemetery is relatively stable, if there was a high frequency of graves within an area then the soil would have been much looser and could easily have caused the sides of the grave cut to collapse in. There were several examples where a grave cut was much larger than the coffin and this may be explained by the loose surrounding soil (G297). In these cases ways to hold back the soil would have been essential, surrounding earlier coffins would also have potentially collapsed into the hole and the closeness of some of the coffins means that some would have been clearly visible in the edges of the cut. There was no archaeological evidence for shoring to hold back the soil but, there was occasional evidence for steps in the grave cut. These may indicate a cut was made into the side of a grave to enable gravediggers to get in and out. Where the grave cut was very deep ladders would have likely been used and possibly hoists and pulleys for buckets.

It is likely that the tools used for digging graves were simple. One small lump hammer handle was found (F202494) within the fill of a grave, this could have been used for shoring and was either an accidental loss

during filling the grave or was casually thrown away. A shovel was also found, lying on a coffin lid, the wooden handle had broken and was probably thrown away, there was no evidence for the rest of the broken handle.

Depth of the grave cuts

The cemetery protocols from 1805 suggest that graves should be placed so that at least 1.26m of soil should be placed on the coffin. Later protocols describe two levels of burial: single depth which requires a depth of at least 1m of soil and double depth that requires at least 1.8m of soil (Wiene 2010). The protocols seem to allow 0.6m for the depth of a coffin therefore the base of a grave cut should be stated as at least 1.6m or 2.4m below ground level. Contemporary ground level throughout the 200 years of the cemetery does not seem to have changed as there is no importation of soil and no large increase in cemetery soil compared to today's ground levels outside of the cemetery therefore contemporary ground level is taken as the same as today. Ground level is between 9.4-9.6 metres above sea level (m.s.l.) in the far north end of the excavation area sloping slightly downwards to the south and west to 9.2m, average depth around the centre of the site was 9.4m. However to account for the slight downward slope of the site the numbers were divided into Area 4 and 5 and a different contemporary ground level was used to compare the archaeological evidence with the protocols. Using the contemporary ground level of 9.4m in Area 4 and 9.2m in Area 5, a level can be extracted of the legal depths to which gravediggers should have dug graves (Table 76).

	Area 4	**Area 5**
Ground level	9.4	9.2
Single depth (base of cut)	7.8	7.6
Double depth (base of cut)	7	6.8

Table 76 Extracted depths of graves, in m above sea level, based upon the Protocol from 1860

When compared with the evidence, there should be two peaks of levels to account for the double and single depths; however there is only one peak in both areas (Fig 99). This suggests that the protocols were not followed, particularly for the double depths where only 2% and 3% of graves were placed. The graph also reflects the deeper grave depths within Area 5 as a general pattern, probably reflecting the slight slope down within this area.

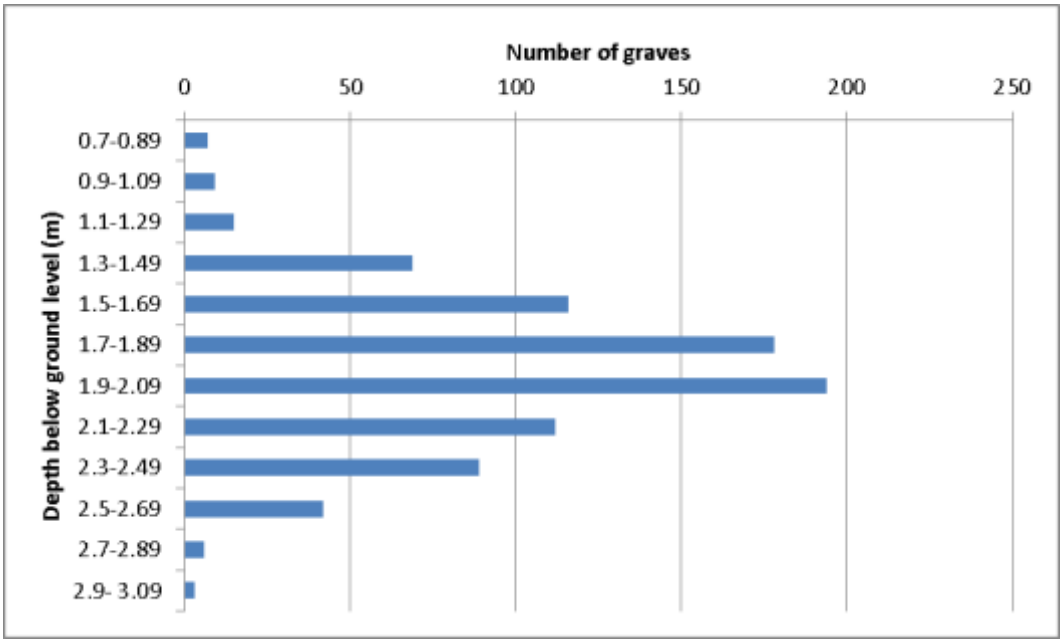


Fig 99 Depth of graves, using the lowest z-value of skeletons (Gravenes dybde udregnet efter skeletternes laveste z-værdi)

The depth of the grave cuts varied and would have required different strategies to excavate. The tops of the coffin were recorded by the archaeologists but not always the base of the cut, therefore depths were calculated using the lowest depth of the skeleton which corresponds to the interior depth of the base of the coffin; it was also the most frequent value that was recorded. It is accepted that this level is not accurate for the base of the cut but it can be used as a good general guide as the base of the coffins were rarely more than 10mm thick and they rested directly on the base of the cut. So the accurate level of the base of the cut would be *c* 10mm deeper than the numbers interpreted.

The shallowest grave cuts were for the cremation urns; these were either square or round depending on the shape of the urn and were rarely deeper than 0.5m from the contemporary ground level. One urn cut contained multiple urns but it was the same depth as all the other urn cuts. The fills of some of the cremation cuts reflected their shallow nature by containing large quantities of gravel or pebbles that are often used to cover the plot surfaces in the cemetery. Of the coffin burials the infant graves tended to be the shallowest.

One of the defining traits of the single graves is that they are shallow. It is known from the cemetery regulations from 1880 that the deeper the grave, the more expensive it was (Wiene 2010: 20). Therefore the shallowness could be yet another expression that the single graves were a cheaper kind of burial. However, if we follow the interpretation of the single graves as line burials, there would be no particular reason to bury these deeper than single depth, as relatives could not be buried in the same plot. This reduced the risk of disturbance, at least until the plot was cancelled after 20 years (Wiene 2010:18). There are therefore reasons to believe that the shallowness can be explained as due to practical and economical considerations although the fact of a shallow grave remains a social difference.

The highest coffin (G61) had the top of the lid at 8.72m, only 0.6m from the contemporary ground surface in this Area (7) at 9.3m. Of the highest graves the majority were of infants that were buried within groups of other infants. There were 12 graves that could be interpreted as being buried within 1m of the

contemporary ground level and a further 11 that were just below this level. The deepest coffin excavated was 6.37m at the coffin lid and the base at *c* 6.05m, making a total depth of the grave cut *c* 3.35m from the contemporary ground level. However this particular group and the next deepest (G1263) were associated within vaults making the circumstances slightly unusual. The deepest non-supported earth-cut grave was within Area 5 with an estimated base at 6.35m (*c* 3.05m deep, G1319) this depth would certainly have required some form of shoring during its creation.

These are not the deepest depths known from grave cuts; St Marylebone, London (Miles et al. 2008) recorded cuts from 1.57m to 4.15m down from contemporary ground level in highly unstable sandy ground. Here there was evidence of collapse of some of the burials and in places up to 10 coffins were stacked on top of each other; there was no evidence for machinery or shoring. Trenches for multiple coffins were often deeper but were also correspondingly larger in size, such as at City Bunhill (Connell & Miles 2010) to prevent collapse of the sides.

Overall the majority of graves on the site were lying between 7.7m and 7.2m.s.l. (n=503, 60%; Fig 100). There was an average depth of 7.48m.s.l. over the entire site but separating the data into areas reflects the slight change in ground level, with Area 4 of 7.59ms.l. and in Area 5 of 7.37m.s.l.

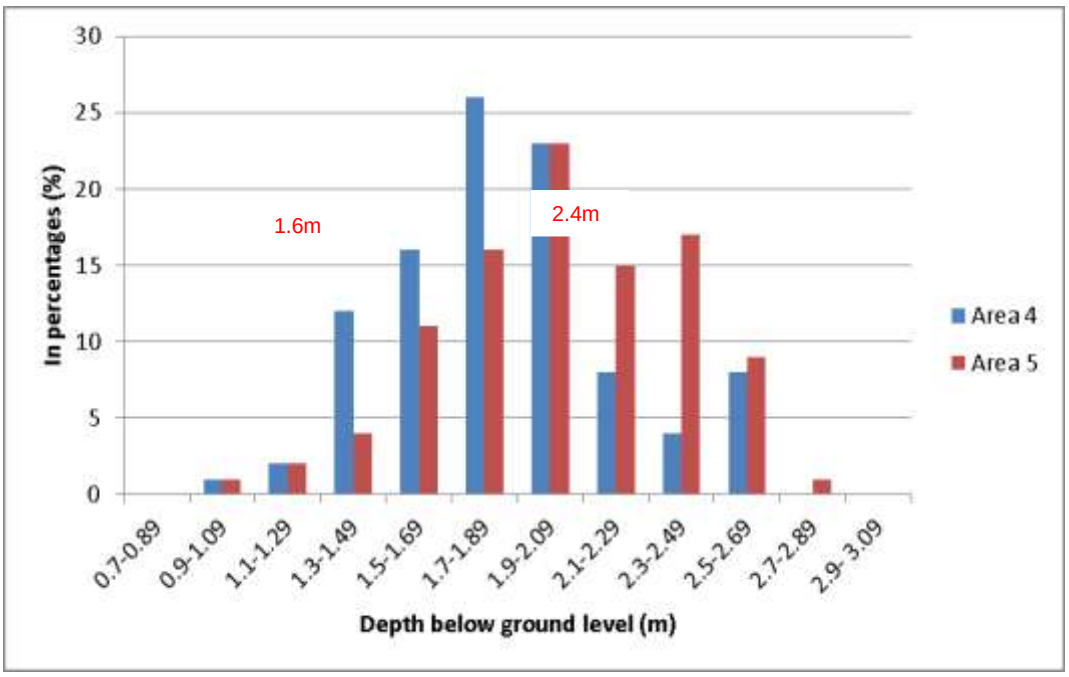


Fig 100 Depths of graves using lowest z-values of the skeleton, separated into Area 4 and 5 (in %). Labels show where graves should have been placed; single depth at 1.6m and double depth at 2.4m (Gravdybdernes procentvise fordeling udregnet efter skeletternes laveste z-værdi og inddelt i Område 4 og 5. De røde tal angiver gravenes dybder ifølge begravelsesprotokollerne: enkelt dybde 1,6 m, og dobbelt dybde 2,4 m)

When separating out subadult from adult grave depths there is a clear preference for them to be buried higher, on average they are at 7.85m which is 1.55m below the ground level (Fig 101). The highest grave cut was excavated to only 8.66m, only 0.74m below ground level. The lid of the coffin was higher at 8.72m (G61). The deepest subadult grave was at 6.77m (G107) which was of an adolescent buried within a vault. There were four subadult graves down to *c* 7.00m; all were placed within family grave plots. In general the

figures show that the gravediggers were not digging graves down to the depths they were supposed to (Fig 102).

There may be a social dimension to the depth of graves, historic protocols do mention that graves can be deeper, but extra payment is required to the gravediggers (Wiene 2010). Perhaps people were aware of the risk of disturbance or grave robbery and thus securing a deeper grave lowered the risk at the same time as the social cachet of being able to afford a slightly different and more expensive grave which marks it out from surrounding graves. So even though grave depth is a practical issue, it also reflects back to the idea that shallow single graves could have been as socially less acceptable. Depth and social status could be bought on the cemetery.

When cremation burials were introduced in the late 19th century (Secher 1956: 54) the burial of the urn was also a more standard practice with burial within a small, shallow grave cut that needed only to be placed just under the ground surface. One deviation from this pattern was two urns that were placed together in one grave cut, this could reflect the practice of keeping the cremation ashes for some time to be able to reunite with another person and share the grave. All cremation urns were placed stratigraphically above any inhumation (coffin) graves.

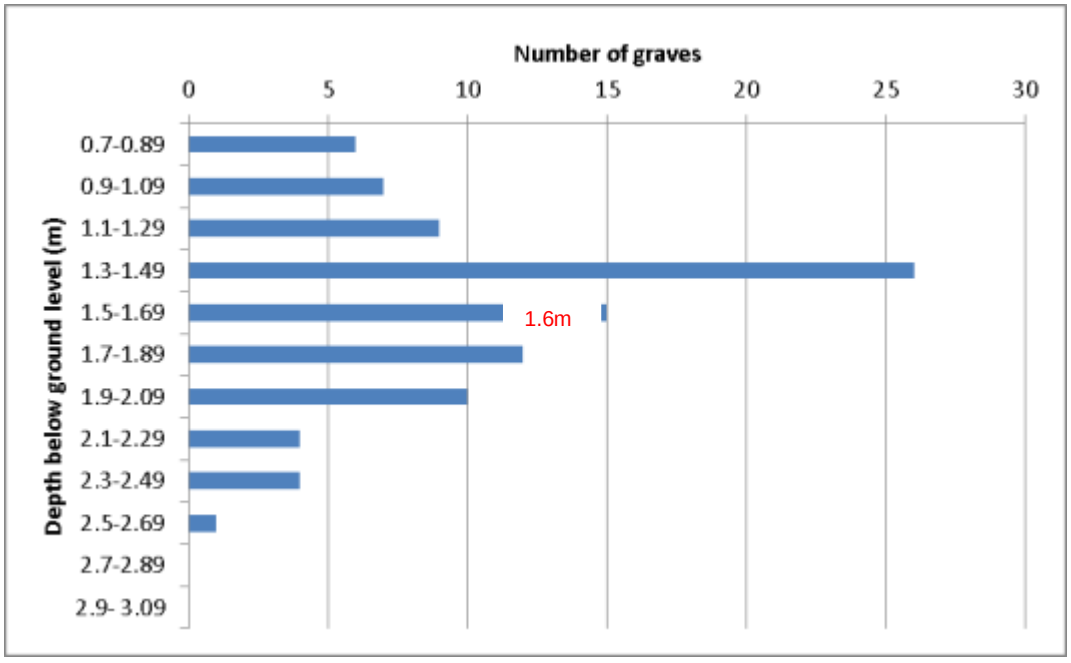


Fig 101 Depth of graves using the lowest z-value of subadult skeletons. Label shows where the graves should have been placed (Gravenes dybde udregnet efter de subadulte skeletters laveste z-værdi. De røde tal angiver gravenes dybder ifølge begravelsesprotokollerne)

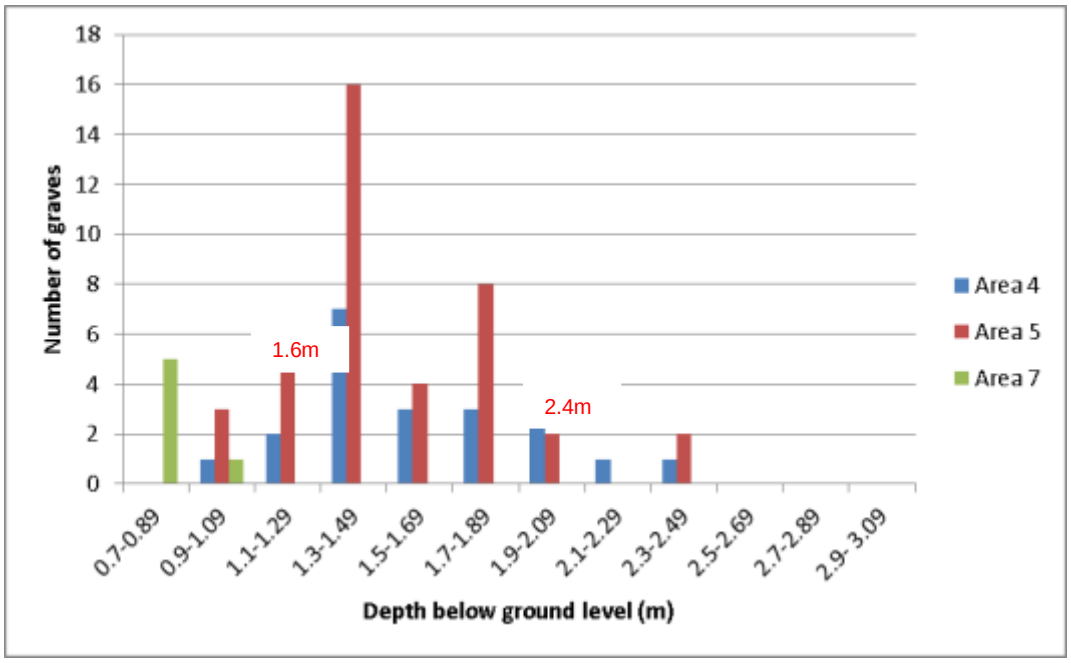


Fig 102 Depth of graves using the lowest z-values of the skeleton, divided into Areas 4, 5 and 7. Labels show where graves should have been placed; single depth at 1.6m and double depth at 2.4m (Gravenes dybde udregnet efter skeletternes laveste z-værdi og inddelt i Område 4, 5 og 7. De røde tal angiver gravenes dybder ifølge begravelsesprotokollerne: enkelt dybde 1,6 m, og dobbelt dybde 2,4 m)

Reuse of graves

Danish law allows for a defined period of grave peace where the grave must not be disturbed for 20 years, after this period it is legally permissible to exhume the coffin and skeletal remains and rebury them in a suitable place (Wiene 2010). If a metal coffin is used then a longer period of 40 years is set aside before removal is permitted. This principle means that a grave is not necessarily expected to rest in peace eternally and reuse of the grave is a possibility. It is clear that grave plots were reused and burials were removed, sometimes only partially. The archaeological evidence shows a whole range of treatments of the graves, including different treatment of the coffin and the skeleton.

The most obvious evidence is in the form of empty graves, where there are often substantial remains of a grave cut and coffin but no skeleton (Fig 103). There were 70 empty graves, more in Area 4 than in Area 5 showing a higher usage and perhaps a higher turnover of graves. Not one of the empty graves have been identified through stratigraphical analysis at this stage, it is possible that positive identification could be possible in later analysis.

Within the lines of single burials, there were no empty graves found. This shows that once the intact single lines were interred there was virtually no organised removal of them. However where later family plots were situated directly over single line burials, there may have been complete removal of the coffin and skeleton but where they were left under pathways they were more likely to be overlooked. This shows that some of the cheaper single graves were in fact allowed to rest in peace far longer than the more expensive graves in the family plots, that either had to be renewed or allowed to pass on to another ownership. It is quite clear that truncation did occur on single line burials which were situated where the later pathways were located but generally the skeleton was left *in situ* rather than completely removed (Fig 104). Within

Area 4, the two northernmost rows, only marginal truncation of them took place at most. It is only in these remnants of single line burials, in areas later turned into family grave plots, that there is evidence of what the entire area would have originally contained.

Truncation of the pre-existing graves could take many forms. Within Area 4, 22 truncated coffins had a complete base meaning that truncation occurred horizontally; removing the lid and sides but the base being left in, thus reusing the exact position of the grave. However 18 were truncated partially on one side, showing that truncation had occurred offset to the position of the original grave, extending the amount of space that could be used in the grave.

The question of what the gravediggers did with the coffin wood and human bone remains an important clue to how they interpreted the cemetery protocols and how they viewed human skeletons and their burials. If a grave became eligible for removal, then the wood should have been disposed of and the skeleton collected and removed to another place. However a multitude of methods were used. In some examples skeletons would have had some form of articulation where ligaments had not decayed. This would have kept the bones joined in their anatomical order; this could be seen in the position of some limbs thrown into the grave fill. Clearly soft tissue and recognisably human remains did not deter the gravediggers from their actions.

Fig 103 Distribution of empty graves (black) compared with charnel groups and disarticulated bone (red and blue) (Fordeling af tomme grave (markeret med sort) sammenlignet med fordelingen af knoglekuler (markeret med blå og rød))

Dealing with existing burials

The documentary evidence states that when old graves are cleared for reuse the remains were to be gathered up and placed in a charnel house which is not within Area G. It was also possible to dig a pit in the base of the new grave to place charnel bones in (Wiene 2010). It is likely that coffin wood was burnt by gravediggers but despite the charnel bones that were found on site, there should be many more bones. The issue of where they went to is unresolved. The officially sanctioned idea of grave peace lasting only 20 years reflects the contemporary lack of knowledge and underappreciation of the processes of decay. Depending on circumstances, a body may not be reduced to a skeleton within this period, and a coffin could certainly be largely intact causing a greater problem in the removal of them.

Fig 104 Truncation of a grave (G365). Red lines show where truncation removed the lower half of the skeleton (Forstyrrelse af grav (G365). Den røde linje markerer forstyrrelsen af graven)

In the process of truncating graves, there must be ways of disposing of the skeletons and coffins; if the skeletons were removed it would create a lot of bones to be dealt with. There were several examples of pits containing human bone however three were only partly excavated within 1m zones. One of these pits (G74) was unique in being an extremely large, shallow pit that contained an entire displaced coffin filled with a large quantity of deliberately placed human bones. The true dimensions of the pit is uncertain; it may have been smaller lower down and possibly included other graves *in situ* or charnel deposits. However this pit, as recorded from the limits allowed, would have taken a considerable amount of time and effort to create and backfill and therefore the intentional placement of it and the bones inside requires an interpretation. It is likely that it was part of a plot change or making way for new graves in a crowded plot that contained a large quantity of burials. If there was no space for new burials, then this could be considered a way of creating more but still keeping the individuals close to the grave plot. If it was connected to the nearest grave plot (G801) then this would have been an alternative to disposal within a charnel pit or other alternatives. This grave plot is along the wall, a monument line, sold as the most expensive and socially ostentatious plot, does this have an effect upon how the charnel bones or earlier inhumations are treated? This is the only such example within the cemetery, and there was no indication of this occurring within the rest of the excavation area, even in other monument lines. The efforts to create this pit and to gather up the quantity of smaller bones suggest deliberate re-interment which may have required authorisation and payment as it would have been a conspicuous action requiring digging into the pathway. Is this deviation from other treatments of charnel groups related to social status?

Some smaller pits were found, one of which may have been more of a general domestic rubbish pit but also contained some human bone (for example G403). There were two other pits that could be interpreted as created specifically to create charnel bones, both were within Area 4 and were in the south west corner of

a grave cut. One was oval, the other small and square, both contained large, easily identified limb bones and skulls from several adult individuals. Only one of these pits (G525) was designated as having selective bones and also contained pieces of coffin wood. There appeared to be no particular positioning of bones within the pit. Having only two identified charnel pits it is difficult to extract any pattern, but there seems to be no employment of the method to use pits to dispose of the skeletons. If bones were placed in large charnel pits, they must be situated elsewhere on the cemetery.

Charnel groups found within grave cuts were divided into those that were randomly placed, where they were recovered from throughout the grave fill or around the coffin, and those that were deliberately placed, where there was some deliberate positioning of the bones. Often these deliberately placed remains were under the coffin, sometimes they were then covered up with palm or pine branches which indicates that they needed to be hidden or somebody might have seen the bones during the funeral ceremony. Other deliberately placed bones were found on top of the coffin so this action would have taken place after the funeral and shows that the grave was not filled during the funeral when mourners were present.

Of the charnel groups, 32% were interpreted as having some deliberate placement, almost a third of charnel groups showing some kind of intentional action from the gravediggers. However seen in the light of the total number of inhumations located, it is still quite a small percentage. Within these deliberate charnel groups most had all parts of the body represented showing that there was little selectivity in connection with particular bones.

There was one example of a coffin (G1498) that had been heavily truncated with only the head end left *in situ*. The bones that were disturbed by this truncation were collected and had been pushed back into what was left of the coffin. So although there had been no compunction about breaking up the coffin and the body, care was taken to collect the disturbed bones. There were also examples of large rocks being utilised to hide bones in the wall of a new grave.

Removal of older graves also necessitated the removal of the gravestones and any decoration above ground, here there has been ample evidence of the breaking up and dumping of these, particularly gathered together in the old well shaft, located just south of the gravediggers' house, where 80 conch shells (that have been interpreted as above ground ornamentation) were discovered.

Some of the coffin wood could be reused; there were examples of wood being used to mark out the area of the new grave or the presence of the charnel remains themselves. One charnel group (G730) of bones and coffin wood was placed 0.5m above a new grave, this group also had two skulls placed deliberately on the northern corners of the coffin. There were also several instances where coffins were filled with charnel bones (Fig 105).

Deliberate placement of bones is a common practice, excavations at St Marylebone, London found several examples where disarticulated bones were found in the base of deeper cuts and interpreted as being to strengthen the base of the cut and as a way of disposal of the charnel bones (Miles et al. 2008: 35). However analyses of these actions are difficult and rare during archaeological excavation. From the Assistens excavation it has been shown that there were a number of different ways of treating disturbed remains. While some were undoubtedly removed, it was common for loose bones to be returned to the earth as part of the backfill of the grave, or hidden under coffins and plant material. However, there was no standardised method that was in use throughout the history of the cemetery.

Fig 105 *In situ* coffin filled with charnel bones (G1572) (*In situ* kiste indeholdende knoglekule (G1572))

Grave robbing?

There is a large amount of documentary evidence of grave robbing in Europe, particularly during the 19th century and yet, it is rare to find it archaeologically. Grave robbing could either be removal of the body for medical research (similar to the 'resurrection men' found in the UK) or for artefacts found within the coffin or expensive coffin fittings. Part of the problem is in the identification of this as a direct action, as the act of digging down into the earth could be indistinguishable from the excavation of the original grave cut. Grave robbing could also take place during the backfilling of the grave. The coffin may also show no evidence of having been forced open and there are many other reasons for why a coffin may be empty or have no valuable objects inside.

Grave robbing for artefacts may be identified by a combination of broken and disturbed coffins, indications of missing coffin decoration (holes where handles or plates should be), and disturbance of the skeleton around likely find spots for jewellery and scattered finds of artefacts that relate to the underlying grave. Grave robbing for the body should be easier to identify, simply an *in situ* and largely intact coffin with no skeleton inside. In such cases only the coffin lid may show signs of destruction and there may also be an absence of charnel deposits in the overlying deposits that would indicate an entire intact body was removed rather than a skeletonised body that would be more likely to become separated.

There were coffins with no associated skeleton but the majority of them were largely highly truncated and the removal of the body would have formed part of the standard procedures for removal of earlier grave contents. For example, an intact coffin (G1344), except for the lid, was found that contained no skeleton. However, the overlying coffin truncates and sits almost inside it. There is no charnel deposit in the sequence but it is likely that the skeleton was removed during the digging of the new grave and treated as charnel by being disposed of elsewhere. Why the coffin was not more broken is not known but it is possible that it served to strengthen the base of the cut, forming a rudimentary shoring of the base and sides. Another possible candidate may be a coffin (G188) that was lying within Area 1 and placed in the top 1m of

the soil. This was an elaborate child's coffin, painted white and with decorative ceramic studs to hold in coffin upholstery. However there was no skeleton and there is no truncation to explain removal of the skeleton. The coffin was 0.85m long which is approximately the size similar to children's coffins who have been aged to less than one year. It is possible that the skeleton has decayed, however the majority of other infant skeletons on the site have been poorly preserved but not completely decayed. So the reason for this coffin being empty is not known and it cannot be confirmed that it was an example of grave robbing.

There was one inhumation that provides potential evidence for grave robbing at Assistens cemetery (G863). It was at the base of a stack, or sequence of three surviving inhumations. The coffin was not disturbed yet the lid had been unfastened and removed but then replaced upside down. The skeleton was extremely disturbed with *c* 25% of it located within the surrounding grave deposit, although no skull was recovered. The coffin was plain but well constructed with a double lining of wood and while there were holes for handles and possibly a grip plate none were recovered. On top of the coffin lid was 0.15m of soil then a second later coffin. This sequence suggests that when the secondary grave was dug the gravediggers found an earlier coffin, interfered with it and removed coffin fittings and disturbed the skeleton looking for personal items of value. The lid had been replaced (albeit upside down) and a layer of soil was deposited to hide this act. The key to this interpretation is the layer of soil over the disturbed coffin; this places an intentional act within the stratigraphic sequence that otherwise cannot be explained. Another explanation is possible however, in which a change of ownership required the removal of previous coffins but this particular coffin was investigated and considered to be too deep to warrant removal. Yet adding 0.15m of soil did not create extra space for the secondary coffin and there would have been no need to disturb and randomly scatter bones or remove fittings of the coffin. Several other coffins showed evidence of missing handles and other skeletons showed disturbance centred on the head and hands indicating a search for jewellery however there is no clear proof that this was from grave robbing.

There is a lack of archaeological evidence for grave robbing in most cemeteries excavated from this period despite it being well attested to historically. It is perhaps the case that an active search for graves to be robbed was not necessary since items could be removed in the process of truncation and removal to make way for a new ownership, or even directly after the committal when the mourners had left. There are no rules stating what should happen to artefacts such as jewellery when existing graves were disturbed in the course of digging new graves. This could have been a permissable way of accessing items and even breaking up the coffin for firewood could have been worthwhile, for how else would the gravediggers dispose of this quantity of wood? One recorded case did occur at Assistens in 1804, when six gravediggers admitted to selling coffins, linen and clothing from graves and were given sentences of between three and four years (Skalk 1973). These particular thefts usually took place just after the committal and often broke or removed coffin lids in the process. This episode led directly to stricter rules brought in by the authorities, yet the archaeological evidence suggests that this behaviour continued in the 19th century.

There is no evidence that this activity occurred recently, as standards in the cemetery were controlled by the change to municipal central control and it seems that truncation and change of ownership did not occur frequently in the 20th century restricting the opportunity for this kind of activity. However, a recent incident of grave desecration within the cemetery, but not on the excavated site, was undertaken in 2003 when a disgraced biker gang member buried in Assistens was dug up again and various clothing and symbols relating to his affiliation were removed from the body (Pinborg 2003), presumably by his former colleagues. This modern grave robbery shows not only an awareness of the personal gifts that would have been placed

inside the grave but what was inside the grave and hidden from view is still an active and powerful force in the living, social world.

Backfilling the grave

Once the grave had been dug and any disturbed coffins or skeletons dealt with, there still remained the act of lowering the new coffin into the grave during the committal followed by backfilling the grave. The material used to backfill the graves and the finds found within these deposits can tell us something about the methods of the gravediggers and levels of activity in a specific area of the cemetery.

There is some direct evidence from the sand or flowers found on the coffin lid that the coffin was lowered into the grave cut during the committal, while the mourners were present. Once the coffin is lowered into the grave cut, any shoring and anything covering the shoring or sides of the grave cut would be removed and grave backfilled. It is at this point perhaps that the tools, such as the broken shovel and lump hammer, were lost by the gravediggers in removing shoring and backfilling the grave. Some cemeteries have provided evidence of small shelves cut into the sides to place 'shelves' of wood to protect the shrouded body or coffin from the weight of the soil (Heilen & Gray 2010:21). There has been no evidence of these at Assistens although there has been evidence of reusing old coffin wood to mark the area of a new coffin but these are not structural.

The grave deposits were homogenous throughout the site and indicted no importation of soil from outside of the cemetery. Small amounts of residual ceramics, human bone and other small finds were mixed in with the soil but gave only a broad range of dates that covered the working life of the cemetery so were not able to contribute towards dating any of the burials.

Where there are larger amounts of residual finds this indicates a higher amount of grave digging activity and increased intermixing of the soil. This resulted in looser, darker deposits that would easily collapse upon being dug through again.Where there was little truncation, particularly in the shallower graves, the backfill closely resembled clearly redeposited natural soil with little or no residual finds and the compaction was far harder. This was particularly common in the lines of relatively undisturbed single burials.

So while the backfill of graves can often be viewed as telling us little, it is clear, if well recorded, it can identify potential areas of high and low levels of activity as well as offering evidence of the working methods of the gravedigger.

Life on the cemetery

Assistens has not been simply a place for the dead, at times in has also been a place where the living has come to mourn, work, socialise and relax. From the beginning of the cemetery there have been buildings designed to allow gravediggers to live on the cemetery, represented by the gravediggers' house in the centre of the excavation site. The cemetery, for much of its life, has also attracted visitors not just to pay their respects to the dead but also to enjoy the green and peaceful surroundings within its walls.

Despite having their own accommodation on site, conditions of employment were poor for the gravediggers and at times they looked for ways to supplement their living. Grave robbing may have been one of those ways. However when the fashion for visiting the cemetery became more common they also sold refreshments from the gravediggers' house, so that Area G became a social centre for people to take picnics. Archaeological evidence for this was in the form of some rubbish pits (G1244) dug down in what would have been the back yard of the house. These contained large quantities of serving ceramics such as

plates and bowls plus glass wine and beer bottles. These were all mass-produced, most local but one sherd from an English factory. Unfortunately the dating is broad for these artefacts however the stratigraphical evidence points to it being early 19th century as a later grave (G1214) is dug directly into the pit. The waste in the pit must have been visible to both gravediggers and mourners and shows that there was no care towards this grave, in locating it elsewhere. This grave is identified as from the earlier phase in the cemetery suggested in part by the poor preservation of both coffin and skeleton. The rubbish pit could also reflect the lives of the gravediggers in their domestic arrangements, although if regular disposal of domestic waste took place on the cemetery it would be surprising that there were not many more pits, so these are somewhat of an anomaly. Some of the residual ceramics from grave fills and topsoil could also derive from the social visits to the cemetery, cups, saucers and bowls may form part of this activity. Two child's toy saucers could also have been lost during this social use of the cemetery.

This evidence demonstrates that cemeteries are not just places where rituals take place and bodies are buried. They are also part of the larger social environment, where activities and interactions on the everyday level take place too.

Burial traditions and the funeral industry

There is naturally an interweaving of different intentions by different participants in the way the dead are commemorated. There are three main actors: the dead people themselves; the family and friends; and the professionals involved in the process, including the priest, the gravedigger and the undertaker. Mixing with these actors are general societal views and traditions that inform these three parties when performing particular behaviours. It can, therefore, be difficult to separate out which pieces of the material culture are products of any of these three major actors. Who decided that a coffin would be adorned with moulding or angels? And who decided to put flowers inside the coffin, or particular items with the person? This section deals with funeral traditions that could be more socially influenced and be the preserve of the undertakers and the funerary trade, whilst acknowledging the agency of both the person being buried and their mourners. These are items that are generally on the exterior of the coffin, or relate to the decoration of the coffin itself. There is some overlap between more personal items that may be placed on the coffin and may relate more as a personal item rather than standard funeral tradition, and items inside the coffin which can also be socially influenced.

Development of the funeral industry

The history of the funeral industry is described by the move into making a deliberate and focused business out of burying the dead; this involves a transition from individual craftsmen, who would be general carpenters, to a more focused funeral business. This involves not just the provision of a coffin, but related regalia, coffin furniture, a hearse, and organisation of the grave plot and funeral service. This is noted in the UK as developing from 1780s, swiftly developing into a combined service provider with ostentatious funeral display, peaking in the 1850s (Brickley et al. 2006: 224-5). How the business develops in Denmark and Copenhagen in particular must be undertaken as later research on the cemetery. The highly detailed and expensive mourning customs and correct forms of display marking out the social status of the deceased and the family can be seen in Danish burial customs too. Higher social classes developed the ostentatious display in the 18th century and these forms of burial are reflected in the vault investigations at Helsingør and Christ Church in the UK; however, the middle classes followed on from these traditions and adapted them. Assistens shows this in the elaborate metal coffins and decorations, although, there is less

elaborated display of coffins in Copenhagen than in some of the contemporary UK cemeteries. For example, there are more detailed coffin motifs, nameplates and decoration from even quite poor London cemeteries such as City Bunhill (Connell & Miles 2010) and Cross Bones (Brickley & Miles 1999). The slightly later start to industrial development of Denmark in comparison to the UK may explain some of these differences.

Funeral rituals and traditions

Funerals could take place within a church, or chapel, possibly the Trinitatis parish church in the city or the chapel on Assistens. It could also occur at the side of the grave however the committal, which is the ceremony of placing the coffin into the grave, may form a different set of traditions and may, or may not, take place with the mourners present. It is full of rituals that would leave little archaeological evidence however there is some archaeological evidence to show that some took place with mourners present and some did not.

There were 15 examples of pure white sand deposited on the top of the coffin (Fig 106) which were large and distinctive enough to be recorded. The natural ground within the cemetery is sandy clay whereas these deposits were clean, pure white or light yellow sand and therefore not derived from the surrounding soil. As such this sand must have been brought in especially for this purpose. The sand is interpreted as part of the Christian ritual of throwing soil onto the coffin to mark the return of the body to the Earth (*jordpåkastelse*) which derives from a passage in the Bible (Genesis 3:19). If this ceremony took place using the general cemetery soil then it would remain indistinguishable from the surrounding grave deposit and therefore impossible for the archaeologists to identify.

Flowers on top of the coffin can often be fixed in place by wire and thus form part of the coffin decoration however there were examples of loose flowers that may not have been fixed, it is possible that these were placed on the coffin as part of the committal. There were 57 coffins in total with evidence for flowers or fixings on the lid. Many of the plant materials used, both inside and out, were either pine branches signifying evergreen and eternal life or palm fronds signifying victory over death (Richmond 1999:151). There was also one example of paper found on top of a zinc coffin (G1464) that could have been thrown into the grave but also marks out the presence of mourners at the committal.

The rituals mark out a transitional state, where one is moving from life to an afterlife, and also help to ease this process for the mourners. As the process of professionalization occurs in the funerary industry, professionals also use symbolism to help normalise what occurs in their working life. Some of this symbolism masquerades as traditional yet was invented to project a sense of continuity in this new professionalism. They also create socially accepted standards that families would want to purchase so as to be seen as carrying out what society considered to be the correct forms of display and respect. Chronological change within these traditions may be a fruitful area to be investigated more fully in the future.

Fig 106 Distribution of graves with deposits of sand on the coffin lid (Black) and flowers or plant material outside of the coffin (Red) (Fordeling af grave med sand på kistelåget (markeret med sort) og blomster eller andet plantemateraile udenfor kisten (markeret med rød))

Coffins

Preservation and recording of details

When examining the data from Assistens, particularly when considering coffins and their styles and decoration, the state of preservation must be considered. The length of time since deposition and amount of truncation to the coffin are just two factors that will have affected this. Most coffins were in a poor state of preservation (Table 77) which restricts the level of interpretation. It is likely that on a number of coffins

there were many more original details than observed that have entirely decayed, or been truncated away. This can make it more difficult to analyse in particular the earlier phase of coffins. However, it was possible to examine a number of aspects of general coffin construction and design.

Comparison of coffin preservation with sex and age

While the sex of an individual will obviously not affect the rate at which their coffin decays any differences in the level of preservation between the sexes, or age groups for that matter, may be representative of other factors relating to their design.

	Good	Medium	Poor	Total
Male	20	104	187	311
Female	42	99	176	317
Subadult	1	7	40	48
Infant	0	5	45	50
Total	**63**	**215**	**448**	**726**

Table 77 Comparison of preservation of coffin comparing with the sexed adults and subadults and infants

Males and females have near equal amounts of coffins registered. There are approximately equal amounts of coffins that are medium or poorly preserved but females have more than twice as much in the good category than males (66% compared with 32%). There could be a number of factors that have caused this difference. One factor could be the date of the coffins with more females buried in more recent years than males. Therefore, the coffin is better preserved due to a shorter length of time in the ground. Another may be that women were more likely to be buried in more solid coffins that preserve better.

When assessing the preservation of subadult and infant coffins virtually none are in the good preservation category and only a few are medium preserved (12% of the total, compared with adults at 33%). So the vast majority, 87%, are poorly preserved. Subadults tended to be buried in thinner coffins, particularly infants and younger children and they have also been shown as being generally buried at shallower depths (see 0) and as such are more liable to be damaged by above ground activities. These factors result in a rapid decay of the coffin which is seen in the preservation rates and low survival rates of any detail. If there were more ephemeral traditions to the coffins, as suggested in historic records of paper decorations (Kragh 2003), none survived.

It appears then that while there is only slight evidence of difference in coffin thickness or construction material between males and females, there is good reason to believe that the coffins of non-adults were either thinner of made of less durable materials than those of adults.

Construction

Nearly all the coffins appeared to have been built to standardised forms. For the most part they were rectangular in shape, as opposed to the single-break, kite-shaped (hexagonal) coffins that are common in the late 18th and 19th century in Denmark and the UK. None at Assistens were recorded as single break. Excavators of cemeteries in America that have also contained rectangular coffins, such as Pima, Arizona, have interpreted the shape as being partly due to a shortage of wood. All the coffins were made of wood, and although no formal identification of wood types was undertaken on site, the majority of the coffins were observed to be made either of elm or pine. Oak coffins were banned in Copenhagen after 1807 due to the need for wood to build a new navy (Tamm 1992) and none were discovered during excavation.

The coffins were generally alike in construction method with three or four long timber planks aligned lengthways forming the base, which were occasionally reinforced across the middle. However, there were a small number that were built with short timbers lying transversely across the base, which were correspondingly strengthened lengthways (Fig 107). It's possible that this style reflects a local variant of construction method, or it may represent a heavier body, so the body would need to be measured (if not weighed) and a stronger base created for the load bearing. It is not known how many were created in this way as it was not explicitly recorded. The sides were again made of long planks, two or three this time, simply nailed into the base and the lid onto the sides. Some coffins were better crafted, with dove-tail joints used to attach separate elements, particularly on the base (front cover, G799). Lids were either flat or raised. Flat lids were generally formed of simple, thin wood that, therefore, had less structural elements to be preserved. Raised lids angled up from each side and had a flat top. When coffins had a raised lid it may have represented the cost of a more complex crafted coffin and also provided a presentation platform for flowers.

Fig 107 Coffin base, (sides removed) with transverse plank base (G1383) (Kistebund med brædder på tværs af kisten længderetning (G1383))

As part of the coffin construction there were various substances, tar or pine resin in the base of the coffin to create a waterproof seal, although only a few examples of this were found. This may correlate with burials taking place more than a few days after death or during hot summers where decay is accelerated. Examples of this practice have been found in St Marylebone, London (Miles et al. 2008: 50).

With no exceptions the coffins in the single graves were made of wood, with no metal linings, and they were generally poorly preserved: out of the 205 coffins, 189 are described as poorly preserved, while the remaining are described as moderately preserved. Despite the generally poor preservation, the outline of the coffins could almost always be observed: 172, that is the vast majority, had a rectangular outline while only seven were tapered. Lids were only rarely preserved. This could possibly be due to the fact the single graves were vulnerable to disturbance because of their shallowness. This is probably also the reason why the shape of the lids could be observed on only 18 coffins. Twelve of these were flat, while six were raised.

In many cases there were two layers of wooden planking, especially on the sides and base, creating a much thicker and heavier coffin. A small amount of coffins had a double lining with a metal sheet, either lead or zinc, sandwiched in the middle. This often formed a water-tight seal around the sides and base, but in most cases the metal sheet in the lid was separate. Therefore it would still be possible to display the body in the coffin prior to burial. The function of the metal lining may have been to slow down the decomposition process once interred, rather than preventing or slowing the process prior to burial. However without the lid also being sealed then it would not have efficiently served this function. It is more likely that the metal lined coffins carried with them an element of social prestige related to their increased cost of construction and elaborated social display. It also may have encouraged the idea that the body would be more protected in the grave even if this was unlikely.

Four coffins had metal shells forming separate structures of a single piece of metal soldered at the corners. These were placed inside large wooden coffins, possibly with the metal base attached to the wood. In all cases these were part of large and relatively elaborate coffins. In these coffins the corpse could not have been displayed prior to burial and the purpose of the metal is more likely to prevent, or slow, decomposition prior to burial. The proportion of metal lined coffins found at Assistens is comparable to those at St Martin's where only 6.7% of coffins contained some metal, and all of these were in identified middle class vaults (Brickley et al. 2006: 153). The metal coffins at Assistens were spread out over the cemetery although two coffins were in one grave plot (Grave plot 611) and there was no spatial distribution correlating with more expensive family plots. The slightly later date of Assistens compared with vault burials where metal coffins were frequent also suggests that metal coffins were not considered necessary by this period in Copenhagen.

Raised lids

Comparison with the overall average preservation of coffins shows that raised lid coffins were far better preserved than flat ones. There is a much higher rate of good preservation for those coffins with raised lids than those with flat lids (29% against 11%), but at the same time there is a vastly higher rate of poor preservation in those with flat lids (59% against 14%) (Table 78). So although there are similar numbers of raised and flat lids, it may be that those coffins with raised lids needed better preservation to be identified as such. It is possible that the poorly preserved lids that were unidentified (504 in total) are more likely to have been raised than flat. However most of the coffins with unknown lid shape were the earliest single burials where there were very few raised lids and preservation would be expected to be poor as they were from an earlier period than most coffins.

	Good	Medium	Poor	Total
Raised lid	48 (29%)	92 (56%)	23 (14%)	163 (17%)
Flat lid	16 (11%)	43 (30%)	85 (59%)	144 (15%)
Unknown	14 (2%)	120 (18%)	504 (78%)	649 (68%)
All coffins	**78 (8%)**	**255 (27%)**	**612 (64%)**	**956**

Table 78 Comparison of lid type with the preservation of the coffin

There is a clear distinction between ages, many more adults were placed in coffins with raised lids than subadults, no infants at all were in raised coffins although the preservation of infant coffins were so poor that it may preclude investigation. However, there were also only three subadult coffins with a raised lid, all of which were placed in family plots, in Area 3 or 5 (G1453, G1523, G1291). The three subadults were all aged to three or four years old and two were identified as buried in the late 19th century. When combined with the data for raised coffins, it is clear that coffins for juveniles were far less elaborated in these factors that survive in archaeological conditions.

	No. of coffins
Male	65 (40%)
Female	86 (52%)
Unspecified adult	10 (6%)
Infant	0
Subadult	3 (2%)
Total	**164**

Table 79 Comparison of coffins with raised lids that had an identified sex and age category of the individual inside

There were many more females buried in raised coffins (Table 79), with the even rates of identified male and females this seems to form a distinct pattern, could it be affected by longer lived old females? Why would they (or their mourners) prefer them to be placed in raised coffins?

Coffin furniture – combining function and display

Coffin furniture refers to the practical function of handles, coffin sashes and nameplates to identify the deceased. However, the coffins were not designed with a strict utilitarian principle and the furniture was also correspondingly detailed depending on the elaborateness of the coffin in general. They also formed part of the social display of the funeral. However care should be taken in using coffin furniture or elaborateness and relating it directly to wealth or poverty, many factors are involved in the display of the dead: religion, personal taste, social prestige of both the dead and the families plus an increase in availability of funeral goods all play a part. From the mid 19th century onwards there is the influence of commercialism in the funeral industry with a vested interest in encouragement of the consumption of its goods. This has been described as the 'funeral industry's intended illusion of wealth for its less affluent customers' (Hacker-Norton & Trinkley 1984, in Ubelaker & Jones 2003). Wealth, or the appearance of it, could be bought to decorate the coffin

Moving the coffin - coffin handles, sashes and frames

Handles (known as grips in the funeral industry), usually came as a set of six or eight on each coffin, the vast majority are plain iron or cloth covered handles but there are some examples of decorated handles with grip plates. The majority of coffins at Assistens had six. The style of the few decorated handles in Assistens

tended to more geometric patterns. Even the most elaborate coffin handles were made of tinned plate and iron and show little in the way symbolism.

There were some examples of feet and some of underlying framework that the coffin sat upon, which were used to place the coffin on uneven ground and to ease carrying. Often a separate structure, it would be likely that most were reused by the undertakers, but evidently some were lowered in as a full set with the coffin. They may have done this to allow the coffin to rest firmly on soft soil or underlying coffins. This practice can be seen in photographs of coffins and funeral processions (see Kragh 2003: Figs on 99 and 125) and may not have changed much today.

There was only one coffin with a modern material used, of white plastic crosses and wreathes, with rope handles also covered in plastic (G1132) which is identified as from a burial from 1979.The lack of modern materials could be surprising due to the recent date of many of the coffins. The symbolism of the motifs has been retained, only the material has altered. It perhaps shows that the funeral industry is indeed heavily reliant on 'traditional' and conservative designs and materials that alter only very slowly. The period spanned by the assemblage at Assistens must cover significant changes in the Copenhagen funeral industry, from using individual craftsmen to the formation of professional undertakers, this occurred during the early to mid 19th century in England and America (Brickley et al 2006; Ubelaker & Jones 2003: 10). This change should be reflected in the changing styles and designs plus, perhaps in an increasing homogenisation of the fittings. A change in burial custom was identified at Voegtly cemetery, Pennsylvania where from 1840-61 increasing industrialisation and capitalism brought with it more elaborate pre-made coffins with elaborated fittings that could be selected from a package of coffin styles (Ubelaker & Jones 2003: 10). There is an increase in the 20th century of plain, white painted coffins with a simple wooden cross on the lid. A similar change can be tentatively identified in Assistens where there is an influence of changing burial customs.

Nameplates (depositum)

Very few nameplates were found at the cemetery; only five in total, four of them that were of similar design in lead were located in the same vault (G186). These four were in poor condition, only one (G99) was in a state to be read, this being of a female who died in 1834. These lead nameplates appear to mark out members of the same family and combined together are unique in the cemetery. Only one other nameplate survived, of a young man (G753), which was found along with other coffin motifs. Although coffin plates are more decorative and robust in earlier periods in the UK, many 19th century coffins tend to have a simple brass plate with name and date on them (Connell & Miles 2010). It was this simple type that was expected when designing the project for Assistens prior to excavation. It is possible that some were made of wood or thin tinned brass and were not preserved, particularly as many of the coffin lids that they were placed upon did not survive. However it is also likely that the nails used to fix the plates would have been survived and been recorded instead yet this was not the case. Even in the mass graves of Cross Bones in London, 23.4% of coffins had some form of decoration including cheap tin nameplates (although none were really decipherable) (Brickley & Miles 1999: 26).

The common denominator for the five nameplates was the extensive forms of elaboration in the coffins they were attached to, coffins in a vault are designed and likely to be seen long after deposition. Unlike an earth-cut grave which will conceal a coffin so that they are less likely to be designed with long term display in mind. Perhaps this explains why the vault burials contained a display of names and longer inscriptions describing the deceased. The other nameplate, despite being buried in an earth-cut grave, was part of a coffin that may have been seen and displayed for a longer period. It had been transported to Copenhagen

from Germany and so there would have been a need to identify the person inside when transporting the coffin between countries (although one other coffin (G826) which may have travelled a long distance to be buried in Assistens was not marked out in this manner). However visibility of nameplates does not explain why so many poorer quality nameplates are present in UK cemeteries. A further interpretation of the lack of nameplates could be related to the design of Assistens cemetery in comparison with some UK cemeteries. Assistens is set up with rows of clearly defined grave plots so that mourners know where their loved ones are buried due to the marking out of the grave plot above ground. Many cemeteries excavated in the UK are more complex, chaotic and intercut with no clear divisions, it is then possible that in these cemeteries a nameplate was considered vital in case of there was a need for moving or claiming buried individuals in this chaotic situation. The lack of nameplates at Assistens may be explained as a lack of a need to display a name prior to burial combined with a sense of not needing to identify the person on the coffin once in the ground as they were adequately identified on the grave plots which could be viewed and remembered in a more social setting.

Plain coffins

The majority of coffins were plain wood with no exterior or interior decoration (n=588/960, 61% of the total assemblage). Coffins which have no exterior features and are also poorly preserved comprise 64% of the total assemblage (n=610/960), so there is a high correlation between coffins where no decoration can be seen and poor preservation. Therefore elaboration of coffins may have been present in much greater frequencies than are recorded archaeologically.

In comparing the plain coffins by sexed adults and subadults there are relatively even numbers for males and females which shows only a slight bias for males to have plain coffins. However there is a strong correlation between plain coffins and infants and subadults where 70-71% had plain coffins (Table 80). Overall the coffins represent plain, standard coffins with the emergence of some limited differences in styles which reflects the relatively late emergence of the Copenhagen funeral industry.

	Plain coffins	Total of coffins identified to age and sex
Male	198 (64%)	311
Female	183 (58%)	317
Infant	35 (70%)	50
Subadult	34 (71%)	48
Total	**450 (62%)**	**726**

Table 80 Comparison of plain coffins (those with no external features) and sex and age categories (not including unspecified adults)

Decoration

Many of the coffins did have external decorative features that had survived decomposition in the ground and could be recorded – 39% in total (Table 81). There is scope for forming a typology of styles and grades of elaboration and decoration.

Area	Total inhumations	Coffins with any details
1	11	1 (9%)
2	74	14 (19%)
3	117	24 (21%)
4	473	132 (28%)
5	386	78 (20%)
6	3	1
7	31	1
No area	12	1
Total	**1107**	**252**

Table 81 Comparing the total inhumations with coffins that have any form of detail related to funeral traditions

In attempting to separate these, a definition was formed to investigate those coffins that seem to have had some form of elaborate decoration that was related purely to funeral related traditions. This includes those with exterior decorations of any kind and those with interior padding (but not other forms of personal details). Of the total assemblage, 252 have some form of coffin details recorded, only 22.7%. The figures (in Table 81) show that there is a higher percentage of coffins with details recorded in Area 4 than any other and even if the somewhat artificial boundary between Area 3 and 4 is removed, then the combined percentage would result in 26% of coffins having some form of detail which is more than Area 5. This difference may be the result of a higher social status of graves placed in front of the gravediggers' house and on the more prominent monument lines.

Decorative features and elaboration

Of the elaborated coffins a significant proportion (15%) were painted white. There were only rare examples of coffins painted in black which is often identified now as a traditional funeral colour. Paint on coffins has been observed in other cemeteries but is rare; Voegtly cemetery, Pennsylvania is an exception (1833-61) where 96 coffins (n= 724) were painted red and 78% of these were for children (Ubelaker & Jones 2003: 10). The quality of the wood is a mechanism of display and painting could have been a way of hiding cheaper wood. However, at Assistens few coffins for children, which seem to be of thinner and cheaper wood, were painted, contradicting this idea.

Crosses made of a thin raised wood and placed on the centre of the coffin are an obvious use of Christian symbolism, but they were all simple plain crosses and none were found made of metal and only one of plastic. These crosses represent a quite simple form of decoration which could also have been quite cheap and possibly sold as part of the standard type of coffin.

Fig 108 Standard painted coffin with cross and raised lid (G274) (Typisk, malet kiste med kors og hvælvet låg (G274))

Plaster decoration found on coffins could be quite elaborated and this could reflect a regional variant of decorative form in Copenhagen and Denmark. The plaster decoration tended to be of Christian themes of angels or cherubs with wings and wreaths of flowers. Most of these were in a Classical aesthetic and seem to be of a standard mould or pattern indicating that designs were chosen from a set list rather than being unique to each coffin.

Very few, if any, coffins at Assistens had patterns of coffin studs on the exterior. Such decoration, though common at other cemeteries, seems to be a phenomenon of earlier periods where many studs are often used which sometimes form various patterns (Cowie et al. 2008).

Overall the level of elaboration of the coffins is quite plain in comparison to other contemporary sites and certainly plainer than earlier sites such as Helsingør. Some of this difference could relate to the placement of the most elaborated coffins, those at Helsingør are likely to have been seen again, having been placed in the floor of the church. Similarly those at Christ Church, Spitalfields were also elaborated but were definitely going to be viewed, often by tourists and visitors, not just families. Therefore, there is distinct separation between coffins made for earth-cut graves that could not be displayed again and those in coffins

or vaults. The decoration forms themselves shows that there was little market for opulent decoration forms or symbolism and few suppliers for them.

There was one distinctive unique coffin found with very elaborate symbolic decoration of lid motifs (G753, see Fig 27) with prominent references to resurrection and eternal life (Richmond 1999:151). Similar symbols have been found in coffin furniture in the UK; St Marylebone had a flaming urn and pairs of angels (Miles et al. 2008: 63). This coffin was laden with meaning and of an unusual construction which possibly reflects a German tradition plus the need for a good quality coffin for transport which also needed to be sealed well. Within the family grave plot no other coffins were decorated in this manner, they conform to the general patterns seen in Assistens, something marked out this person as needing to be commemorated in this manner.

Inside the coffins

Textiles that relate to the coffin and furnishing of the coffin were few and almost all relate to more elaborated coffins where there were other signs of traditions on the coffin. No textile fragments could be directly connected to mattresses but the presence of wood shavings and hay suggest a packing that the body could lie upon but also to make the coffin appear soft and more like a bed for the dead person. Examples of these practices are in the hay which has been found at Christ Church (Litten 1998) and surviving mattresses have been found at other places such as Helsingør (Aagaard 2002). Several clusters of feathers also survived under the head where textile often did not, showing that household pillows were also used. Some of the textiles are likely to have been made especially for burial. There were also occasional surviving examples of coffin lace decorating the coffin rather than the body (G518). Coffin related fabric, like covers and linings, could have been produced especially for burial purposes, whereas winding sheets, (sofa) pillows and blankets might have been taken from the normal household. Or they could have been bought specially from the undertaker. One specific example of use of an everyday item is the blanket used as a pillow; it showed signs of repair and use indicating that it may have been a personal item and showing elements of care from the family towards the person.

There were some unexpected finds on the coffin which seemed to be linked with coffin furniture, found in the base of the coffin or underneath a pillow were ordinary bottle corks, in one example up to five in one coffin (G711). There is no currently known precedent or parallel for this finding, although the numbers are small (16) it is a clear pattern in six coffins. Of the inhumations all were in elaborate coffins, four of metal and two of double lined wooden cases with external moulding decorations and paint. All had signs of upholstery or packing and two had pillows that the corks were found underneath. All but one grave was of older women and five have possible identities where the dates of burial range from 1894 to 1917. It is possible that the corks are accidental inclusions that were placed in the coffin amongst coffin fillings such as wood shavings; indeed one coffin also had a token and a piece of coal. It may also relate to the practice of a wake where social events were connected with eating and drinking, the coffin may have been open during this time; did the cork represent an inclusion of the dead into the feast? One coffin (G1413) had a separate body board and an unusual metal coffin that could indicate movement of the body for the wakeor for travel.

There was only one clear piece of evidence for very modern and practical function; one coffin contained a modern plastic body bag, sealed with a zipper which led to high preservation of the soft tissue (G902). Another example of wrapping the body in medical sheets was present in a coffin where the person displayed sign of surgery close to the time of death in the form of surgical tubes present in the body (G720).

Decorations on the earliest coffins

In trying to create some form of chronological data, the earliest coffins were analysed for their decoration, this includes both graves found in the single row burials and coffins from family plots. Only 20 of the very earliest coffins had any exterior details (Table 82), while furniture such as handles and crosses on the lid, which are common for later coffins, was completely absent. Internal coffin details are even scarcer (Table 83). The scarcity of coffin detail could be explained in part by the general poor preservation of the single row coffins, which bias the results compared to the later and better preserved coffins. However, the simple rectangular outline of the coffins and the fact that flat lids were most common seems to suggest that the coffins used in the single graves, in general, were of a very plain and simple kind. This might be an expression that the coffins used for single burials in general were of the cheapest possible kind. Following this interpretation, the simple coffins are likely yet another expression that the people, who were buried in single graves, belonged to a poorer section of society. Three single row burals are suggested as containing some decoration however one (G821) was of some plant material in a very disturbed coffin which is likely to be intrusive, another (G1452) is a mistake in the data and contained no packing inside the coffin. Only one single row burial (G821) seems genuinely to have contained a form of moulding consisting of a flat board on the coffin lid possibly for the display of flowers. This makes this burial extremely unusual within the single row burials for having any form of decoration. The rest of the burials identified are mostly from family burial plots or rows of child burials but are simply early burials.

Exterior details	**Group ID**
Feet	G1168, G1255, G1342, G1351, G1353
Plaster decoration	G1092, G1098, G1104, G1108, G1148, G1170, G1255, G1321, G1331
Moulding	G821, G1108
Paint	G977, G1094, G1245
Flowers	G528, G1094, G1245
Wire/ ribbon	G1169
Fine sand on the lid	G988, G1332
Iron bonds	G1421

Table 82 Overview of the exterior decorations on coffins from the earliest phase

Internal details	**Group ID**
Packing	G810, G865, G988, G1143, G1452
Tar	G1104
Unidentified metal object	G1170

Table 83 Overview of the few internal decorations on coffins from the earliest phase

New ways of disposing of the dead – cremation

Towards the end of the 19th century an entirely new way of dealing with the dead became common, part of this was associated with the lack of burial space and changing views on the expense of the coffin burial but there was no longer a need to keep the body intact. So the change in religious feeling was also a large factor in this new opinion. In 1881 an association was formed in Denmark to promote cremation as an

alternative to inhumation burial. It led to opposition from many circles, including the church. The first crematorium in Denmark was built in 1886 in Frederiksberg, Copenhagen although it only became legal to cremate bodies in 1892 (Secher 1956: 54). By 1937 only 9.6 percent of Danes were cremated (Sommer n.d.) and this is borne out by the small number of cremations in the cemetery, where none were dated to before 1900. In Assistens it could also be seen as a way of ensuring burial within in a crowded family plot where there was no more space and therefore could also have been a practical decision. The change to this type of burial was slow at first but became more acceptable in the 20th century but it says something about the person and family in choosing this form of disposal. Perhaps it is related to the increasing cost of burial but could also be bound up with a move away from traditional feelings about funerals or a decline in religious sentiment. It also points to a more efficient and more modern sensibility.

Only 81 cremations were excavated, out of which 25 had tags which identified the deceased. All the tags, except one, were ceramic and had identification numbers which show the date and crematorium used. The exception tag was a folded card which contained the name, date and location of the individual. The tags form part of the identification during the cremation procedure. The majority of tags may have been extremely similar in material and style but the urns differed. The iron urns were cylindrical in shape, tapered at the base with hinged lids, the wooden urns are square and are simply manufactured with thin pieces of wood with stakes in the corners both types are relatively plain and undecorated. Only one urn was an extremely elaborated ceramic rectangular container. A very small number of cremations had no visible vessels and may have been originally contained in unfired pottery urns which disintegrated rapidly and left behind a solidified mass of cremated bone. There is even evidence that the cremation tradition influenced the material of coffin wood as it no longer needed to be robust enough to prevent grave robbing and disturbance. Instead coffins were made thinner and more flammable (Howorth 1997: 130). The later protocol relevant to the site began in 1885 and records 119 urns in the family grave plots, in which 57 of the urns noted do not specify the material, 57 were iron, eight wooden and two were clay (Zander 2009). Out of the urns registered only two date to the first decade of the 20th century, the earliest in 1905.

There appears to be no spatial pattern to the distribution of cremation urns though none have been found outside of family grave plots, which is probably reflective of the later date of burial at a time when the cemetery was much more controlled by professional staff. However, there are some small clusters in particular areas and also areas with an absence of cremation burials; for example, there are no cremation burials within the south-western corner of the site along Jagtvej. Clusters of cremation burials exist in most areas, one in particular was in grave plot 177 where a family buried seven urns from 1942-78 (Fig 109). The first two urns here may have been part of a double burial, both being placed in the same cut; this is supported when comparing the historic protocols where the first urn, though of an earlier date than the next, is described as being moved from Helsingør and so could have been reinterred at the time the second urn was buried. Cremation and urn burial appear to have become a tradition for this particular family which also had the practical benefit of fitting all these members of the family into a plot of limited size.

Fig 109 Urn group being excavated in Area 1 (Urneklynge under udgravning i Område 1)

The cremation burials represent dramatic change in the way the members of Trinitatis Parish bury their dead: it seems generally to represent a simpler form of disposal in terms of the level of display of the urn. Perhaps this shows that the funeral industry was more conservative in applying the commercial possibilities of having elaborated urns than in the case of coffins, so a simpler, standard iron urn was used instead. As coffins with, albeit limited, decorative features were being buried at the same time as these plain and simple urns, it seems that the choice in having a cremation is not simply based on the method of disposal of the dead, but also the method and form of ritual and presentation of the dead.

Commemorating the person

This section interprets the more private side of funeral traditions, interpreting patterns from personal items that are placed within the coffin and sometimes worn by the person. The items are often grave gifts towards the person and may reflect the character and lifestyle of the person as well as their social status and commemorate their relationships in life. The finds themselves should not necessarily be thought of as personal possessions of that individual.They could also be expressions of grief, or ritual touches from the mourners that put something of themselves in with their loved one, therefore care must be taken in ascribing finds to the dead individual. There are patterns in the care and social display of the body, where it may have been important to highlight certain social aspects of the person. An open coffin and a funeral become a performance of the rituals which promote the deceased, their family and other mourners.

Overall patterns of display

Although these private finds tend to be inside the coffin they could still function as display items. Alternatively more hidden and personal grave goods can also be seen as symbols used in rituals of grieving and not necessarily as the possessions of the dead (Downes 1999). There is a significant amount of finds from Assistens cemetery marking out a rise in the consumerism and use of material goods available to use

within a coffin. This is reflected in the flowers, clothes and arrangements of the person. There is a possibility of chronological changes with increasing trends towards supplying personal items and display within the coffin, with higher strata of society representing this in coffins from the post-medieval period and this pattern filtering down to other social classes. Certainly Helsingør and Christ Church coffins contained some elaborated personal items but the display was more focused on the body. A poorer mid 19th century community such as at Cross Bones in London contained only three coffins with evidence of everyday clothing and no personal finds (Brickley & Miles 1999). The amount and quality of the finds could point out the trend towards inclusion of personal items as well as the status of the people in Assistens. However it more speaks of the bonds between the deceased and the mourners, with gifts that could be part of the rituals involved in funerals which were related to how one should behave at a funeral.

Grave gifts in the single graves

That the single graves in general contained poorer citizens of Copenhagen is to some degree supported by their minimal content of grave gifts: grave gifts have been found in only nine graves. Jewellery, which could be seen as an expression of some degree of wealth, was only found in one single grave (G847). It consisted of a gold ring, possibly a wedding ring. Another find which might suggest some degree of wealth is a face cloth made of silk found in G784. No obvious religious items were found. However three coins or tokens found in three graves (G364, G1452 and 1480) could be interpreted as Charon coins, and could thus reflect belief in afterlife. Another grave gift in the much later dated row of child burals is the rubber ball found in a child's grave (G1170). The ball could be the deceased child's favourite toy or a gift given after death but expresses how the individuality of the child was marked out even in the coffin display and reflect the relatives' care for the deceased child. This confirms that even though the birth rate was high and child death more common in the 19th century than today, the death of a child was was an event for sorrow and mourning.

The person inside the coffin

All inhumations were within coffins so the position of a body is restricted by the shape of the coffin. All skeletons recorded were supine (placed lying on their back), with only two exceptions. The arms tended to be placed along the sides of the body, but in some cases the hands were placed over the hips or chest, clasped together. Unlike a shroud a coffin does not hold the arms into place; therefore the arm opposition may alter.

The legs and feet were laid out together. There were examples of the legs lying extremely close together; this would have required a shroud or some form of wrapping to hold the legs and feet together. A few inhumations did show legs apart with the feet in each corner of the coffin, in some circumstances this may be due to the large size of the person which allowed only this position. Others had slightly bent knees, though this was likely caused by the body sliding during movement of the coffin. So there is a mixture of use, with some evidence for shrouds or tight wrapping of the body within the coffins.

Of the two exceptions of bodies being laid flat, there seem to be practical considerations involved; one male skeleton (G1508, Fig 110) was found *in situ* lying on their front. The pathological condition the individual suffered from shows that he would have had a bent back and it is possible that the undertakers were unable to fit him into the standard size coffin and therefore placing them in this prone position was a practical factor. Certainly this implies that no individualised coffin was constructed for this person. The second exception was of a female skeleton lying on the side with the knees bent and hands placed at the

shoulders (G522). There seems to be no pathological condition but the large amounts of soft tissue present suggest a large body which perhaps also did not fit into the standard size coffin.

Fig 110 Skeleton lying upside down in the coffin (G1508), flower bouquets had been placed on the back of the legs (Individ lagt på maven i kisten. Der var lagt blomsterbuketter på benene)

Dentures – making the person appear alive?

Over 22 dentures were found, many full sets and generally of a modern hard plastic material with porcelain teeth; these were often found inside the mouth of the skeleton. When placed in the mouth the dentures would have the effect of keeping the shape of the face (G518, front cover) Without the false teeth the face will appear shrunken and enhance the 'look' of death. This has direct implications concerning the display of the body, where dentures may be an indication that there was an open coffin. Most people would not die with their false teeth in place; therefore they are deliberately inserted afterwards as part of the preparation of the body. Although dentures are a highly personal item, they are not usually reused by another person and therefore rarely handed down.

The most elaborated false teeth (G697) were a highly skilful piece of craftsmanship that included springs connecting the upper and lower ivory teeth. Due to the tight springs on either side their natural tendency would have been to lie flat so when preparing the body and inserting them into the deceased's mouth, it is quite likely that the jaw would have needed to have been tied to keep them from springing apart. These dentures were quite old fashioned for this period; porcelain teeth which did not decay like ivory were widely available in the mid 19th century. The good quality of the ivory could suggest that the dentures were little used but considered important in the social display of the dead body.

Textiles and the sleep of death

Within the coffin the textiles helped to create a unified vision representing how the dead person should look. It is clear that some individuals were arranged so that mourners could view them in the coffin. This presentation seems to be created to present the dead as sleeping, or at rest (Tamm 1992: 104). The clothes and coffin furnishings create a comforting place, which also hides the coffin. Photographs of people lying in their coffin, often with their family and mourners around them are well known (see Kragh 2003 for some

good examples). These show how the person is laid out, with cloth coffin linings, clothed and faces composed to appear as if sleeping. The textiles and the fastenings used on textiles, which often are the only surviving remnant of the clothing, are both elements that allow analysis of this idea. The body positions of virtually all the skeletons found, as discussed above, were supine, often with evidence of a pillow under the head and with some covering, blankets for example, over the person. This creates the look of sleeping in a bed that appears to be a standard position of individuals at Assistens.

Personal clothing – special burial clothing?

The majority of the textiles comprised pieces of woollen cardigans, with smaller amounts of other clothing types. There were also the textile pillows and coffin decoration that could contribute to the feel of sleeping in a coffin. Most of the textile fragments were knitwear, and the overall use of this is a special trait at the Assistens cemetery, which has not yet been observed at other cemeteries. Tabby weave was also used, especially for coffin related textiles. The possible linen shrouds, that have now decomposed, would probably also have been tabby woven. Twill was rarely seen, but existed in various different clothing parts, from blankets to face cloths. Other excavations from the same period, such as St. Martin's in Birmingham, also have many wool fragments, but they are mostly tabby and no knitwear is mentioned (Walton 2006: 163-78). This makes the fragments from Assistens quite unique.

The standardised look of the cardigans and buttons suggests that they have been made especially for burial, but it is an uncertain interpretation, as people might have used the cardigans while being alive. The safety pin from F200788 could be a sign of repair (Fig 34), but no other reparations have been observed on cardigans, which could point at the clothing being completely new or perhaps little used 'Sunday best' clothes. The nylon stockings (F200257) had some loose stitches that must have appeared while using the stockings, so they are not new. The shirt of artificial fibres (F201129) had no buttons (Fig 35) and must therefore have been made for burial purposes, which its new and unused look also confirms.

It is possible that the dead at Assistens cemetery were wrapped in linen shrouds but only fragments of these have survived in the soil. This idea also does not accord with the more everyday nature of some of the clothes, such as shirts or the cardigans. Although winding sheets, or shrouds were not identified, the position of some skeletons suggest tight wrappings of some form were present as the legs and feet are lying tight together and the hands are held over the pelvis suggesting that during the processes of decay they were kept in place by material.

The overall impression is that people have been buried in clothes with an "everyday" look, whether or not is has been made especially for burial. There is a general trend of anonymity and uniformity amongst the textiles and this is most likely due to a certain burial fashion that emphasised the importance of keeping people warm in the grave, rather than exhibiting their wealth. However few common everyday clothes have been found, there are no trousers or skirts and no day dresses. Although there are occasionally hints of daily clothing in stockings, sock and shoes the majority seem to form a different category – of clothes that are specifically for burial but have a look of the everyday.

Only a few examples of especially fine clothes were found, e.g. the silk skullcap as well as the student cap, which seems to have been intended more as a grave gift rather than an item to be worn, but it would have been a rare and highly considered status symbol at the time. It is of course impossible to know what linen shrouds might have decomposed in the soil. The impression brought to us by the preserved textiles may be heavily biased towards materials and items that preserve easily.

As the dating and identification of the Assistens Cemetery graves is still an ongoing process, no development in the clothing over time can be seen so far. However, a clear difference to the earlier predominantly 18th century burials at Christ Church and St. Olai in Helsingør is seen, as these burials have almost only linen clothing and no knitwear of wool (Reeve & Adam 1993; Aagaard 2002). There seems to be a fashion towards plainer burial clothing, compared with these sites, where the textiles are less elaborated, despite being specifically made to use as burial clothing. The coffin is no longer a place for display in the same sense as earlier periods.

Clothing is represented far more by the evidence of how they were fastened together; buttons were recovered from 189 skeletons which far exceeds the amount of clothing found in the coffins. The position of them indicates clothing to the upper body interpreted as shirts, rather than trousers or lower coverings. In particular the porcelain buttons were extremely standardised and generally found without remnants of textiles. It is possible that these form a standard dress for the body of some kind of white shroud or nightgown that has not survived and was a common way of displaying the body. The uniformity of this could also suggest a form of hospital or poor house uniform or equally just an extremely easy and common way of dressing. There were also large quantities of copper alloy buttons although the patterns of these were less uniform than the porcelain buttons indicating a wider variety of clothing which could represent the more everyday clothing found in the textile fragments.

The display of jewellery

Jewellery placed within a grave makes a personal statement marking out a part of the identity of the person; they can be purely decorative for display and also retain a functional purpose such as the hair combs. There is a high representation of jewellery at Assistens compared to cemeteries from earlier periods or contemporary cemeteries where there is a distinctly different population. The hospital cemetery at Farimagsvejen in the centre of Copenhagen for example contained only two copper rings (Winther 2010). Even earlier and possibly higher status burials at Helsingør contained no personal jewellery. The provision of jewellery belonging to an individual is a direct challenge to the idea of 'returning to the earth' with no material goods that is common in the medieval period onwards. The data from Assistens now shows that attitudes to death had changed and were reflected in what was placed with the person, either by request of the persons or by mourners. Jewellery as a grave gift represents a multitude of ideas, which could be gender related, an indication of status, marriage or wealth or purely decorative.

There was a distinct gender difference in the provision of jewellery in the grave; only 18 males compared with 54 females had jewellery, making females three times more likely to be buried with decorative objects. Males had only one ring, usually identified as wedding rings, only one male also had an earring. However the grave is highly truncated and disturbed and it is likely to be a residual item from a disturbed grave in the vicinity. There were no traditionally male jewellery items within the graves with identified skeletons. Examples of other jewellery that have supposedly masculine characteristics such as cuff links and one watch were found from skeletons that were not identified as male or female. So there is a noticeable gap where males are not buried with decorative finds. However, it is possible that there are less types of male jewellery and also that traditional male jewellery was more likely to be passed on as heirlooms rather than seen as personal items. In a similar way jewellery was reserved for females and children in Pima, Arizona (Heilen & Gray 2010).

Spatially there seemed little pattern in the distribution of jewellery, either when examining all jewellery or jewellery identified by sex of the skeleton. The jewellery was predominantly found with older people, from

the age of 50 onwards with very few pieces found with younger adults and none with children or adolescents (Table 84). This could suggest that older people were treated differently and that jewellery was seen more as marking out their longer life and personality.

Age in decades	<20yrs	20s	30s	40s	50s	60s	70s	Unaged
Male	0	1	2	1	4	5	0	4
Female	1	1	4	0	13	11	11	13
Total	**1**	**2**	**6**	**1**	**17**	**16**	**11**	**17**

Table 84 Jewellery found with skeletons identified as either male or female, ordered by age in decades

There was also evidence that more females were likely to have more than one item of jewellery in their grave. This could relate to paired items of earrings and hair combs, as from the females there were 85 finds from only 53 females but the males each had only one find in each grave. Is this an attempt to provide a full set of jewellery marking out the females in their best or most precious items? Providing jewellery to family groups could also represent the families way of presenting themselves as wealthy, however there are only four definitive clusters of jewellery in Area 2 (G191, G210, G262) Area 4 (G616, G650) and (G767, G785) and Area 5 (G9494, G950). These could show close familial relations between the graves.

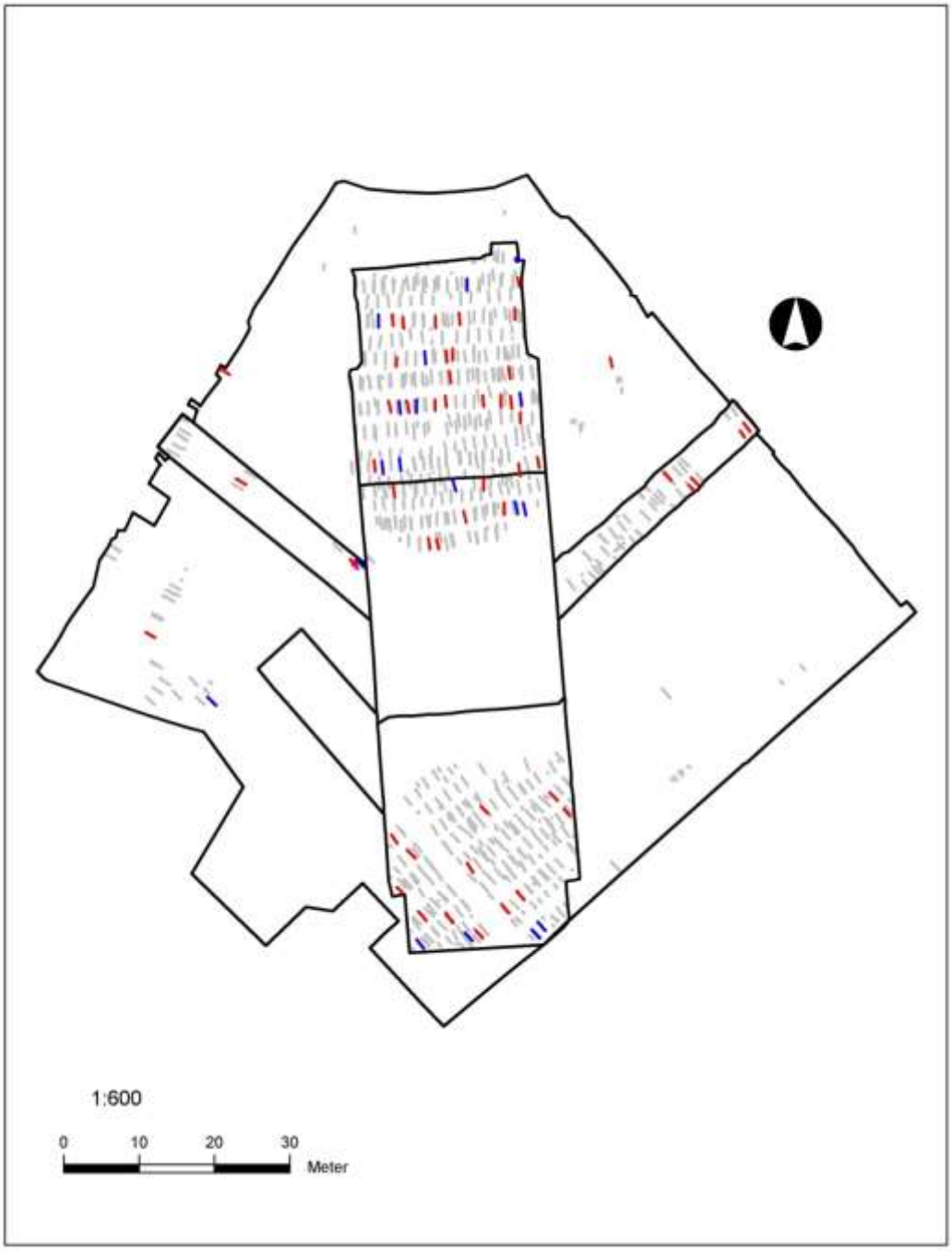


Fig 111 Distribution of jewellery divided by sexed adults. Blue = Male; Red = Female (Fordeling af smykker i henhold til køn. Blå = mænd, rød = kvinder)

Wedding rings

Of the jewellery the largest category was of rings; most of them were rings that are identified as wedding rings with engraved inscriptions of the name of the spouse and a date. Many of the rings carry stamps defining the quantity of gold (carat), jeweller/producer and in several cases the city and assayer (*Guardeinen*) mark. The city mark of Copenhagen was a reproduction of the three towers from the city coat of arms (Sølver 1929: 191). The assay stamp can be dated to a specific time period as there have been few assayers and each have their own design. Only two designs have been observed, the older of these two is

Peter Reimer Hinnerup, the assayer from 1840 to 1863 and Simon Chr. Sch. Groth from 1863 to 1904. Rings identified from male graves which were dated ranged from 1842-93; rings from female graves dated to 1816-1902. This broader range may reflect the larger amount of rings but also the tradition of females having rings could be a longer one. Different jewellers are represented by their stamps such as H. Niebuhr & Søn (F13819) or Frit Alfr. Grim and Helmuth Reinhard Niebuhr who had a shop on Gothersgade, founded 1890 (Krak 1950: 423) or Arent Dragsted (F8839) who founded his company in 1854 (Krak 1950:141) and whose shop was on Bredegade.

The majority of the rings were found with females (70%), all were adults. In some cases an individual had two rings which could be the engagement and wedding ring. However there were examples of identical rings with identical inscriptions except for the different initials suggesting that when the spouse died the survivor wore both rings. Something that hints at this is the modification of the rings; they were either expanded or made smaller to fit the new wearer. Three rings from female graves contained female names, in all three examples they are with paired rings and it is suspected that the husband died before the wife and the ring was not buried with him but rather kept by the widow and worn and then buried with her. This may explain some of the lack of male rings in the graves. One example is from a female (G1485) who was wearing a modified wedding ring with her name on it. It presumably originally belonged to her husband, which was then modified to fit her smaller fingers. There is now a distinction in the tradition of keeping or burying the rings, between her husband who was buried without his ring and this woman who was buried without her own ring. Why was this done? It could be that her ring was handed to another family member as an heirloom.

There were other rings that are clearly not wedding rings, but perhaps engagement rings or for display. Although jewellery is scarce in other cemeteries, for example Voegtly cemetery (Ubelaker & Jones 2003: 10) this may reflect the traditional views of a community that decreed that adults were to be buried plainly and also that weddings rings were not common in the US or UK before 1900.

Identifying personal ideals

There is some evidence that adult and child burials at Assistens varied in their form and modes of presentation. This relates to the type of coffins used and the presence of objects placed into them. However, no specific form of socially constructed child or adult burial was identified.

The main assemblage in Assistens concerns adults, who are generally defined by their placement within the family graves, in being placed inside coffins and being more commonly given grave gifts. Only adult graves contained jewellery of any type or had any surviving clothes. There was only example of surviving flowers from a subadult grave which is a distinct difference compared with the adults. Some children were marked out by their placement in specific lines and their thinner, more delicate coffins but overall there were fewer finds. Two subadult graves contained toys; a rubber ball (G1170) and a doll (G1090). Neither of the individuals have been identified and it is not possible to define the sex and there can be no naive assumption firstly that the toys belonged to the specific child nor that the items can define the child's sex.

Children in other cemeteries have been treated differently, in Voegtly cemetery, Pennsylvania; they were celebrated as different to adults who had a relatively plain burial tradition. Small deliberate toy gifts such a marble, whistle and copper bell were all found (Ubelaker & Jones 2003: 10). Some also had jewellery and more children had shoes than adults. Curiously, although rare in the cemetery overall, there were more juveniles with shoes in Pima in Arizona (Heilen & Gray 2010) but shoes were rare in Assistens both for adults or children.

There were few adolescents found in Assistens, but there seems little differentiation between them and adults; they were buried in the same areas as adults with finds and clothing so there is no clear boundary showing the transition between childhood and adulthood within the evidence. There are some patterns in differentiating age categories between children and adults and further research may generate more concrete results.

Denmark is a predominantly Lutheran Christian country. This can be seen in the evidence of traditions and rituals as well as the coffin decoration and some finds within the coffins. While many coffins had crosses on their lids, and other religious symbols associated with them these could simply be the custom and not representative of the actual feelings of the dead; they are simply reflecting what is expected to be symbolised on a coffin. However, there are examples of objects placed in the coffin that appear to be of an overtly religious nature and are suggestive of a genuine religious sentiment. The objects were not common and so may be seen as signs a more devout or overt belief.

Overall the gifts were too few to ascribe general patterns in age or sex for the assemblage but all but one of the religious gifts were placed with mature or old adult females. Three hymn or Psalm books were also found within coffins but no details could be deciphered (F200287, G196; F201340, G711 and F202314, G524). The clearest symbols are the statue of Jesus (F202601, G1565), a very plain mass manufactured item based upon Bertil Thorvaldsen's Jesus. The original statue in Vor Frue Kirke was made in between the 1820s and 1830s and it is uncertain when this statuette could have been produced as many replicas have been made. A large crucifix is categorised as a piece of jewellery as it has a chain and probably reflects not so much a daily worn piece but occasional, it could also reflect more Catholic taste as the image of Christ on the cross tends to be less popular in Protestant religions (F200522, G329). It is possible that it is part of a rosary.

There were always minority religions present in the country, some of which have their own cemeteries or, as in Assistens, a separated section which was not within the excavation site. However there is some evidence that Catholics were also excavated, seen in the finds associated with certain skeletons or coffins. As well as the above mentioned crucifix, one clearly identified rosary was found (F202315, G726); it was placed in the right hand of a person with the chain trailed up the right arm. The material is unusual, it being made of wooden beads on a string, which did not survive, and a small plain crucifix at the end. The rosary is a distinctively Catholic object but, it does not necessarily mean that the person was Catholic themself, as it could have been an heirloom or gift from a mourner. These items do suggest that Catholics could be buried with other Christian denominations.

One very ambiguous item is the silk cap found on the head of a male (F200686, G648). The cap resembles a Jewish kippah or Catholic zucchetto, worn only by clergy, but not in every detail. It seems unlikely that an observant Jewish male or a Catholic priest would be buried in a mixed faith cemetery and display an obvious symbol of faith. A cross of leaves on the body also indicates a Christian faith and overall the burial was quite elaborated. There were no other obvious signs of faith in surrounding graves reflecting the whole family's beliefs. The item then does not suggest a religious foundation it could be inspired by the design but indicate a status or occupation. The individual has not been securely identified as the grave sequence in this area is complex but examination of the potential plot, (grave plot 709) suggests a family plot that is dominated by artists and craftsmen.

Commemorating the personal – gifts

There will always be examples of unique grave gifts and these may reflect some distinctive aspect of the person rather than broader social conventions. There were only a few of these found and they were made of widely varying materials. Similarities or differences in traditions may await further identification of the individuals in the cemetery and family groupings.

There was no pattern in age or gender of individuals which had personal grave gifts, ranging from the doll placed in a small child's coffin (G1090) to the statuette of Jesus found in older male's grave (G1565). The location of the gift in the coffin varied little, the statuette of Jesus was found placed on the right upper arm and a child's ball was found clasped in the hand. These items could have been put in by the mourners during the open display of the body in the coffin. However one item, a photograph in a frame (G1141) was found placed underneath the lower legs of a woman. This suggests that the frame was placed before the body, possibly by the funeral professionals and speaks of a long intended and thought-out gift. Other mementos are familiar such as letters placed on top of a coffin (G1464) and a lock of hair enclosed in a paper or card rosette (F202034, G1380). These items could belong to the person or to family members.

Another personal item within one grave was a small decorated enamel badge. This was a 'Kings Mark' badge which was specifically created to mark King Christian X's 70th birthday in 1940 (F201902, G1393). Although the grave was disturbed it has been identified to a male who was buried in 1944. The Kings Mark badge was on sale during the German occupation and as well as a symbol of Danish national pride was also worn as a sign of resentment to the occupation. It is tempting to assign this as such to the man, it may also have been a gift representing a family or friend's attitudes to the situation.

There are items which are unique but can be understood as representing either the dead person or family or friends wanting to represent themselves in the coffin. Although for example flowers are a common gift placed outside of the coffin, a more specific gift inside could be a direct representation of individual people. Within one coffin were two specific unusual finds of a cap and a small decorative flower vase (G1485). The grave goods in this coffin show a lot of time and thought was spent on the presentation of the woman for her funeral. It is likely that the vase and cap had significant sentimental value to the woman or to the mourners. It is possible that the cap, similar in style to a Danish student cap, relates to her connection with Copenhagen University.

It is not known when the practice of placing gifts inside the coffin became common, certainly medieval practices of grave goods are rarer and a plain burial was encouraged. However 17th century graves are known to include occasional personal gifts that speak of a rise of the individual within society who was to be marked out with particular items that could be displayed prominently in an open coffin viewing.

There will always be finds that are difficult to interpret within archaeological sites and cemeteries are no exception; the reasons for deliberately placing some items within the coffin will not be understood easily. One of the strangest objects found in the coffin was interpreted as a complete enamel urine bottle (F200577, G532, Fig 112). Although it is possible that this interpretation is incorrect, another function has yet to be ascertained, certainly the wide neck does not suggest a hot water bottle and the overall design is most similar to urine bottles. Overall this is an elaborated inhumation in very good condition with ample evidence for care in burial and traditions both to the coffin and the person. Effort was made to individualise this burial with clothing and jewellery, plus the unique find of the urine bottle. This cannot have got into the coffin by mistake, the rest of the inhumation has been made with care in a high quality way. There is no reason for this person to have been put in the coffin and the bottle to have been forgotten, it was quite

clearly displayed between the legs. It is a deliberately placed object although why it was present must remain, until further research, uncertain.

Fig 112 Skeleton with urine bottle placed between legs (G532) (Skelet med urinflaske placeret mellem benene (G532))

Osteological interpretation

Demography

The osteological analysis provides a demographic profile of the population. The mortality profile for the entire assemblage (854 individuals) reflects an ageing population consisting largely of adults, 86.1% (n=735) compared to 13.9% (n=119) subadults. Individuals of old age formed the largest proportion of the buried population. However, the relatively high number of mature and middle adults recorded osteologically may result from epidemics undetected in the skeleton. Whereas the low numbers of individuals from the young age categories may be a result of poor preservation combined with limitations imposed where excavation took place. The majority of the un-aged and unsexed adults, which comprise a relatively high percentage (26.2%, n=224), underwent field assessment. Most of the field assessed skeletons were less than 50% complete, which limited the possibility of sex as well as age determination severely.

The infant mortality of *c* 6% (the first year of life) is slightly lower than expected: During the 19th century and early 20th century infant mortality is known to have been relatively high in Copenhagen (Johansen 2002). According to the statistics, *c* 20% of the newborns in Copenhagen in 1890 died during their first year (Johansen 2002: 186; Løkke 1998). There was a high risk of complications associated with childbirth, congenital abnormalities, problematic infant feeding and most importantly, exposure to the infections and epidemics during the industrial period. Within the first year the mortality risk declines, but the decline was much larger for the children who had survived the first month than for the newborn. The low number of infants as well as children represented may, as mentioned above, be associated with poor preservation or

they may simply have been buried elsewhere on the cemetery. From the early days of Christianity unbaptised children were generally not allowed to be buried in consecrated ground. This should also be considered in the interpretation. Based on these factors, the mortality rate is, therefore, likely not a correct representative of the actual mortality pattern of the time.

Analysis of the data on the sex of the individuals buried indicates that the proportion of males and females are very similar. However, combined with the ageing information it seems that females outlived the males - a trend which is also seen in modern days. According to recent demographic studies, Danish females have consistently, since 1840 to the present, lived approximately four years longer than males (Juel & Christensen 2007). The specific age difference and the age at death distribution indicated by the osteology results will need to be compared to the historic records, before any wider conclusions on the demographic distribution can take place. The major factors of longevity are indeed influenced by health, lifestyle and living conditions. These have varied between the sex, age and socio-economic groups. However, to what degree needs further investigation.

Stature

The stature means and ranges observed are broadly compatible with contemporary skeletal assemblages. As might be expected, the mean stature of the Assistens sample, which largely comprised middle classes, is similar to the mean stature of the living populations recorded in relation to conscripts, medical and social anthropological studies during the last century (Hansen 1907-11; Asmussen & Christensen 1967; Andersen et al. 1982) (

Table 85, Fig 113).

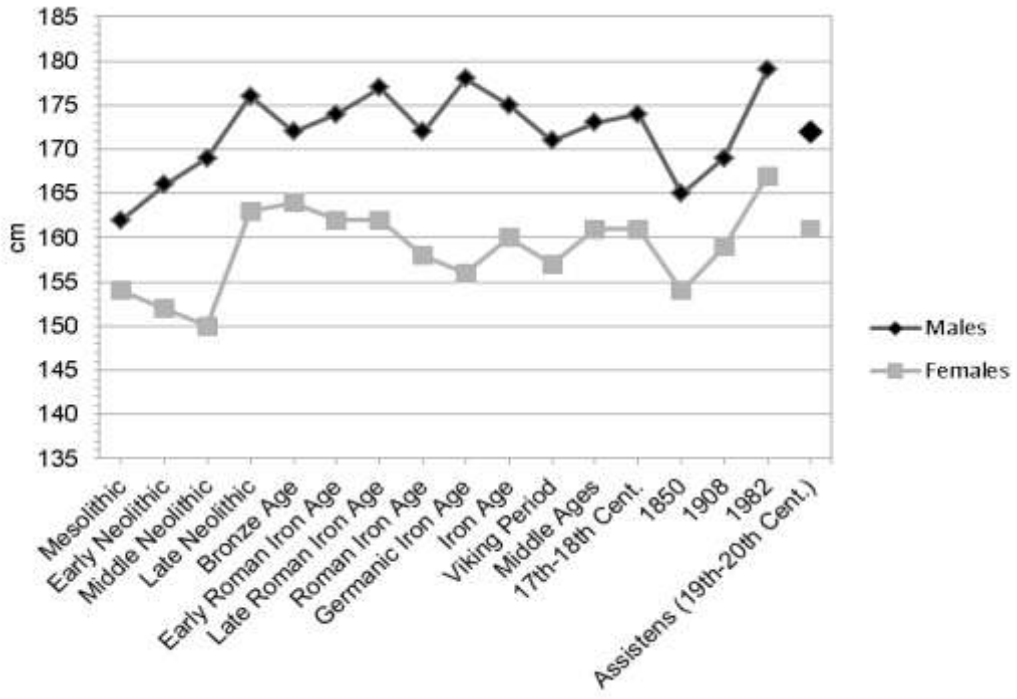


Fig 113 Figure of the average stature for males and females in Denmark through time based on long bone length. The data from 1850, 1908 and 1982 are based on stature measured on living populations in medical and social anthropological studies. (Den gennemsnitlige højde for mænd og kvinder i Danmark gennem tiderne, baseret på

lårbenslængde. Data for 1850, 1908 og 1982 er baseret på højder målt på levende befolkninger i medicinske og socialantropologiske studier)

Human growth is to a great extent governed by both genetic and environmental factors, and it is a fact that the improvement in hygiene and nutrition, which has occurred during the industrialization, has had a major effect on physique, not least in the form of increased stature (Asmussen & Christensen 1967; Andersen et al. 1982). However, the results of the Assistens data presented here is a reflection of the mean stature over the use of the cemetery and has not been subdivided into shorter time periods (e.g. decades) at this stage. Furthermore it comprises a mixed group of social classes, although the majority is believed to belong to the middle class.

	Males			Females			
Time period	**Mean**	**n**	**SD**	**Mean**	**n**	**SD**	**Data source**
Denmark							
Mesolithic	162	6	6.69	154	7	3.39	
Early Neolithic	166	4	4.36	152	5	1.00	
Middle Neolithic	169	10	8.99	150	7	5.53	
Late Neolithic	176	50	6.37	163	16	5.86	
Bronze Age	172	7	5.54	164	6	7.76	
Early Roman Iron Age	174	52	5.03	162	31	4.37	Bennike 1985
Late Roman Iron Age	177	24	5.85	162	20	4.67	
Roman Iron Age	172	4	5.03	158	2	4.24	
Germanic Iron Age	178	3	4.04	156	3	4.16	
Iron Age	175	9	6.80	160	14	2.79	
Viking Period	171	23	6.11	157	27	5.05	
Middle Ages	173	43	4.58	161	21	4.00	
17^{th}-18^{th} Cent.	174			161			
1850	165			154			Mackeprang 1907-11
1908	169			159			Hansen 1907-11
1982	179			167			Andersen et al. 1982
Assistens (19^{th}-20^{th} cent.)	172	182	5.58	161	186	5.68	Jørkov 2011
England							
Christ Church, Spitalfields (18^{th}-19^{th} cent.)	170	211	6.16	157	124	5.65	Molleson et al. 1993
St. Martin's (18^{th}-19^{th} cent.)	172	173	5.59	159			Brickley et al. 2006
St. George Church (18^{th}-19^{th} cent.)	172			160			Boston et al. 2009

Table 85 Average stature variation for males and females through Mesolithic to modern day Denmark with comparison to average data obtained at Assistens and from 18^{th} and 19^{th} century sites in England

There is a general agreement that stature is capable of reflecting the state of health of a population, although genetic factors also play an important role. Stature in the past varied considerably from period to period. They are also similar to contemporary middle class assemblages in England at Christ Church, Spitalfields (Molleson et al. 1993), St. Martin, Birmingham (Brickley et al. 2006) and St. George's Church, Bloomsbury (Boston et al. 2009).

The stature range for each sex and the overlap in individual male and female statures revealed a consistent height variation within this population. The means and ranges are broadly comparable with contemporary skeletal assemblages in the UK (Christ Church, Spitalfields, St. Martin's and St. George Church (Fig 114).

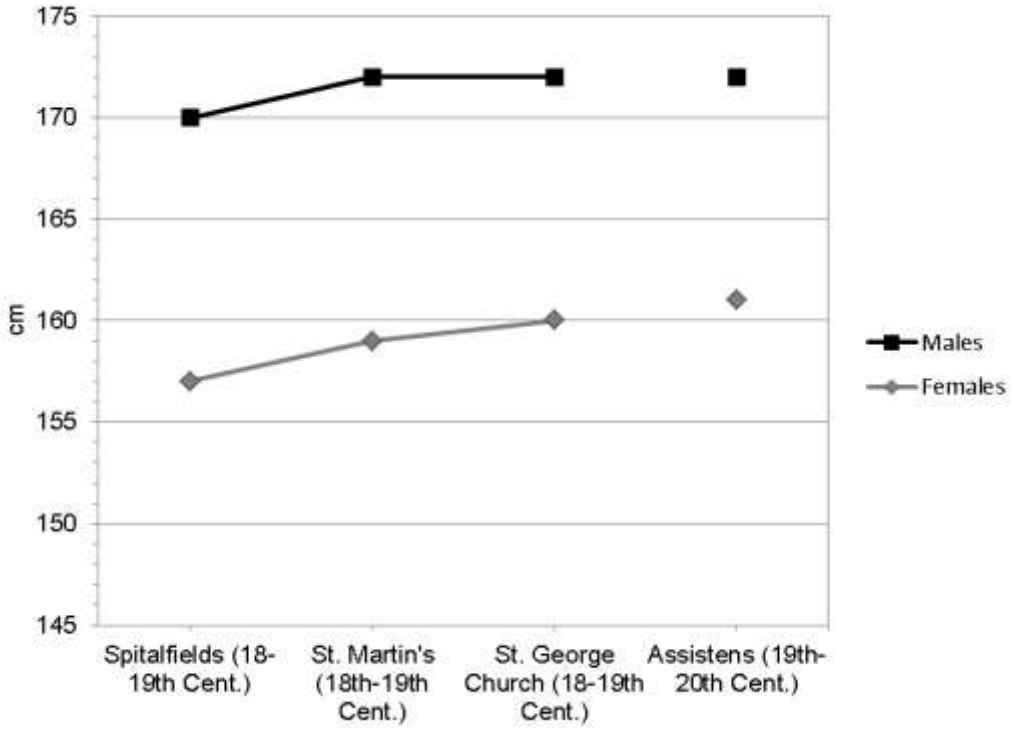


Fig 114 Average stature for males and females in the 18th-19th centuries at Christ Church, Spitalfields, St. Martin's and St. George Church, London compared to average stature among Assistens assemblage (Gennemsnitshøjde for mænd og kvinder i det 18. og 19. årh. f (fra Christ Church, Spitalfields, St. Martin's og St. George Church i London) sammenlignet med individerne fra Assistens Kirkegård)

The mean stature for males is 1.72m ranging 0.25m and for females 1.61m ranging 0.30 cm. If a mean stature is calculated for the available time periods 1850, 1908 and 1982 in Denmark (after Mackeprang 1907-11; Hansen 1907-11 and Andersen et al. 1982) a similar mean is reached. The significant increase in stature during the 20th century is noteworthy. In the light of the period, the change in sanitary living conditions known from the historical records and the general health status observed in the skeletal remains, it is possible to assume that once the stature range for the Assistens assemblage is analysed chronologically, an increase in stature, especially during the 20th century may be visible. At this point, however, we can only speculate and much further research into this is needed. How this relates to the general health, the socio-economic status, environmental changes as well as the nutrition of the population and other contemporary urban cemeteries in Scandinavia and Europe would need to be investigated. Further investigation of stature of the Assistens population can be found in Jørkov (2015).

Dental health and dentistry

The dental health and dentistry provides an important glimpse into the types of dental treatment available. Dental disease and other afflictions of the teeth were suffered by many in the 19th and 20th century. The analysis of skeletons from Assistens revealed over 66% of adults with carious lesions (cavities) and 49.8 % with mineralized plaque deposits (calculus) stuck to the surfaces of their teeth. This suggested a starchy diet that was high in carbohydrates and containing sugars, as well as poor oral hygiene. Almost 66.5% of individuals had also lost at least some of their teeth during life, most likely through decay and disease. Males were more affected by caries and calculus than females. The frequency is slightly different from

observations made in contemporary sites in England (Brickley et al. 2006; Molleson et al. 1993), where females were more frequently affected by caries than men who instead are more affected by calculus.

Overall the levels of dental health observed in the individuals buried at Assistens varied greatly. Dental decay was probably the most common reason for tooth loss, which is important to take into consideration when estimating furture caries rates based on tooth counts. However, the high proportion of old aged individuals within the assemblage should also be considered. The dental decay and tooth loss is probably related to the change in the diet at this period with more refined carbohydrates and sugar being widely available. From the mid 19th century the production of sugar beets increased extensively and the prices on refined sugar decreased making it affordable to the wider public (Hyldtoft 2012). This in combination with limited knowledge or practice of oral hygiene over time made the caries intensity increase correspondingly. A calculation of the caries intensity on a tooth basis, including Diseased Missing (DM) index and the number of caries lesions per mouth seems to indicate that females were more affected by dental decay and that the caries rate for females increased more rapidly during the industrial period than in males (Jørkov, 2014).
It is furthermore evident that females are more often completely edentulous compared to males, who in reverse have the highest frequency of ante mortem tooth loss. During the 19th century there were no suitable materials or techniques available for treating dental decay. The materials used to restore cavities were not very stable, and the dental drill was, to a modern perspective, very primitive. The most common and easiest treatment of dental decay was therefore extraction. General physical appearance was a vital part of life, but for those who could not afford dental treatment having their teeth pulled out could be both convenient and economically more favourable as the expenses that followed continuous dental visits could be avoided once and for all.

By the late 19th and early 20th century major advances were seen in the practice of dentistry and the development of new restorative techniques. Materials such as amalgam (mix of mercury, silver, copper, zinc and pewter) and silicate cement (soluble sodium salts) a precursor of plastic filling were introduced to fill cavities (Wilson & Batchelor 1967; Jørgensen 1976; Asmussen 1981), and affordable prosthetics were used to replace missing teeth (Ring 1985).

Generally the dentures varied in material and quality. This is also seen at Assistens. The problem was the lack of a durable and affordable denture base material. As it has been seen, swagged gold and ivory teeth dentures were used, but were expensive and only affordable to the rich. Partial prosthesis with metal bases (made from an alloy of chromium and cobalt) and single tooth prosthesis were also present but may also have been only for those who could afford them. By the late 19th century hard vulcanite rubber (*kautsjuk*, also referred to as caoutchouc) came into use (Ring 1985); it was a less expensive material and was light and easier to model and fit. The demand therefore increased and by the early 20th century it was no longer a luxury only the rich could afford. The false teeth that fitted in the dentures were made of porcelain. Although human teeth have been used coming from live donors or could be extracted from the dead, the prosthetic teeth among the Assistens have all been made of porcelain except for one made of ivory. The most recent dentures found, are made of acrylic resins and are a lighter pink colour. This type of material came in use in the 1950s (Jakobsen 2011 pers. comm.). Besides the dental diseases and various types of dentures and dental repair observed, a number of adult individuals showed evidence of staining on the teeth that may possibly be linked to smoking. One individual had a pipe notch which undoubtedly is a result of habitual smoking with a clay pipe. This is very likely an underrepresentation of the actual prevalence of pipe smokers. It was not possible at this stage to systematically quantify dental staining, nor relating it to

smoking. The frequency would possibly also be misleading as the number of edentulous individuals may have included pipe or cigarette smokers.

Skeletal pathology

Despite limited time and the varying condition of preservation encountered on site, flexible sampling did result in detailed pathological descriptions of over half of the *in situ* skeletons while only gross pathologies were described on the field assessed skeleton (not included in this report).

The pathological conditions found in the assemblage document aspects of the health problems, but many examples undoubtedly once present were not observed because of poor preservation or due to the analysis approach.

The results reveal the diversity of problems sustained by the population. One has to be aware that the skeletons examined only represent a sample of the once-living population and may therefore be an unrepresentative sample. Thus it may not show the actual disease load in the population. It is, furthermore, important to reiterate that because the field assessed skeletons were not formally examined for pathology, the overall disease prevalence among the overall Assistens assemblage (n=854) may be erroneously low.

A major difficulty when diagnosing pathological disease in archaeological skeletal remains is that many conditions may only affect the soft tissues of the body, such as the skin or organs. Childhood diseases such as measles, whooping cough and chicken pox along with other conditions that can affect both children and adults alike, such as cholera, parasitic infections and smallpox, will not be seen as evidence in skeletal remains. While diagnosis of disease is not always straightforward, written records can be biased and may reflect the author's preferences and opinions. There can also be a tendency for people to write about, and illustrate, the more dramatic and sometimes rarer diseases. Additionally when reading about signs and symptoms of disease in historical records, one must be careful not to interpret the wrong disease.

Infections

The assemblage from Assistens has shown that chronic conditions associated with different infectious diseases affected the population of Trinitatis Parish. Several types of bony changes have been observed that could be a direct indicator of infectious disease.

The non specific infection, periosteitis was the most prevalent pathological alteration associated to the infectious disease category. Although it can be a direct indicator of an infectious disease, it may also be linked to an impaired state of health. Infection does not always mean disease; in fact, it usually does not. It may be associated to simple inflammation of the periosteum, or where more severe caused by bacteria that enter directly from a penetrating wound or via the blood stream and then inflames the bone. How it transforms into a disease relies on many factors including proper treatment. Prior to penicillin, sanitation was even more vital than it is today, but good health is rarely reached unless nourishment is considered as well. A well nourished individual has a better chance of surviving an infection than an undernourished individual. Protein-deficiency reduces the ability for the immune system to overcome an infection (Scrimshaw & San Giovanni 1997). This may lead to a vicious circle, where infections cause malnutrition (for example through diarrhoea) and malnutrition in its turn reduces resistance to new infections.

Considering the time period and urban environment with crowded living conditions and poor sanitation, there was surprisingly little evidence of tuberculosis, which we know from the historical sources, was one of the main causes for death during the 19th and early 20th century (Johansen, 2002). In fact Copenhagen

had a higher than average mortality from tuberculosis than the rest of the country (Johansen, 2002). Despite a decline in tuberculosis mortality after 1890 (Johansen 2002: 191), due to the improvement in sanitation, new sewage systems and implementation of public health policies (Løkke, 1998; Hyldtoft, 1984) the general view in the 1920s was that pulmonary tuberculosis had been underestimated as a cause of death in the 1890s and that many of these deaths had been reported as death from bronchitis (Johansen 2002:180).

However, although tuberculosis seems to be almost absent in the Assistens assemblage it should be noted that bony lesions are rare in the majority of tuberculosis cases. Recent clinical studies have shown that skeletal involvement is found in only 1% of patients and before the availability of antibiotics, this figure averaged 5-7% (Aufderheide & Rodriguez-Martin 1998: 133). Therefore, most cases of tuberculosis go unrecognized in skeletal studies. Only one adult male (SB22417) (0.2%) showed spinal lesions consistent with tuberculosis. The average prevalence in post-medieval England calculated from the London Bills of Mortality by Roberts & Cox (2003: 339) was 0.62%, whilst an even higher rate of 1.39% was reported for the St George's assemblage (Boston et al. 2009). The reason for the low prevalence seen at Assistens can in part be due to poor preservation of vertebrae as well as ribs, which has limited the observation of the pathological characteristics significantly. Another reason may be that the individuals who died of tuberculosis were buried in another area of the cemetery or simply were buried at a hospital cemetery designated for tuberculosis victims.

Infectious diseases were also transmitted through sexual intercourse and venereal syphilis is known from medical sources to be a common condition during the 19th and mid 20th century (Boas 1950). The skeletal lesions of venereal syphilis (the gummatous lesions) appear in the tertiary stage of the disease, if the disease has not been treated. These may not occur until 2 to 20 years after the initial infection. It is, therefore, likely that the only example found of a middle adult female with the tertiary stage of syphilis was not treated, or at least not effectively. The prevalence of tertiary stages of syphilis has been noted in a number of contemporary skeletal collections in England and is similar in rate to Assistens of 0.2%. Reported rates at Christ Church Spitalfields and Kingston upon-Thames was 0.21% and 0.28%, respectively (Molleson et al. 1993 & 1993; Start & Kirk 1998). The prevalence of the earlier stages of syphilis is more difficult, if not impossible to identify, as they leave no markers on the skeleton.

Joint diseases

Osteoarthritis (OA) in both synovial joints and the spine affected females more than males. Females were more commonly affected in the knees while males were affected in the shoulder joints. For both sexes, osteoarthritis in the spine was most common in the neck and lower back.

Degenerative changes, especially OA, are among the most frequent changes observed in archaeological skeleton finds. This assemblage is consistent with modern populations where females tend to be more affected than males (Rogers & Waldron 1995: 32). While the aetiology of OA is multifold and varies in severity between joints, it commonly affects middle-aged and elderly people and seems to worsen over time. Osteoarthritis in the knees, for example, used to be considered a 'wear and tear' disease, although there are many factors besides age such as physical activity, repetitive stress, genetic susceptibility as well as obesity that can lead to knee OA. Osteoarthritis in the knees has also been associated with obesity but also chronic overuse (repetitive movements such as squatting/kneeling combined with heavy lifting as well as inappropriate footwear (high heeled shoes). Osteoarthritis in the shoulders can be associated with

repetitive stress of the shoulder muscles and joints. The repetitive pulling and rotation moves in heavy shoulder lifts may cause such condition.

It is tempting to link the observed changes on the skeleton to behavioural information obtained from historical sources. However, the quality of (independent) behavioural data is not straightforward.

The age at which a person started work will influence whether the changes will occur in their skeleton, and the longer a person has done a particular task, the more likely it is that changes will be seen, i.e. if a job has commenced prior to skeletal maturity. The duration of work will also influence whether we can recognize the occupation in the skeleton i.e. if a person does the work on a daily, weekly or annual basis. There are a number of specific changes in the skeleton that might be present and can be interpreted as the result of a distinct activity. Essentially bones can adapt to activity, and bone will change shape if it is placed under physical stress because it is plastic in nature (Knüsel 2000).

Relating skeletal markers to specific occupation was challenged by Lai and Lovell (1992). They attempted to relate the engagement of fur trade of three historical male skeletons to various skeletal markers including enthesophytes and Schmorl's nodes, vertebral osteophytes, spinal OA and extra spinal OA (shoulder, elbow, hip, knee). The activity stressors were believed to originate from carrying, lifting, and paddling or rowing. Most of the identification was restricted to osteophyte development. Since most human populations show varying degrees of osteophyte formation, it is difficult to see how such evidence argues for a behavioural interpretation. Knüsel and colleagues (1997) investigated patterns of activity related stress indicators in the spine (from for example, carrying and lifting) among different social classes from a medieval monastic cemetery. After controlling their sample for age, the lack of clear patterning of vertebral involvement led the authors to conclude that the vertebral column may not be an ideal structure to study occupational stress either (Knüsel et al. 1997: 481). From an epidemiological viewpoint, information concerning amplitude of activity related stress, age of onset of activity stress and duration of activity stress is almost always lacking. Attempting to reconstruct specific activities based on skeletal patterns of osteoarthritis is, therefore, challenging.

Other joint diseases such as DISH, ankylosing spondylitis and rheumatoid arthritis observed at Assistens would have caused discomfort including stiffness and pain and thereby may have affected the daily lives of these individuals. The lack of proper medical treatment for all the severe joint diseases observed would possibly have lead to dependence on other people and may have limited the possibility of carrying out their occupational duties. This would have been serious, if the disease, such as ankylosing spondylitis occurred during the prime working years (i.e. the twenties). While DISH has been related to diet and diabetes, ankylosing spondylitis and rheumatoid arthritis are associated with genetic disposition. Both DISH and ankylosing spondylitis were most prevalent among males and well in accordance with the male: female ratio as indicated by medical statistics (Aufderheide & Rodríguez-Martín 1998; Waldron 2009). The females were mostly affected by rheumatoid arthritis. Whether the increase in sugar-rich diets is the cause of DISH at Assistens cannot be disregarded and a comparison between lifestyle, diseases and dietary reconstruction should be looked into further.

Trauma and fractures

Trauma to bone can be accidental, due to violence or pathological. It can represent both antemortem and perimortem fractures. The growth of industry, increased building activity and the advent of new manufacturing techniques brought with it associated occupational hazards for those going to work in, for example, factories and building sites. This could involve fractured bones resulting from falls from heights,

amputation of limbs that were caught in machinery and other workplace incidents. It is likely that many of the limb fractures observed in males can be related to this. In particular one case of possible accidental injury was observed in a male (SB57805) who had the fingers of the right hand partially amputated. Also widespread use of horses for transportation and leisure activities may have resulted in fractures linked to falls or kicks. However, it is difficult to identify which fractures could be linked to which activities.

Rib and nasal factures are both injury sites that in many cases may be linked to inter-personal violence, although this is not the only cause. During the analysis of the material from Assistens, five cases of fractured nasal bones and eight cases of rib fractures were recorded, all of which were observed on males. Whether these occurred as a consequence of domestic violence or other violent acts such as, for example, pub brawling is left unknown. The fractures of the lower limbs are more difficult to associate to a specific activity or violence. They are likely associated to accidental injuries as mentioned above although violence cannot be ruled out. As for the females, the majority of fractures were observed on the arm bones (the right radius and ulna). The fractured radii, femurs and hip combined with the old age of the individuals, are well in accordance with typical fall injuries. A fractured ulna (Perry fracture), may be associated with defence injuries and thereby linked with violence. It can, therefore, not be ruled out completely that the fractured ulna seen on a female at Assistens is due to violence. However, since the radius of the same arm is also fractured, a classic fall fracture is the most likely cause. The majority of the factures were healed, indicating that the fracture occurred possibly years prior to death.

Ballistic injuries could be accidental but are usually associated with violence and suicides. In the two cases of projectile injury, neither individual had survived the incidents. The characteristics of the lesions and the position of the lesions (entrance and exit wounds) help in the reconstruction of the incident. Furthermore, the appearance of the lesion may aid in the identification of the velocity, the distance from which it was operated and the direction of the bullet. From stratigraphical analysis of the archaeological contexts and comparison of the limited data currently available likely positive identifications of both individuals were made. Further documentary sources concerning the deaths of these individuals (i.e. newspaper articles, death certificates and/or autopsy report) were obtained. According to these, one individual had committed suicide and the other had been shot by a second person. The osteological findings were largely in agreement with these records, but further study is needed. Based on the detailed descriptive data obtained, photographic and radiographic images and the historical records available, future study will continue on these single cases.

Other conditions that have been associated with trauma are circulatory diseases, where a fragmentation and collapse of the joint causing abruption of blood supply to that joint. This can quickly lead to bone necrosis if the blood supply is not immediately restored to the area (Roberts & Manchester 2001: 87). The most commonly found circulatory condition is osteochondritis dissicans, observed in nine adults. The majority of these were affected in the knee, also known as Osgood-Schlatter's disease. The condition most often occurs due to accidents (i.e. falls).

Evidence of treatment

Bone fractures healing in a position of poor alignment are common findings in skeletal remains. Not all could afford to employ a doctor privately, but there were the public hospitals (for example Almindelig hospital) which would have given assistance to individuals with chronic illnesses. Based on the large number of healed fractures with no indication of secondary infection, it may be inferred that either the bones were never infected or knowledge of how to treat an infected fractured bone (most often seen if

fractures were open) was widespread. However, the majority of the fractured long bones were healed in a malaligned position indicating poor treatment of alignment. Fractures of the shoulder, femur and lower leg as well as dislocations of hips are surrounded by large muscle groups and are more difficult to stabilize. They are therefore also the most common sites for malalignment. Trauma would result in a long period of immobility, dependence upon others and possible subsequent crippling due to a grossly shortened limb. Due to time factors the fractures recorded from Assistens, were not studied systematically to determine if there had been any therapeutic intervention. However, a number of cases for which some information on treatment could be deduced were noted. For example, one individual showed evidence of having professional treatment of a fracture. This was a female with Colles' fracture of the right radius, which had healed in a well aligned position. All other individuals with trauma to long bones had evidence of malalignment causing limb shortening of varying degrees. Two males, with poorly aligned fracture of the tibia and fibula and severe shortening of limb, had degenerative changes and pronounced muscle attachments in the shoulders, arms and hands. These changes to the upper body could suggest that they had been walking with crutches and thereby compensating the weight with their upper body.

The high frequency of poorly aligned fractures may suggest that the majority of the individuals could not afford or did not seek proper treatment. It could also imply that proper treatment was sought but was done poorly resulting in malalignment. However, a more detailed analysis of the socio-economic status of these individuals would be required to justify such a statement.

Other evidence of medical treatment taking place is seen on the two individuals who had undergone amputations of the legs. One patient did not survive the operation, while one had survived a few weeks to months prior to death, as seen by the slight remodelling of the remaining limb part. Amputation is one of many techniques that have been used by surgeons through millennia either due to injury during warfare, punitive action against a criminal or captive or as a surgical amputation for therapeutic reasons (Waldron 2009: 158; Ortner 2003: 168). The latter is likely to have been the cause for both of these individuals. Further medical treatment is evident in the individual having a hip-prosthesis. The model of the prosthesis indicates a more recent burial (after 1960) and the lack of bone healing around the prosthesis indicates that the patient did not survive many days after its placement. It is likely that complications may have followed the operation, which resulted in death.

A case of mastoidectomy, a surgical intervention of the mastoid process, was observed on a mature adult female (SB4253). Whether the operation was due to an ear infection cannot be determined at this stage, but can be investigated in the future.

Surgical tubes that were found in several individuals indicate that they must have been hospitalized prior to death. The surgical tubes found in one female (SB13708) seemed to be protruding through the abdomen (anteriorly). One tube was pointed inferiorly through pelvic outlet. These are likely to be from an operation for drainage of pus or urine. Another female had a surgical tube found in the pelvic region, but no particular direction was able to be observed upon recovery. What the cause of this hospitalization or the cause of death is not possible to infer from the skeletal remains, but may be possible to investigate if a positive identification can be made in the future and medical records still exist.

Autopsy

Autopsies have been performed in Denmark since the 17th century to establish causes of death (Thomsen 2004). The demographic data shows a prevalence of 4.5% among the assemblage, with females having the highest frequency. Many autopsies were performed for educational purposes, while forensic autopsies

were performed in cases of sudden or unexpected deaths. Pathologists mostly focus on the soft tissues unless damage to the bone is evident. It is at this stage not possible to differentiate pathological from forensic autopsies. Not even the case of ballistic injury of the male mentioned above which had been autopsied was subject to a forensic autopsy. This became evident from the death certificate and available autopsy report. Further studies on the autopsied individuals is required, where the osteological observations may be compared to the autopsy report i.e. the observations made by the pathologists at the time.

Congenital defects

Congenital defects cover a range of abnormalities that are present at birth or manifest themselves later in life due to faulty development. Amongst the more common defects seen in this assemblage are minor variations in the number or form of ribs and vertebrae. The majority of congenital defects observed would have been asymptomatic and would not have affected the daily lives of the individuals. In fact it is quite likely that most would have been unaware of their existence. However, there are a few exceptions. Having cranial deformities may have had an influence on their psychology as well as social life, especially the adolescent with Crouzon's syndrome. Crouzon's syndrome affects vision and hearing sensations which can lead to almost blindness or deafness. Furthermore, it can influence the respiratory system and cause eating problems. This together with the somewhat abnormal physical appearance must indeed have caused both psychological and social difficulties. While medical treatment is possible today, it is doubtful if such was available at the time. Depending on severity, survival into adolescence and adulthood would have required full medical care and not least family support.

Hallux valgus was observed in one individual. In the 19th century, the prevalent understanding of the bunion—hallux valgus—was that it was purely an enlargement of the soft tissue, first metatarsal head, or both, most commonly caused by ill-fitting footwear. Contrary to common belief, high-heeled shoes with a small toe box or tight-fitting shoes do not cause hallux valgus. However, such footwear does keep the hallux in an abducted position if hallux valgus is present, causing mechanical stretch and deviation of the medial soft tissue. In addition, tight shoes can cause medial bump pain and nerve entrapment. It is more than likely that the observations made at Assistens is an underrepresentation of the actual prevalence. As with many unnoticed conditions, poor preservation and/ or missed observations due to the analysis approach is a probable cause. It has not been possible to quantify rib deformity resulting from wearing of stays or corsets. The most obvious cause has been poor preservation of ribs.

Nutritional disorders

As mentioned earlier, undernourishment or malnutrition could have crucial impact on mortality, especially among infants. Besides increasing the susceptibility to infectious diseases, food intake affects metabolic rate, body growth and maintenance and metabolic disorders. Evidence of vitamin deficiencies (vitamin C and D) is present with the infants and children among the most affected. Such metabolic disorders were not uncommon, especially during the industrial period with the dark overcrowded city and lack of sunlight and sufficient nutrition. The living conditions and food availability that are responsible for producing any of the deficiency diseases will almost certainly pre-dispose an individual to other deficiency diseases. It would not have been uncommon for an individual to suffer from more than one condition. Vitamin D deficiency is primarily caused by a prolonged lack of exposure to sunlight and/ or dietary deficiency of foodstuffs containing vitamin D. Although there are a number of rare hereditary conditions that can result in severe

skeletal manifestations of vitamin D deficiency (Brickley & Ives 2008: 81), it is likely that the prevalence of vitamin D deficiency in this assemblage is attributed to deficiencies of sunlight and dietary practice. The majority of individuals affected by vitamin D deficiency (rickets) were young children (between one to two years old) and one child of *c* nine years at the time of death. The adult version of vitamin D deficiency, osteomalacia, was observed in one adult female. What the socio-economic status or time period these individuals belong to is not yet clarified. Rickets and osteomalacia are not just diseases of the past, but are continuous problems today due to cultural customs or the lack of exposure to direct sunlight.

Vitamin C comes from wide ranges of foods especially citrus fruits and vegetables such as potatoes and cabbage. Both potatoes and cabbage were common foods in Denmark, especially among the poor. However, until a child is able to feed on solid food it relies heavily on the nutrients received from its mother. Either through the placenta while still in the womb or through breast milk. If the mother herself is undernourished while being pregnant, this deficiency can in severe cases affect the foetus that will be born with this deficiency. Some women preferred having a wet nurse instead of breastfeeding themselves. Due to social pressures it was not uncommon for unmarried women to hand over their newborn to foster parents. For these children, this often meant that they were fed on pasteurized or condensed milk (Johansen 2002: 86). It was not until the early 20th century it was discovered that the processing of pasteurized milk destroys the small amounts of vitamin contained within it and that cow milk contains insufficient sugar and C-vitamin and too much protein and mineral salts for an infant (Bradley & Parish 2009). In the 18th and 19th century, scurvy was common in the wealthiest families who could afford to feed their children on fashionable formulas including pasteurized and condensed milk (Johansen 2002). If the infants with observable skeletal changes consistent with vitamin C deficiency were fed on pasteurized milk, or the mother was undernourished this may explain the prevalence seen at Assistens. There are still questions concerning the identity of these children, which the archaeological and historical records may shed light on in the future.

Dental enamel hypoplasia, radiographic Harris lines in the long bones and porotic lesions of the skull (cribra orbitalia and porotic hyperostosis) have all been observed among the assemblage. These skeletal manifestations, however, have a multifold aetiology, which cannot solely be attributed to metabolic disorders. Nevertheless, enamel hypoplasia (observed in 42 individuals), Harris lines (observed in 19 individuals) and porotic lesions of the skull (cribra orbitalia and porotic hyperostosis, observed in 34 and 12 individuals, respectively) are all skeletal pathological markers associated with malnourishment and metabolic stress. Except for enamel hypoplasia, the skeletal traces of the condition often disappear once reaching adulthood. This is of course, if the child recovers from the condition. However, in this assemblage the majority of individuals with Harris lines and cribra orbitalia were in fact adults. Cribra orbitalia is often associated with iron deficiency anaemia. Low maternal iron status can cause iron deficiency in the infant. And just as today, a malnourished child in the past was unlikely to be deficient in just one single dietary element. As we have seen in this assemblage it is also associated with rickets and scurvy. The lack of iron in the diet in the 19th century might account for the cribra orbitalia evident in the adult remains. But, apart from an iron-deficient diet, excessive blood loss through injury, chronic disease such as cancer and parasitic infection of the gut probably had a large part to play during this period. The majority of the affected individuals had healed cribra orbitalia, indicating recovery from the condition. Harris lines are an indication of arrest in growth and represent periods of stress. Nutritional deficiencies or other childhood diseases have been implicated as causes (Roberts & Manchester 2001). For a line to appear the individual has to have recovered from the stress period, i.e. a person continually malnourished and diseased will not display

Harris lines. They are in effect “recovery lines” (Roberts & Manchester 2001: 176). Because of the constant bone turn over that takes place during life, the Harris lines should, in theory, disappear into adulthood. Why so many adult individuals show Harris lines, therefore, needs further investigation.

Osteoporosis was another prevalent metabolic disorder observed in 9.3% (42 adults). It is a condition often linked to increasing age and hormonal changes (particularly in women after the menopause). It was therefore not surprising to find the majority of affected individuals among the females in the mature and old adult age group. However, it can affect both sexes as seen in this assemblage and not only be due to age and hormonal changes. Diet, lack of exercise, prolonged lactation and a high number of pregnancies, smoking, caffeine and alcohol all have their part to play. For example the prevalence of osteoporosis noted in a middle aged female (*c* 33 years old) may be associated to prolonged lactation and high number of pregnancies, while osteoporosis observed in the three males, may besides age be linked to their lifestyle. This link needs further investigation.

Neoplastic disease

A major health problem frequently seen today, but scarce in the archaeological record is neoplasms. Few cases were seen in the assemblage. The disease affects both soft tissue and bone, but is often too aggressive to manifest on the skeleton. It takes many forms, but characterized by uncontrolled growth of tissue cells, commonly known as tumours. Both malignant and benign forms were seen at Assistens. Button osteomas were observed on the cranial bones of four individuals. These would have been symptomless and would have had no consequence in daily life. A few cases of malignant neoplasms, however, were noted. One individual, especially, displayed a possible case of osteosarcoma, which is likely to have been secondary manifestation of a tumour from the ovaries, cervix or kidney. Since osteosarcomas are so highly malignant, the absence of, or belated, treatment would result in an early death. A number of individuals displayed bone cysts, osteoblastomas and other unidentified malignant neoplasms, that in future research requires further attention.

A number of miscellaneous conditions were noted including Paget’s disease. Paget’s is rare in the archaeological record (Roberts & Manchester 2001: 184). This might be due to the fact that it can only be recognized (macroscopically) in the later stages of the disease. Pagetic changes might be detected in earlier stages if bones are routinely x-rayed. The diagnosis of Paget’s in this assemblage observed in two individuals (one male and one female), was indeed aided by the use of radiographic imaging.

General discussion and conclusions

The osteological examination of the remains at Assistens has revealed much detail about demography, health and disease of the 19th and 20th centuries. We know from historical sources that by mid 19th century, extreme poverty afflicted the working class in many areas of Copenhagen. The infrastructure could not keep in pace with demand, leading to poor environmental standards and air pollution was beginning to become a chronic problem (Johansen 2002). However, to what degree the industrialization and the socio-economic means had on the human health in Copenhagen as seen from the skeletal remains and to what extent the health is different or similar to contemporary urban and rural populations in Denmark as well as Scandinavia and Europe needs further investigation. Assistens is the first cemetery to be excavated in Denmark dating from the industrial period up to modern times. Therefore, there is very little contemporary skeletal material from Denmark available for comparison. The most recent material stems from the 18th century at St. Olai Church in Helsingør (Bennike 2002), the 17th to 19th century cemetery of Holmens Church

(Jørkov 2014) and the 19th century hospital cemetery at Farimagsvejen in Copenhagen (Winther 2010). Nevertheless the material from Assistens holds an immense research potential. The osteological investigations reveal diverse pathological conditions. The majority, not surprisingly, involved joint diseases with degenerative and arthritic changes as the most common affecting the spine and knees in the females and spine and shoulders in the males. Joint diseases are not specific for urban populations, but a common disease. Infectious diseases are also presented, despite many infections and epidemic diseases going unattended in the skeletal record. Although the historical records indicate tuberculosis was not only present but a major cause of death, the skeletal evidence presented in only one individual is suggestive of its presence, but was not dominating (at least not in a form that can be observed skeletally). However, it should still be considered, that pathological conditions that are not observed does not exclude their presence entirely. Especially individuals from epidemics, such as tuberculosis, may have been buried elsewhere.

The population suffered extensive dental disease. Caries lesions (cavities), calculus deposits and alveolar abscesses were all observed. Many teeth were lost during the lives of the individuals as a result of these disease conditions. For those who could afford it, teeth had restored with fillings, veneers or root treatments, while others had their missing teeth replaced by dentures.

Relevant questions that arise when analyzing the prevalence of pathologies in a skeletal assemblage is how many individuals were treated and recovered from a specific disease and how many were not affected at all? Recent statistical studies show that females more often seek medical treatment than males, which to some extent is why they also outlive the males (Vedsted 2007). Some of the chronic conditions may represent lack of treatment or simply that the patient was not treated properly.

Osteologists usually lack any direct (and independent) evidence of behavioural attributes of earlier societies and therefore often seek out other sources for such detail (i.e. historical/ethnohistorical records). However, it should readily be apparent that this form of documentation is almost always inadequate to the task, as it lacks both the necessary precision and specificity.

The extent of historical information that is available may reflect interests at the time, and such information needs critical evaluation. These are usually too imprecise to offer much in the way of rigorous insight and cannot provide an adequate means of independently testing the influence of behaviour on skeletal response. For example due to public health concerns, abundant evidence may be available on the impact of disease on a population, yet precise disease diagnoses or information on the impact on subgroups of the population may be lacking. Historic sources may document aspects of emigration or mortality yet they need to be interpreted in consideration of complex factors that may be relevant. For some recent historic contexts, there are, however, a few notable exceptions in which the quality of documentation has allowed a means of testing certain behavioural relationships. In particular, the Christ Church, Spitalfields site (Molleson et al. 1993; Cox 1996), St. Martins (Brickley et al. 2006) and the Mary Rose ship (Stirland 1991; 1997) in England. Nevertheless, the osteologists must always use the historical sources with caution and critically evaluate whether they provide an independent test (from that of the skeletal material) to verify either general or specific relationships. The osteological data has so far only been presented and evaluated as crude prevalence rates. Nevertheless, it has given us a valuable insight in to the potential information the material holds for future study.

The people and society

While the previous chapter has examined the results of the osteological data this chapter, although only a preliminary study of the available evidence, aims to place this work within a social context. During the period that the cemetery has been in use Copenhagen has expanded greatly, drawing in people in from the countryside to an expanding urban city with the lure of work in the factories, warehouses and construction industry of the Danish industrial revolution whilst staying the centre of the Danish intellectual, cultural and political classes (Hyldtoft 1984). In the 20th century though many of the factories and heavy industries are gone Copenhagen has still grown, drawing in people from not just across Denmark but from around the world (Johansen, 2002). Part of the project's aims was to see if it was possible to identify these demographic changes over time and how urban life and culture is represented archaeologically. The reliability of demographic reconstructions is dependent on the accuracy of the osteological data and the degree to which the excavated remains are representative of the once living population. It is known that not all members of Trinitatis Parish were buried at Assistens. Other individuals may never have lived there at all, for example one individual for whom some historical data was available was born on St Croix in the Danish West Indies and died at 20 years of age in Lockstedt, Germany. It is very possible that he had never visited Copenhagen until his body was brought there in a coffin. The historical data available, concerning individuals, the local area and the country as a whole at this time, allows such factors to be taken into consideration when drawing conclusions from this excavation. However, calculating demographic indicators based upon the skeletal data, even from a cemetery with good historical records, is likely to be fraught with inaccuracies (Corruccini *et al.* 1989). It is, therefore, of interest to see where combining archaeological, osteological and documentary data is able to aid our understanding of demographic, social and cultural changes in Copenhagen. It is hoped that these initial interpretations can be used as foundations and expanded by further research in the future.

The affects of industrialisation and urban growth on health

Stature over time

While the height of individuals within a given population may vary markedly, the average height of a population, and its changes over time, can indicate patterns in health and lifestyle. An adult's height, as well as being reliant on genetic factors, can be affected by environmental conditions while the individual is still growing. Therefore, changes in the average height of the population over time could represent changes in health standards and living conditions. Evidence of stature variation over time in Dutch males, for example, suggests that it is possible to link the health and wealth of a population with average stature (Maat 2005: 287). However, there is a danger in assuming general trends in economic growth will be neatly reflected in average stature values as the financial benefits of economic growth are not necessarily evenly shared throughout all groups in society and increases in national wealth don't necessarily mean an improvement in health and nutrition. It has been shown that average stature can actually decrease at the beginning of the industrial revolution despite a rise in average income before increasing again beyond previous levels. Known as the "antebellum puzzle" this was first noted in a study of data from military records at the time of the American civil war (Komlos 1987) and has subsequently been identified in Europe in other early industrial societies (Sandberg & Steckel 1987, Komlos 1993). This may be due to an increase in disease in densely populated urban environments and the increasing availability of long distance transportation, aiding the spread of disease. Other explanations include a decrease in protein in the diet

(Komlos 1987). To see if this was true at Assistens cemetery all individuals that could be identified with an age, date of burial and had stature measurements recorded were separated by decade of birth (burial year minus age at death) and sex; each group then had their average height calculated. There were only 66 adult males and 91 adult females whose birth year could be calculated and had their stature recorded (Table 86).

	Male		Female	
Decade of birth	**Average height**	**No. Individuals**	**Average height**	**No. Individuals**
1760s	-	0	1,56	2
1770s	-	0	-	0
1780s	-	0	-	0
1790s	1,79	1	1,57	2
1800s	-	0	-	0
1810s	1,76	3	1,61	5
1820s	1,72	3	1,64	5
1830s	1,71	11	1,56	9
1840s	1,72	15	1,62	8
1850s	1,69	12	1,61	17
1860s	1,73	7	1,62	9
1870s	1,72	4	1,59	13
1880s	1,73	6	1,60	9
1890s	1,72	3	1,65	2
1900s	1,76	1	1,63	1
1910s	-	0	-	0
1920s	-	0	1,66	1

Table 86 Average height (m) of men and women by decade of birth

The data does not contain evidence that there was any significant change in the average male height during the course of the 19th century. The male heights do though suggest this population was taller than the average Dane of the same period. Danish military recruits of the time had an average height of 1.65m and 1.68m in the periods 1852-56 and 1896-1900 respectively (Danmarks Statistik in Forsvaret n.d.). If these recruits were approximately 20 years old they can be compared with the men born in the 1830s and the 1870s where the average heights are 1.71m and 1.72m respectively. However, the stature difference between the Assistens males and the conscript height may also be associated to the method used for estimating stature from skeletal remains (The method by Trotter (1970) is based on American white soldiers of various socio-economic backgrounds who died during the WWII and the Korean War and therefore not genetically nor environmentally or socio-economically compatible to the Assistens individuals). The data shows no significant difference in average female height during the 19th century in this population. However, the limited sample sizes from the cemetery data makes any inferences unconvincing and more identified individuals are needed to draw any worthwhile conclusions.

If the individuals buried in the lines of single grave are treated as a separate population then it is possible to compare their stature with that of the rest of the excavated individuals to see if there are any significant differences between the two. There were 26 adult males in single graves who had stature recorded, the average being 1.70m. This compares with an average of 1.72m for the rest of the adult males. There were fewer women from single graves with stature measurements recorded, 15 in total with an average of 1.60m as compared to 1.61m for the rest of the women. However, these differences are statistically insignificant (based on an independent samples t-test).

There is no evidence from the current stature data indicating a worsening or improvement in the living conditions or general health of the burial population over the period of the cemetery's use. It should also be noted that while there is no sign of a change in average stature to coincide with the increasing urbanisation of Copenhagen in this period, this urbanisation means that many individuals in the sample will have grown up in a non-urban environment. It is not possible to tell which individuals were born in the city and which grew up in the country, exposed to considerably different environmental conditions during their developing years, then moved to the city in later life.

At the beginning of the 19th century Denmark had a mainly rural population with 80% living in the countryside and Copenhagen being home to 10% of the population. In the second half of the 19th century Denmark saw rapid economic and urban growth with industrialisation concentrated in Copenhagen. Between 1800 and 2000 Copenhagen's population rose from little more than 100.000 to more than 1 million, 19% of Denmark's entire population (Andersen & Engelstoft 2004: 56).

Changes in living conditions, resulting from the increasing industrialisation and urbanisation, and changes in health care are not represented by the average stature data, so far examined, available for this population. Stature measurements are not the only indicator for such changes however. The data presented here is still too limited to warrant any conclusions. Further investigation of stature among the Assistens assemblage can be found in Jørkov (2015).

Age profile

As well as searching for improvements in health through stature the life expectancy and number of individuals reaching old age are also signifiers of the overall health of a population. When individuals were separated by age and date of burial there was a clear trend for an increase in the percentage of the population reaching old age (defined as 56 years and above) over time (Fig 115). This suggests a steady improvement in health over the last 200 years. In an industrialised city such as Copenhagen this may be seen as a sign of improvement in working conditions but those laid to rest in Assistens Cemetery were not generally thought to be paupers who had suffered the worst conditions in the factories of Denmark's industrial revolution. Instead the historical registers suggest that they tended to be middle class. Therefore, the improvement in health demonstrated is more likely due to a reduction in, and better treatment of, disease than a lightening of the physical burden of everyday life. The ages used for this comparison were the osteological assigned ages. A number of individuals were identified and their age at death was different from the osteologically assigned one, generally higher, in about a third of cases. This could also be the case for some of the unidentified individuals. This tendency to underage old individuals has been noted in other osteological studies and is not unique to this project (Molleson *et al*. 1993: 169).

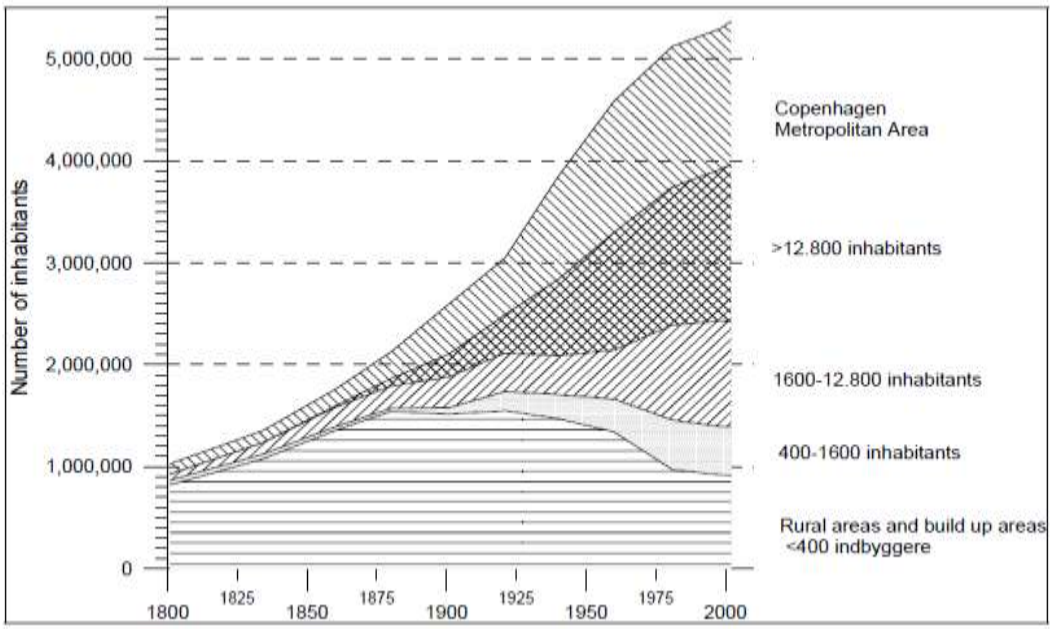


Fig 115 Percentage of aged individuals reaching old age over time (Procenten af alderbestemte individer der opnåede høj alder (56 år eller derover))

When the age demographic of the adult population is looked at, there is a spike in deaths in the age range 46-55 years in all periods (Fig 116). Similar results can be seen in other urban cemeteries of a similar period, such as the 18th and 19th century cemeteries at St Marylebone (Miles *et al.* 2008: 104) and Spitalfields (Molleson *et al.* 1993: 22), both in London. However, there does appear to be evidence that the young adults are becoming healthier over time, or that medical treatment for this age group is improving. This, however, cannot be viewed as a reason for a higher proportion of deaths in this period being of old people. For example an old person dying in 1920 say, is not a beneficiary of better health of young adults at this time, but rather a survivor of conditions young adults were exposed to in the mid-late 1800s. It should be remembered then that when trying to infer demographic trends in the living population from the evidence of the dead that populations are not stationary, mortality can be selective and that different groups within a society may be differentially susceptible to risks (Woods et al. 1998: 344). In this case it is known that Copenhagen was growing in population. This may be due to both immigration of rural inhabitants and changes in fertility rates.

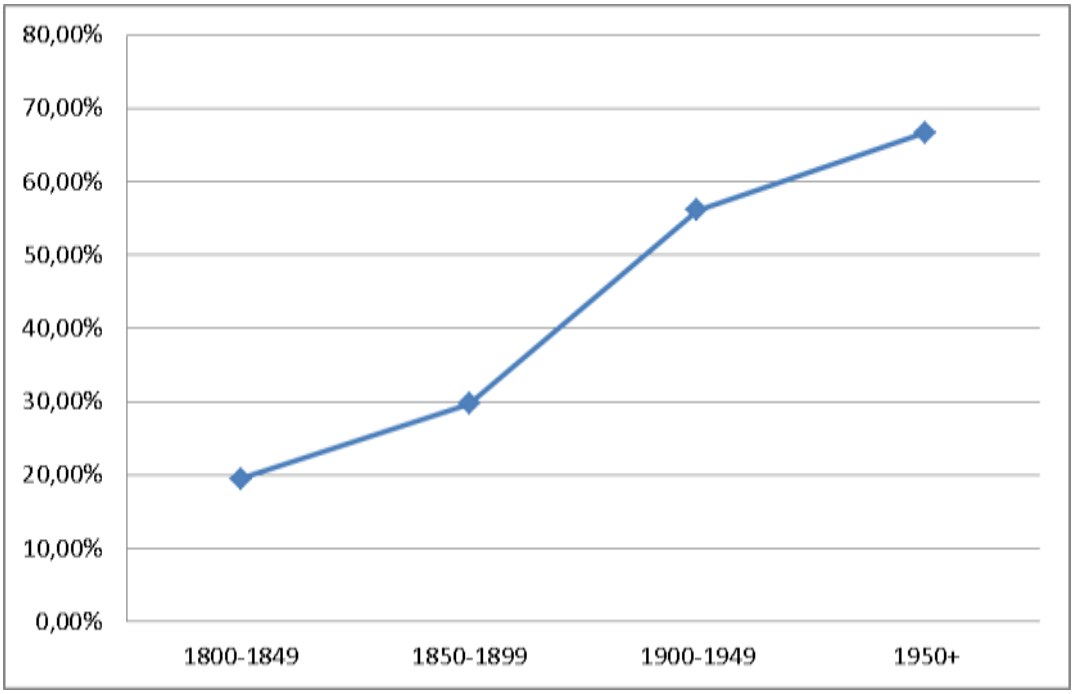


Fig 116 Age profile over time (Aldersfordeling over tid)

When the age profile of the cemetery population was separated into male and female profiles it was possible to see a clear variation between the two (Fig 117). Whilst both males and females had a spike in deaths in the mature range this was smaller in the females. The females also had two other spikes in age at death, one in the middle adult A range and one in the oldest age range. The spike in the oldest range shows that women are living longer than men on average with fewer dying before they get to at least 66 years of age and therefore women, once into adulthood, had a higher life expectancy than men. The first spike in the middle adult A range, the only other time the rate of female death is higher than the male, suggests that in this age range women are more exposed to some form of health risk that men are not. This could very likely relate to child bearing and is discussed in more detail below.

Children's health and infant mortality

By examining the children excavated at Assistens we can look for signs that the growth and changing nature and social attitudes of the city of Copenhagen had a negative or positive impact on their health. A comparative study of medieval and post-medieval child health from urban and rural cemeteries in England by Lewis (2002) indicated that industrialisation, and not simply urbanisation, was detrimental to children's health. It might be expected then that there would be evidence of worsening child health throughout the period of industrialisation.

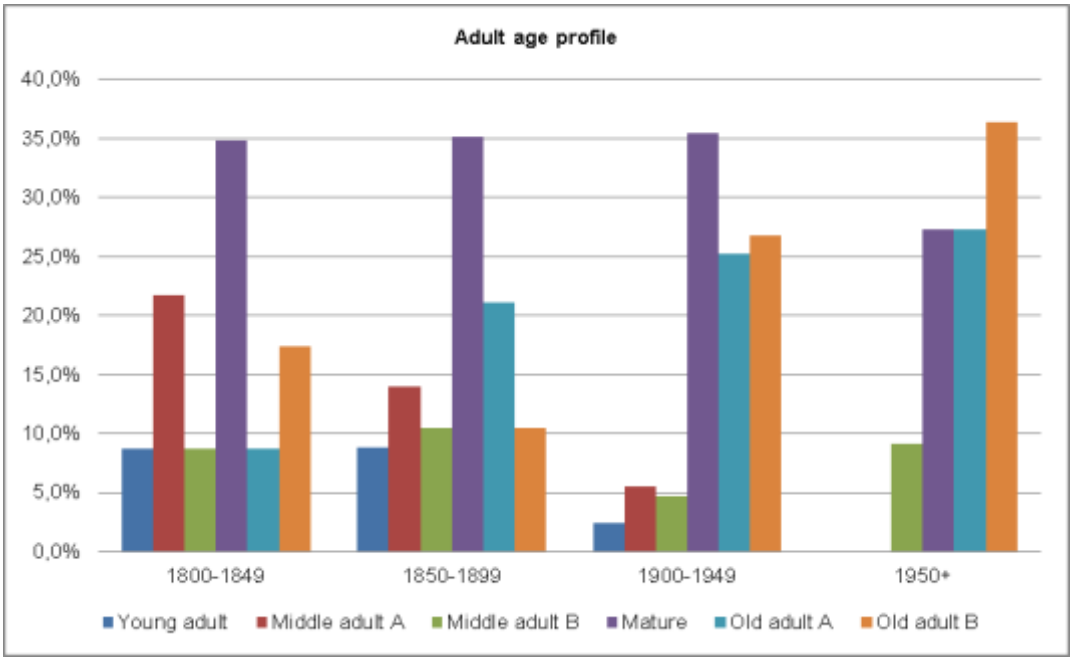


Fig 117 Age profile of men and women (Aldersfordeling for mænd og kvinder)

For the purposes of this chapter all individuals whose osteologically assigned age was less than 18 years have been included. There were 119 of these sub-adult skeletons recorded, of which 51 were infants (less than 1 year of age). Of these 119 only 43 could be dated, all but one of which came from the 19th century. Though this might look at first to be a sign that the 20th century saw a great improvement in the hygiene levels that children were exposed to and better health care available to them (Løkke 1998), the available data is too limited to draw any conclusions from (there were 76 undated sub adults). A near complete absence of any children from the 20th century would be odd even with improvements in health care and living conditions and it is possible that that their absence is due to changes in the spatial organisation of the cemetery. Many of the children excavated were located in a line of graves containing no adults. It is possible that once this designated children's area was full new child graves were placed elsewhere, outside of the excavation area.

While it is difficult to identify the cause of death in individual cases there were pathological indicators of ill health in a number of infants and juveniles, scurvy being present on 14 sub-adult skeletons and rickets on 4. Metabolic diseases such as rickets are a useful gauge of nutritional status of western European populations (Maat 2005: 285). Such conditions although often caused by poor diet were not restricted to the poorest in society. The weaning of newborns on formulas of less nutritional value than breast milk by wealthy families could be a contributing factor in the levels of rickets as Lewis (2002) suggests was the case with the children buried in the crypt of Christ Church, London. There was a lower level of rickets in the Assistens children than that from Christ Church (Molleson *et al.* 1993) suggesting breast feeding was more common among this population. There were though, higher levels of scurvy at Assistens implying that overall diet was poorer than in the children from Christ Church (Fig 118). This may be an indication that the population excavated from Assistens were less wealthy. However, without comparative data from rural Danish populations of the same period it is not possible to state how the children's health compared with what was typical nationally.

Fig 118 Child with scurvy (G1170) with rubber ball in left hand and blue plaster at head end of coffin (Barn med skørbug (G1170) og med gummibold i venstre hånd. Kisten havde gipsudsmykning i hovedenden)

Enamel Hypoplasia (EH) on the teeth can also often represent poor health or diet during childhood, although trauma or illnesses in otherwise healthy children can also cause it. As it is still visible in the teeth of adults it is possible to obtain some information from the entire cemetery population. The frequency in those individuals with some surviving dentition who demonstrated EH within the entire excavated population was 14%. However when the frequency was calculated for those individuals buried in single graves the figure was 30% whilst for the rest of the cemetery the frequency was only 11%. This could suggest that this single grave group had poorer levels of health in childhood than the excavated population as a whole. Again though, one should be wary of relating this to poverty. In one case a one and a half year old child with EH was buried in a well decorated coffin with a porcelain doll (G1090). It is also impossible to tell whether the adults displaying EH grew up in Copenhagen or migrated there from the countryside in older childhood or as adults as the population growth figures clearly show must have been very common.

There is no clear evidence for a change in infant death rates over time, though this appears to be due to spatial changes in the cemetery layout rather than a consistency in infant mortality observed in the sample. The overall infant mortality rate for this population was no higher than would be expected for the time. If the single graves do represent the earliest inhumations then there is some evidence for an improvement in health over time. However this cannot be linked to the affects of industrialisation as it is believed that these individuals grew up long before the start of the industrial revolution in Denmark.

Social difference

Lifestyle and occupation

The location and degree of pathologies present on the bones such as arthritis and the presence of enthesopathies (marked muscle attachments) are often used as a way of suggesting an occupation carried

out by an individual. Certain jobs, especially those requiring repetitive actions, can put stresses on particular joints causing greater levels of wear than usual. However, there are many other factors such as weight, sex and genetics that affect such pathologies and make it almost impossible to single out a specific profession as the cause. It may be more useful to view patterns of osteoarthritis across the entire sample population to examine trends in the types of joints that suffer most. This may work well in populations where a particular job or profession is dominant, such as within a hunter-gatherer community or an industrial community dependant on a primary industry, like a mining village. Those buried in Assistens though were employed in a diverse range of professions and thus any trends are unlikely to be due to one specific job. In some cases though, it has been possible to suggest an occupational link to a particular pathology observed on the skeleton. An 87 year old individual, who could be identified by name (G1447) had arthritis in the hands that the osteologists suggested could be related to an occupation involving frequent stress on the hand joints. The historical records showed him to have been a master joiner, a profession that would have involved frequent manipulation of materials with the hands. However, his advanced years may also have been a significant contributing factor.

The difficulty of identifying an individual's profession, or even social class, from the pattern of pathology observed on their skeleton is illustrated by the cases of Jørgen Hansen (G1227) and William Borberg (G646). There were markers on the skeleton indicative of heavy physical labour in both cases, however, historical records show that Jørgen Hansen was a *partikulier,* someone who lived off a trust fund and that William Borberg was an ambassador. It is possible then that their pathologies were the result of poor health, excessive weight or even particularly strenuous pastimes.

One identified individual (G1146) was a master joiner who died in 1915, may display evidence of the dangers inherent in many people's working life. The examination of his skeleton showed that he was missing fingers from his right hand (see Fig 65, SB57805). The loss of the fingers was clearly the result of some form of accident rather than a medical procedure due to the damage caused to the rest of the hand and the general lack of clean cuts to the amputation. It is tempting to view this accident as some form of industrial accident and, while many other explanations could be suggested, his job as a joiner makes it a highly plausible suggestion.

Long-term illness

Sometimes specific and uncommon pathologies give an insight into an aspect of an individual's lifestyle. They may be signs of a long-term disease or trauma that severely restricts the individual's ability to go about his or her day to day life in a normal manner. The person may have had to rely upon help from family or other members of society to help them get by and their symptoms or disfigurement may have affected the way in which others interacted with them. There were a number of individuals found at Assistens for whom this would have been the case.

A woman of about 40 years of age was found with signs of tertiary or late stage syphilis (G1219). Syphilis is normally a sexually transmitted disease and for it to have advanced to the late stage it is likely to have been untreated. The physical symptoms were so severe that they would have been noticeable to others and a cause of discomfort and pain to the woman. This may well have affected how society treated her, it is possible that she was ostracised due to the stigma of having a sexual disease. Her coffin was plain with no elaborate decoration outside or in and, although many of the coffins found were like this, there is no sign of excessive care or financial output in the burial.

Another individual, an adolescent of about 15 years of age (G365) not buried in a family plot, suffered from Crouzon's Syndrome, a craniofacial abnormality which causes disfigurement of the head and face. This would have affected their social interactions with others, especially strangers, who would immediately notice an unusual appearance. It is likely that the individual would have needed some level of care during their life. Whether this help came from family or a nurse, in the home or a special institution is unknown. However, when death occurred money was spent to give this individual a resting place in Assistens and so it is likely that family members took an interest in the individual.

A man of about 32 years (G813) was identified as suffering from brucellosis, a disease often caused by consuming milk from infected cattle. The muscular pain and sweating that are symptoms of the disease would have caused great discomfort and likely have restricted his ability to work, carry out a normal life and ultimately may have caused his death.

A man buried in a metal coffin (G1508) suffered such severe ankylosing spondylitis, causing much of his spine to fuse together, that his hunched over stance meant he could not be fitted into his coffin properly and had to be laid to rest face down. Such extreme fusion and curvature of the spine, along with fusion of a number of other skeletal elements, mean that even normal activities such as walking would have become difficult.

These cases indicate how the archaeological record can give insights into aspects of individuals' lives as well as how society treats those with debilitating diseases and disabilities. Despite their conditions, all these people received a burial in Assistens, with the cost and organisation needed deemed appropriate.

Indicators of wealth and status

The funeral material culture can be used to analyse if there was a link between elaborated coffins and coffin furnishing and wealth or status.The metal lined coffins numbered 40 in total and though they were found all across the site there was a small concentration in the area north of the gravediggers' house (Area 4). These coffins would have been more expensive to make and purchase suggesting that they indicate that the individual laid to rest in one, or their family, were relatively wealthy in comparison to the rest of the cemetery population. Of those buried in the zinc coffins 17 could be identified (see Table 87). The profession of some of these individuals was known, though in the case of the women none of whom had recorded professions, however, the profession of their husband and father were known in a number of cases. From these professions we get an idea of the social position and potential wealth of the families, albeit this can only give a rough indication. The majority appear to conform to the relatively well-off middle class.

Group No.	Age at death	Year of death	Profession (or that of husband/father)
826	22	1910	Engineer (Ingeniør)
753	20	1872	Merchant (Købmand)
15	65	1933	Manager (Forvalter)
1413	78	1894	
640	42	1897	
1472	84	1928	Merchant (Købmand)
532	89	1916	Doctor (Læge)
458	72	1911	Doctor (Læge)
191	66	1921	Naval Commander (Kommandør)
1007	92	1945	Lieutenant Colonel (Oberstløjtnant)
258	85	1927	Draper (Manufakturhandler)
35	69	1889	Gardener (Gartner)
356	42	1950	Silver Smith (Sølvarbejder)
799	52	1904	Merchant (Grosserer)
1464	75	1929	Master Joiner (Snedkermester)
556	78	1916	Spice Trader (Urtekræmmer)
1006	78	1970	Ship Broker (Skibsmægler)

Table 87 Identified individuals in zinc coffins and their professions

When the average heights of the individuals buried in metal coffins were compared with the population as a whole there is a difference. From nine individuals sexed as male the average height was 1.74m as compared to 1.72m for the entire sample. For the 21 sexed as female the average was 1.62m as compared to 1.61m for the entire sample. Statistically speaking these differences are meaningless due to the tiny sample size of the individuals buried in zinc coffins, however both the tallest male and the tallest female excavated on site were found in zinc coffins. This lends some small amount of weight to the argument that those wealthy enough to afford a zinc coffin were healthier, in terms of their childhood diets at least, than the sample as a whole.

Of the 40 zinc coffins four had an inner zinc coffin as opposed to a sheet of zinc sandwiched tight between two planks of wood all forming a single solid structure though the lid was nailed closed. The four with inner zinc coffins would have remained air tight even when the outer wooden lid was removed. This could be due to a desire to avoid the smell and hygiene issues of decomposition and, therefore, suggests that the individuals buried in them had to wait longer than usual between death and burial. Of the four, two were identified and both are known to have died outside of Denmark (a young man near Hamburg, Germany and a young woman in Berlin, Germany) and their bodies were transported back to Copenhagen. The transportation of these coffins would require even more money and, therefore, reinforces the wealthy status of the families. These cases also highlight a desire to return the body 'home' for burial. This may be a way of bringing the family together in death rather than simply wanting to be buried in native soil. The young man is known to have been born and raised in St Croix, in the Danish West Indies (now the US Virgin Islands), but a number of his family members were already buried at Assistens. So Copenhagen may not have been home for him, but plot 555 in Assistens cemetery was a home for the family. This suggests that the family plot is not just a practical way of securing a resting place for multiple members of a family, but is also borne of an emotional desire to keep ones family close in death as well as in life. The wealthier a family is the greater lengths they can go to to realise this desire.

‘Bad’ deaths

Two graves upon further investigation displayed evidence of ‘bad’ deaths. Both individuals had gunshots to the skull, suggesting suicide, but both were nonetheless buried within family graves in consecrated ground. Historically Christian tradition did not allow burial within consecrated ground for suicides. The elaborated coffins both were placed in do not reflect these deaths in any punitive manner; the material culture employed in both cases was still reflective of the status of the person or mourners rather than reflecting the manner of their deaths.

Newspaper accounts describe a 22 year old married woman (G826) shot by her lover in Berlin (Dagbladet 1910). There is no mention of her husband and her body was transported home and buried in her family plot with her married name pointedly not recorded. Considerable expense was employed on the coffin and transportation, but also in the external display of the coffin and the internal display of the body, with the hair arranged to cover the bullet wounds in the skull. Despite the scandalous end she was still treated with all the ritual and tradition the mourners could provide. Despite having a lover, who killed himself after her, and the possibility of a suicide pact she was still treated in an extravagant and social way. A funeral with ritual was indicated by the presence of pine branches around and outside the coffin indicating that a funeral committal was held with the usual and expected kinds of rituals.

Society’s way of dealing with suicide is exemplified in the treatment of a 39 year old man (G297). The accounts of his suicide (Berlingske 1913) are quite clear, and mention the possibility of bankruptcy. The autopsy report, however, reveals that he had severe stomach cancer which would only have allowed him to live for a few more weeks or months. There is no sign of elaboration on the coffin or personal gifts, but despite the bankrupcy the mourners and family still placed him in a plain and unornamented coffin but of good construction, within the family grave. The hay filling and the performed autopsy suggest that this person was not displayed in an open coffin. There was also a layer of pine branches on top of the coffin but it is not known if this was associated with his funeral rituals or of the overlying, later coffin.

Advances in medicine and hygiene

Development of hospitals and medical treatment

During the period that this area of Assistens cemetery has been in use the quality and availability of medical care has dramatically increased. Although hospitals had existed in Copenhagen since the medieval period they were in reality little more than religious run poor houses. It was not until the founding of the Royal King Frederik’s Hospital in 1757 that Copenhagen had a hospital by any modern definition (though the Royal Maternity Hospital for unmarried mothers was opened in 1750). However, the middle and upper classes still tended to avoid institutionalised care preferring instead to receive medical care in their homes (Vallgårda 1999: 98). In 1863 the large Municipal Hospital (Kommunehospital) was founded that accommodated a number of new specialities that led to improved care for a range of conditions. This had the affect of encouraging all classes to seek specialist care in the hospital rather than at home (Roed 2004: 133). In the later 19th and early 20th century other large, modern hospitals, such as Bispebjerg Hospital (1907) and Rigshospitaet (1910 – taking over from the closed Royal King Frederik’s Hospital) opened. It is interesting, therefore, to identify evidence of this development in medical care in the archaeological record. The types of medical care identified were varied. Evidence was present on a number of skeletons indicative of surgical procedures and a number of finds indicating hospitalisation were found in some graves.

Prior to the latter half of the 19th century surgery was carried out with no antiseptics or anaesthesia (Porter 2001:174). This would have made even procedures considered low risk today both very painful and extremely dangerous due to the chance of infection. There are two cases of amputation, both carried out in the 1910s, and in both cases the individual died shortly after the procedure. It seems highly likely that their deaths were the result of complications caused by the surgery, possibly infections. It is only possible to speculate as to the reasons that such a severe surgery was deemed necessary; they may have been due to massive fractures caused by a crushing accident or perhaps by a severely advanced infection such as gangrene. Five other individuals were found with rubber tubes suggestive of medical intervention. Why the tubes were not removed after death is unclear, it could be a sign that little time was spent on the preparation of the body before placing it into the coffin. They show that the individuals died whilst receiving some form of medical care, most likely in a hospital. We know then, that they sought professional help for some illness but that this help was ultimately unsuccessful.

In only one case was the fractured bone properly re-aligned. It is possible that the ability of doctors to reset broken bones was very limited but as this is a common and well-developed procedure by this period it is likely that other factors are involved. It is more likely that most people sought no professional help or that the individual did not rest to allow proper healing, perhaps the need to avoid losing income meant that people returned to work too soon after injury. The last possibility suggests that although care was available for initial emergency treatment to the broken bone, follow-up care was unavailable or too expensive for most people.

The individual with the hip prosthesis (G1510) brings the evidence of medical treatment up to the 1960s. Within the lifetime of the cemetery medical treatment had developed from poorly treated broken limbs to be able to conduct full hip replacements. The first full metal hip replacement was not conducted until 1960 (AAOS 2011) whilst the cemetery protocols show that this individual was buried in 1961. Therefore this operation must have been somewhat pioneering but the dates also show that the individual did not live for long after the surgery and may even have died during the operation. This procedure demonstrates the usefulness of medical interventions identified in the archaeological record as an aid to dating. Although there were burials found that dated to as late as 1984, there were no other joint prostheses or other forms of artificial implant found. This may be due to the popularity of cremation, rather than burial in later years.

At the current stage in research there is not enough evidence to chart the development of medical treatment over time or to see variation between different demographic groups; future research may hold great potential for further investigation. Relating these cases tell us much about individual lives. It is possible to identify traumatic events in a life and in some cases gain some knowledge of events leading up to death. These cases show that the archaeological record is capable of telling us about the experience of individuals as well as populations.

There were 20 individuals displaying signs that they had been autopsied. There is no evidence for autopsies prior to 1850, though two males buried in single graves had been autopsied. While the performing of an autopsy does not necessarily indicate that the individual was treated, or even died, in a hospital it does show that their body was taken to a hospital where post-mortem surgical procedures were carried out prior to burial. In all cases the top of the skull was reunited with the rest of the body and placed in its anatomical position for burial.

Whilst death becomes ever more medicalised the act of disposing of the body retains its spiritual and folk traditions. So where significant medical intervention has taken place leaving its mark on the body there

becomes a convergence of the scientific and the traditional, thus creating new problems in terms of the preparation of the body for burial. Where a part of the body has been removed shortly before or after death it must be decided whether or not this separated body part is still “of” the person and if so should it be buried with the person? If it should, how is this to be done? In the case of the autopsied skulls all were placed back in position on top of the head. It was not clear due to the state of preservation if the top of the skulls had been stitched back or held in place by other means, though in two cases newspaper was found inside the skull (G488, Fig 119). The newspaper may have been used to stop the top of the skull sliding off without stitches. However, in the case of one of the amputated legs, the leg was reunited with the rest of the body in the coffin but not in its anatomical position (G530, Fig 120). This could perhaps reflect social attitudes to the disfigurement of different parts of the body. The head and face were of primary importance in the social display of the dead but it is unlikely that the coffin containing the amputated leg was opened for mourners to view.

Fig 119 Newspaper (F200777) used to fill cavity of an autopsied skull (Avis (F200777) anvendt til at udfylde et obduceret kranie ud)

Fig 120 Torso (G530) with amputated leg (Torso (G530) med amputeret ben)

In a least one of the four cases where rubber tubes were found in the torso the tubes would have protruded out from the body. Assuming that the bodies were clothed when buried these tubes could have been hidden from view even with an open coffin suggesting that appearance was more important than the reality. It cannot be known whether these individuals had open coffins before burial but it is clear that the visibility and extent of the medical intervention would become a factor in the decisions the family of the deceased made regarding the funeral.

Maternal mortality

Though it is impossible to tell from the skeletal evidence whether a woman died in childbirth, by looking at the age at death of individuals a spike in deaths in the main childbearing period of women's lives may indicate that childbirth has been the cause of death for a significant number of individuals. The data from this excavation show that in both the young adults (18-25 years) and the middle adults (26-45 years) most individuals that could be sexed were male. However, when the middle adults were sub-divided into 26-35 years and 36-45 years there were significantly more women than men in the first group (31 women, 17 men). This had been disguised by a much greater number of men in the latter 36-45 years group. The only other adult age group with a higher number of women than men is those aged 66+ years. The likely reason then for the spike in female deaths, as compared to male ones, between the ages of 26 and 35 is conditions related to pregnancy and child birth. Similar figures are seen in other urban cemetery populations of similar date such as St Marylebone (Miles *et al*. 2008:104) and Christ Church in London (Molleson *et al.* 1993: 22)

There was not enough evidence to show a change in maternal mortality rates over time as there were too few relevant skeletons that could be dated. As the only period in life when women faced a higher chance of death than men (not including 66+ years) in this population is between the ages of 26 and 35, suggesting that this was the most common age range in which women were giving birth. While it may appear strange

that there is no noticeable increase in female deaths in the young adult group (aged 18-24 years) it is possibly because, despite it being very common for women to have children at this age, with many having large numbers of children in the 19th century, compared to modern day Danes, most of their children would have been born in the 26-35 age bracket.

If these extra female deaths in the age of 26-35 are considered as being due to childbirth then it is possible to extrapolate a figure for the maternal death rate in the population. This results in a relatively high rate of deaths and if the improved conditions of the 20th century are taken into account the figure for the 19th century would be higher still (Løkke, 1998). If the deaths of all the women that died beyond the number of men in this age group were related to childbirth and if the average number of children a woman had was seven (Ahlburg & DeVita 1992: 18), then the maternal mortality rate would be about 0.95% or 9.5 in 1000 (using the equation (100/f) e/n= mortality rate, where f= total no. females aged and sexed, e= the no. extra females in the 26-35 age range and n= an assumed average number of child births per woman). This figure (which is essentially the number of extra women who died in the 26-35 age range divided by an assumed average number of pregnancies) is meant as a rough guide rather than a definitive rate.

During the 19th century the prevalence of puerperal fever (also known as childbed fever) as a cause of death in women was high (Løkke, 1998; Johansen, 2002). Puerperal fever is caused by bacterial infection during pregnancy and labour but this was little understood until the late 19th century when scientific knowledge of germs and how they spread disease increased. The Royal Maternity Hospital was opened in Copenhagen in 1750 but this was not necessarily a safe haven for expectant mothers. There were at least two severe outbreaks of puerperal fever epidemics here in 1786 and 1791-2 (DeLacy 1989: 533). Although maternal mortality rates improved in the 19th century, hospitals of the time were still very dangerous places and rates in hospitals were seven times higher than those for home births (DeLacy 1989). Denmark was one of the last countries in Western Europe where deliveries in hospitals and clinics replaced home births and still by 1900 only a small amount of Danish women gave birth outside the home (Vallgårda 1996: 173). It was the work of the Hungarian obstetrician Ignaz Semmelweis that first proposed that puerperal fever was caused by poor hygiene standards, particularly particles from dead and decomposing bodies on the hands of doctors and students who had been present at autopsies being passed on to pregnant women they examined soon after. He collected data that showed hand washing by doctors could dramatically reduce the rates. However, without a clear scientific explanation as to why this was the case many of his contemporaries were resistant to his ideas. A particularly strident opponent to the ideas of Semmelweis concerning the role of hand washing in preventing puerperal fever was Carl Edvard Marius Levy, the head of the Danish maternity institution in Copenhagen in the mid 19th century. He wrote in 1848 "*... his [Semelwies'] opinions are too unclear, his observations too random and his findings too uncertain for him to draw any scientific conclusions.*" It is not possible to identify puerperal fever osteologically and there were certainly other complications, such as haemorrhage and eclampsia that would contribute to the maternal mortality rate. Social class is another factor that should be taken into account as the middle and upper classes were reluctant to use hospitals until the late 19th century so it was possible that puerperal fever was more common in poorer women. Unfortunately as there were no clear data relating the death rates in this group to dates it could not be shown that the high rate was reduced as hospital hygiene conditions improved. The repeated stress of multiple childbearing may also be a factor. At around the beginning of the 19th century women in the United States were giving birth to about seven children each with this number falling to 3.6 by the beginning of the 20th century (Ahlburg & DeVita 1992: 18).

Occasionally archaeological evidence suggests death in childbirth. In one case a woman of about 30 years of age was found with a young infant (G930), only 38 gestation weeks old, in the same coffin lying in her arm. As both individuals would have had to have died at very similar times to be able to be buried together, along with the ages of both, the most likely scenario is that this inhumation represents a mother and child who died during, or shortly after, birth. Another mother and infant were also found in an almost identical position (G1385). There were also two cases which showed that a woman had died while pregnant but possibly not due to issues related to the birth. Two women were found with a foetal skeleton located in the area of the womb (G815 & G819, Fig 121). In these cases the ages of the foetuses were identified as 19 and 29 gestation weeks, before full term was completed. In one of the cases the woman had rubber surgical tubes still *in situ* in her torso supporting the idea that a pre-existing medical condition or one related to the pregnancy rather than the birth was the cause of death.

Fig 121 A pregnant woman with in situ surgical tubes G815 (En gravid kvinde med operationsdræn in situ G815)

Dental care

With developments in dentistry and oral hygiene throughout the 19th and 20th centuries it was interesting to identify evidence of this archaeologically. The data also raised the possibility of recognising social and demographic variations in the attitudes to dental care.

The osteological results show some interesting differences in the oral health and prevalence of dental care between the sexes. More women had fillings in their teeth than men and partial or complete dentures were found with more than twice as many females as males. This may appear to suggest than women had poorer levels of dental health than men. However, the prevalence of caries, calculus deposits and abscesses, while similar in both sexes, is higher in all three for males. It appears then that women were more willing to visit a dentist than men. The reasons for this are not clear but could be related to social attitudes to beauty and the acceptance of bad teeth. It may also be that there was a fashion for extracting

all teeth and replacing them with prosthesis before medically necessary to avoid future pain and cost and to conform to the desired dental aesthetic.

Amongst both male and female we can see a clear increase in the number of partial or full dentures present over time (Fig 122). There is no evidence of dentures in burials prior to 1850. This shows that from sometime in the mid 19th century the availability and affordability of dental prosthesis to the people of Trintatis parish has greatly increased. What was almost unheard of has become relatively commonplace.

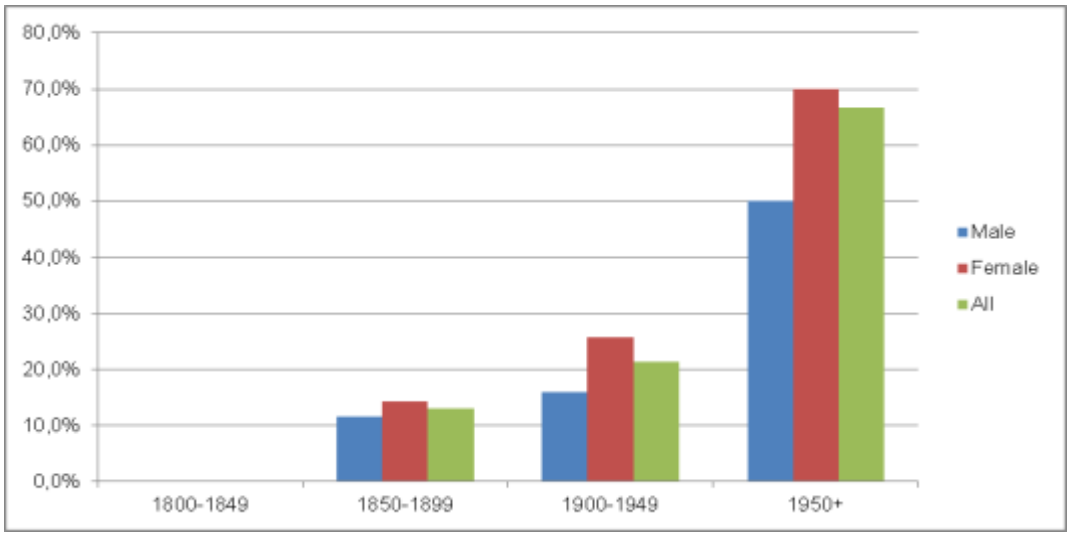


Fig 122 Percentage of individuals with partial or complete dental prosthesis over time (procentvis fordeling af individer med tandproteser over tid)

This increasing availability of dental care, however, did not lead men to completely overcome their reluctance to visit the dentist. The higher rate of dentures worn by women than men appears to be a constant over time.

Amongst those individuals that were considered to have been buried in single graves none had been buried with full or partial dentures and none had any filings.

Kidney stones

Diets high in protein and low in carbohydrates are known to increase risk of kidney stones (Gottlieb 2002). Prevalence rates in modern studies on this medical condition show that men account for 80% of cases (Coe, Evan & Worcester 2005). However, of the 22 individuals with whom stones were recovered, 18 were female and only three male (one was with an unsexed skeleton). It is necessary therefore to determine if this number is an anomaly in the sample population or in the recovery process. The stones recovered during the excavation tended to be relatively large, ranging in size from 3 to 136mm (of those with details recorded) and in weight from less than 1g to 960g (Fig 123).

There are number of different types of kidney stone but, the largest and fastest growing tend to be struvite stones, normally related to urinary-tract diseases. These struvite stones account for about 10-15% of kidney stones in general. However, unlike other types they are just as common, if not more so, in women as in men (NHS 2010). Struvite stones are formed of crystallised ammonium magnesium phosphate and calcium carbonate-apatite as opposed to calcium that most other stones are made of (Coe, Evan & Worcester

2005). It is a possibility, therefore, that many if not all of the stones recovered at Assistens were struvite stones. This may to some extent explain the significantly, and unexpectedly, higher number of women found with kidney/bladder stones.

Fig 123 Kidney stones from SB14460 (largest is 136 x114mm) (Nyresten fra SB14460 (største er 136 x114mm))

If this is the case then it shows that the recovery of stones during the excavation was biased towards large stones and therefore towards struvite stones. However, an analysis of the stones' chemical composition is needed before any definitive conclusions are reached. This would mean that archaeological data is likely to underestimate the presence of kidney stones in men even when poor recovery rates are taken into account. As this excavation was carried out by experienced professional archaeologists, albeit in frequently muddy, wet and snowy conditions, it is probable that this bias in recovery of larger stones is one that would be repeated in many other cemetery excavations. This has implications beyond this site and reinforces the need to take collection bias into account in future archaeological research.

Comparison of osteological age and sex with historical records

This section is an initial assessment based on the sample of those individuals that have so far been identified. It is a preliminary study only and does not take into account the possibility that there could be errors in the documentary data that was available or the process of identification.

A comparison was made between the known age at death of the potentially identified individuals and the ages they were assigned using standard osteological methods. The osteological methods assigned an age category and in some cases, where analysis was more difficult or less revealing, a broader category was given. Many individuals were also assigned a specific age based upon an average from the different techniques used by the osteologist. In many cases the process of identifying an individual involved

comparing archaeological and historical information with the osteological data. Therefore it is possible that some errors in the osteological assessment have influenced the decision of identifying individuals.
Of 283 identified individuals (33.1%, of 854 individuals) there were 200 cases where an age category could be compared to a known age at death. The assigned category was correct in 106 (53%) of cases and incorrect in 94 (47%).
Only 157 individuals had their age at death listed in the cemetery protocols and had also been assigned a specific age using osteological techniques. On average there was a difference between the two of 10.53 years. In 34 cases the osteologically assigned age was older than the real age, in 15 the assigned age was the same as the real age and in 108 cases the assigned age was younger than the real age.
The errors in specific age were then analysed depending on the age category into which they had been placed to see if there was certain age groups that were more accurately aged than others (Fig 124). This included only the most refined age categories as there was not enough information available from those placed in wider categories to estimate a specific age.

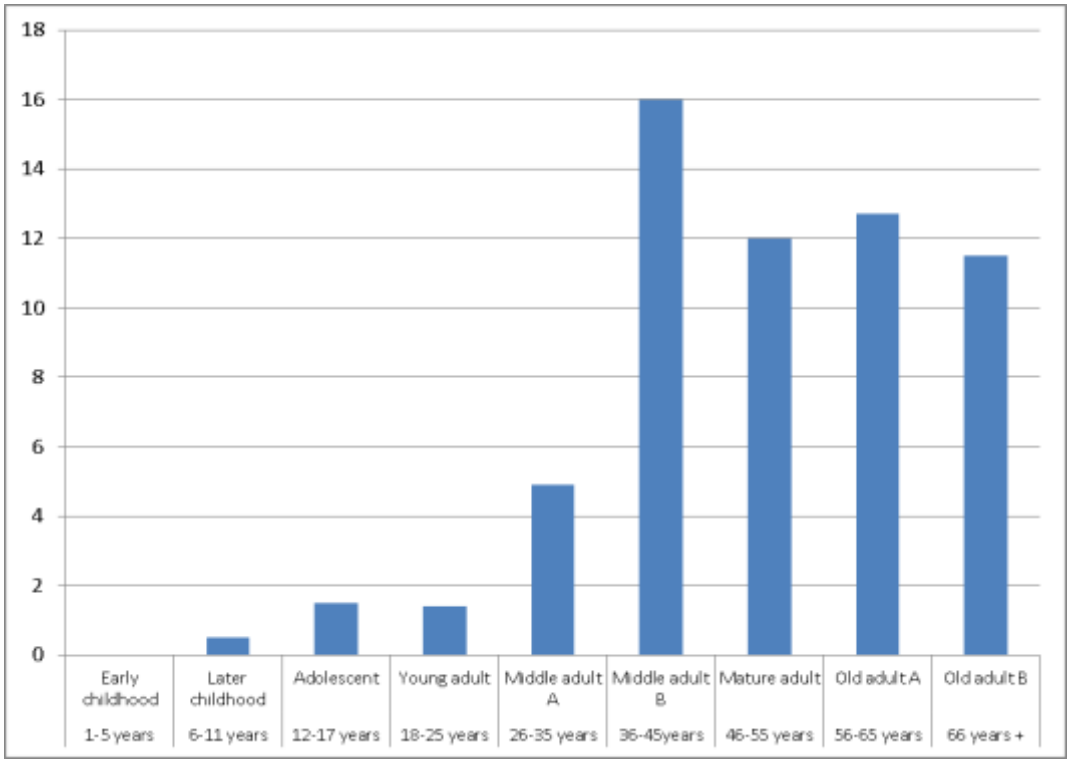


Fig 124 Average error in assigned age in years (Standardafvigelsen mellem den osteologiske alder og den i gravprotokollen angivne alder)

It is clear from these results that there is a tendency to under age old individuals, often by quite significant amounts. As growth finishes at maturity there is little continuing skeletal change to identify and what changes there are tend to be degenerative and not so well correlated with age (White & Folkens 2000) this result is perhaps not so surprising. A similar trend was noted from Christ Church, Spitalfields in London but in contrast, there was no evidence for the over aging of individuals under the age of 40 (Molleson et al. 2002: 169).
When the sum of each age category was recalculated to take into account the known errors the amount of individuals aged 66 years and over increased from 21% to 50% and the amount of individuals aged 46-55

years went from 31% to 9%. In the category between these two there was a change from 22% to 15%. If this pattern was repeated across all the individuals excavated there would be a much greater number of elderly individuals and much fewer middle aged ones. This would cancel out the spike in the number of deaths in the 46-55 years category.

No individuals sexed as strongly male or female were identified as the opposite sex. Of the 18 identified individuals who were sexed as possible female by the osteology, two were identified as male. Of the 12 possible males one was female and all the other 11 were male. Four had their sex identified as ambiguous (as opposed to unknown) of which three were identified as female and one as a male. These results suggest that there was no significant bias in osteological sexing of the excavated skeletons towards either male or female.

Identifying individuals and narratives

One of the aims of the project was to integrate the three different types of data: the archaeological, osteological and documentary sources to provide a broad narrative concerning all aspects of the cemetery. One of the tasks is to use these sources to identify individuals buried within the cemetery. This would enable the dating of the burial traditions and cemetery activities, adding a chronological narrative examining, for example, social class, migration or families. However identifying individuals brings more than a name back to the skeletons but helps to widen the potential for what can be studied with the skeletal material; testing methods and tracking changing nutrition, occupational patterns and documented diseases.

The history of cemetery excavations has meant that there has been an overdependence on skeletons, resulting in a narrative for cemeteries that prioritises them as the primary focus: that the sole aim of an excavation is to identify and excavate the skeletons. The Assistens project has aimed to do this important task but also to create a wider data set that broadens the knowledge not only of the bodies but also the material culture and the evidence of the actions and intentions that have caused the skeletons to be placed in the ground.

It is clear that some skeletons will never be identified. However with care many more could potentially be identified than the 33.1% that is discussed in this report. Still, this research requires a robust and critical approach towards all sources. It is not a simple matter of comparing the grave sequence with the historic protocols. The grave sequence has been proved to be altered, some coffins have been moved around, others truncated, some left *in situ*. There is no regular pattern that can form a way of identifying coffins and skeletons. The distinct lack of nameplates (in direct contrast to many UK cemeteries of this period) severely hinders secure identification of the person. The documentary sources such as the cemetery plans and the cemetery protocols must also be examined critically. The accurateness of the plans is variable; it is clear when comparing the archaeology with the plans that the grave plots behind the gravediggers' house are not accuratetly shown. The veracity of the cemetery protocols are also questioned by the presence of skeletons that do not seem to have been recorded. Thus identification of grave plots and individuals within them remains a complex question; it is not a simple matter of identifying the grave plot, then consulting the written records: this would only produce incorrect results. All these factors must be assessed before secure, evidence based identification can be made. Identification must come through a combination of stratigraphical, osteological and finds evidence, with concern for the security of the identification.

So who have we found? We have identified people who were buried comprising a range of individuals from the very young to the old, some people from the same family, others are unrelated individuals. So far there

is formed a fascinating glimpse into social class, occupations and lifestyles, plus the illnesses that affected their life and possibly contributed to their death. There is also much evidence on how the families and the mourners acted towards them in death.

Yet we have also found other people within the excavation, we have excavated narratives concerning the gravediggers and the funeral professionals, as well as the architects and authorities who created and ordered the cemetery, setting the spatial constraints that all users and workers within the cemetery had to conform to or challenge.

8 Project Assessment and Research Potential

This chapter is an assessment of the results of the excavation. It discusses the organisation of the project and the methodologies used. Thereafter it discusses the preservation of the finds and sums up the handling of them. Finally the chapter summarises what cultural historical knowledge has been gained from the project and considers the potential of the results for future research.

Project logistics

The excavation at Assistens Cemetery was part of the Metro Cityring project. Inevitably the demands of such a project were complex and unique. Overall the project required a longer period to plan in detail and assess the needs of the project prior to the start of the fieldwork than was afforded. Prior to the project leaders starting work, some basic guidelines had been set for the project such as the immediate reburial of remains and an approximate and unconfirmed timetable and budget (Københavns Bymuseum 2009). The general site methodology was however created in a short period of time, by the project leaders before the start of the main excavation. Fieldwork started with a watching brief one week after employment of the project leaders, main excavation started five weeks after this. In this time period a Method statement, the methods of excavation and recording including the databases plus recording sheets were created. The need for more detailed imaging of the skeletal assemblage also required a mobile X-ray machine on site. Staff training was a priority in the first few months. The consequence of this was a delay in decisions concerning the archaeological side of the project, osteology recording was also delayed and the X-ray machine was not ready for use until March 2010. Finds recording was delayed until March and no reburial took place until the end of April 2010. Some of the consequences of these delays also resulted in tight assessments of the potential work rate. On evidence from previous cemetery excavations of this type and period, it was on average possible to excavate one grave per day per person. However this kind of work rate was only achieved towards the end of the project when staff was sufficiently confident in the procedures and techniques, and the procedures were also robust enough to be used. The difference is mostly caused by the more intensive use of technology during fieldwork but which also had significant benefits (see below). This kind of time pressure is common in all archaeological projects and did lead to the adaptation of methods, recording and prioritisation but also had some effects on the working environment. The quality of archaeological recording therefore was high but not optimal.

A student project had been undertaken of one of the available historical cemetery protocols which resulted in an Access database (Zander 2009). The data covered a section of the excavation area and not all known burials. Although this research was well done and was vital to allow some assessment of the number of graves and type of archaeology it was limited as a tool to plan a large archaeological excavation in a commercial environment. The original assessment made based upon this data suggested *c* 500 graves to be excavated, which is far fewer than the *c* 854 graves that were eventually excavated. Financial, time and staff resources had to be built upon this data (the only data available) resulting in incorrect assessments and limiting the archaeological methods, procedures and information that could be recorded.

It wasn't possible to carry out anysurvey of the site prior to the start of fieldwork. No surviving monuments or visible grave plots were therefore recorded and thus a vital piece of the connection between the below

ground archaeology and the visible monuments was lost. The value that such information could have given was highlighted by the large amount of information gained from the one grave plot on site that was recorded archaeologically.

Project methodology

Specific detailed procedures and manuals were prepared for the project. These were adapted and adjusted to the altered circumstances in the course of the excavation. Known methods and techniques fitted well to the project needs. Specific adaptations, such as procedure for charnel groups, were created during the fieldwork in response to the need to register actions that were not covered in the original documentation. The use of new software and documentation methodologies was meant to aid the staff in the project. However the short amount of time for this training prior to starting work and the extended education which was needed for new methods and software impacted upon working time. The use of IntraSiS made recording more consistent, focused thinking and standardised recording. It also enabled swift assessment of results and gave the ability to control the rate of work. The negative consequences were that it took a longer time during the fieldwork to enter the data than was planned for. However when compared against a time assessment for the overall project, it was found to speed up the post-excavation documentationSingle context recording was used on the excavation. It is often seen as a slow method of recording archaeology, however the greater detail with which even a supposedly simple archaeological action such as a grave can be recorded is hugely enhanced by this system. The use of single context documentation was vital to gain detailed information on contexts such as grave cuts and deposits and these have proved invaluable in interpreting the cultural historical aspects of the site. Its use has provided new information about cemeteries which are often rarely documented and proved that it is worth taking the time to use this system. This style of archaeological recording was new to many staff however and the overall principles needed more time to be communicated and discussed.

Archaeology and documentary sources

One common problem when dealing with historical archaeological projects is the question on how to use the often abundant written and cartographic records in conjunction with the archaeological information.

During the excavation this topic was discussed frequently, since the access to historical maps of the cemetery and grave plots made comparisons with the archaeological evidence inevitable. This was especially so, since the historical sources and the material remains often did not conform. What this site (and many other historic projects) has proved is that the archaeological evidence is a valid perspective bringing out the interactions between human behaviour and material culture in a way that historical sources do not (Buchli & Lucas 2001).

This can challenge what is thought to be settled knowledge and raise new questions. There is no doubt that the documentary data available when combined in a careful and considered manner with the archaeological data provides a powerful and intriguing source of information giving a great deal of potential to the site. One way to consider this is to treat historic documents as just another type of object that should be considered with the same questions as the excavated data (Johnson 1999).

Osteology methodology

The methodology of the osteology that had been planned from the start of the project had to be adjusted towards the limits of the project. The implications of having more skeletons than originally envisaged and having to change the database from Excel to a specially designed Access database (in order to increase data search, analysis and allow links to IntraSiS) led to changes in the analysis approach and a delay in recording.

Instead of analysing all skeletons of more than 50% completeness, a flexible selection of skeletons which were more than 50% complete were chosen that could provide useful and scientific valuable data for both the osteological as well as the archaeological interpretation. This meant that little over of half of the skeletons processed (53%) underwent full or low resolution analysis, while 47% were field assessed. Due to time and staff restraints on the project, archaeologists with osteological education conducted the field assessments. Field assessed skeletons had, where preservation and completeness allowed it, long bones and cranium radiographed in order to obtain metrical as well as data useful for ageing on these individuals. Although the field assessed skeletons did not undergo any detailed pathological analysis or descriptions, some general pathology was noted with help from the experienced osteology staff and specific pathological elements were radiographed for future scientific investigation purposes. The combination of different levels of osteology knowledge, the skeletons being *in situ* while conducting the assessment and the fact that poor preservation limited observations, resulted in somewhat restricted osteology data.

The excavation was divided into two stages of fieldwork. In the first, main stage, skeletons were fully analysed or field assessed. At the second stage (the last months of the excavation) osteological staff was limited to one osteologist only. This meant adjusting the methodology once again, to a low resolution analysis. The focus was on the degree of bone preservation, completeness of the bones and to establish the biological profile as well as pathology. Full detailed description on inventory and metrical data had to be excluded. Basic metrical data of long bones and cranium, can however, be obtained from the radiographic data of each skeleton.

The recording of the remains had to be of the highest standard and detail in order to allow future research from the obtained data. Although adjustments to the detail of recording had to be made, an effective recording was still maintained which followed the standards.

The amount of skeletons analysed per day per person varied and could not follow the very limited time estimated for the osteological assessment. Although it was originally agreed that one skeleton could be analysed per person per day including data entry into Access, it readily became apparent that this could not be achieved. Instead approximately half a skeleton was analysed per person per day. However, the time it took to enter data also took considerably longer than expected. While the data should have been entered immediately onto the Access database, time only allowed for summary data of demography, stature and pathologies. Data entry will not be completed within the resources of this project. Registrations of specific pathologies are available on paper record and there are plans to have them scanned and available as pdf's in the future.

The speed, at which each skeleton could be processed, depended on several factors: the state of the remains i.e. level of fragmentation, degree of soil covering the bones (in majority of cases this meant having to wash and dry the bones before further analysis could take place) and the amount of pathologies affecting the skeleton. Washing of bones was originally considered not to be very important, but experience showed otherwise. Pathologies could easily be missed, morphological features of the pelvis used for ageing could not be observed properly and soil disturbed the radiographic imaging. In turn this

would lead to misdiagnosis of pathologies, add considerable error to the age estimation and result in useless radiographs, hence a loss of data.

The short amount of time available for preparing for the excavation had effects on the osteological work. This included staffing for the project. On site, there were not enough experienced osteologists compared to the amount of skeletons recovered. Having such a strict time frame also severely influenced the initial set up of protocols, guidelines and equipment available.

Generally the human remains are often stored at the respective museums performing the excavation until funding can allow further analysis of the physical remains by more experienced osteologists. This normal procedure of retrospective sampling and analysis was not possible for the Assistens assemblage as the remains were to be reburied promptly.

It was vital that the osteological data was obtained to the highest standard possible. A mobile x-ray unit, a Sedecal Dragon Canon, was used on site as part of the recording. This allowed further data collection and enabled quality assurance of the recording as for example, pathological diagnosis can be verified and measurements taken where there was limited field time available. Having an x-ray machine on site also facilitated a much larger data collection.

Of the 459 skeletons that had x-rays taken (53.7% of total analysed), 307 (89%) had been fully analysed, 73 (68.9%) had undergone low resolution analysis and 79 (19.5%) were field assessed (Table 88).

An original estimation of 600 skeletons was used to calculate cost effectiveness but there was an overall negative discrepancy of 141 skeletons that were not x-rayed. It was never intended that every bone would be x-rayed but that significant elements of each individual would be taken. The initial planning of the osteology expected to x-ray 100% of the sample, but it was rapidly realised that this was not possible. For example, it became apparent that intact coffins or poorly preserved skeletons *in situ* could not be x-rayed, which was included as part of the argumentation for the unit. This was in part due to the limited room capacity in the isolated x-ray container as well as strict radiation security parameters on site. The reason for not x-raying a higher number of field assessed skeletons was due to the often very poor state of completeness and preservation. Taking x-rays of poorly preserved and fragmented skeletons would not be useful for scientific analysis. However, despite the negative discrepancy of individual skeletons x-rayed, the number of radiographic images for each of the x-rayed skeletons was substantial. In fact each skeleton that was x-rayed had on average ten images taken per individual, which equal 4590 images in total. Having x-rays completed externally would not have allowed this high number of data. Not having an x-ray machine on site would have meant missing out on a substantial amount of data such as the metrical data from the field assessed skeletons and low resolution analysed skeletons, documentation of age as well as pathologies. The x-ray machine was efficient in data documentation and collection without compromising ethical standards or research potential. In addition, the radiographic data can now be retrieved digitally, and processed in future scientific investigations. In addition having an x-ray on site did not only benefit the osteology documentation excessively, it was also used for x-raying finds, where material, structure and features could not be identified from visual observation only.

Type of analysis	Total no. of skeletons analysed	Total no. of skeletons x-rayed	%	Expected no. of skeletons x-rayed	Discrepancy between estimated and actual x-rayed skeletons
Full analysis	343	307	89.5		
Low resolution analysis	106	73	68.9	600	
Field assessed	405	79	19.5		
Total	**854**	**459**	**53.7**	**459**	**-141**

Table 88 Number of skeletons analysed compared with the number of skeletons x-rayed

Osteological conclusions

It is evident that most information is obtained from fully analysed skeletons. The type of analysis is of course also determined by the research potential of the material. When time, resources and staff is limited, low resolution analysis should be preferred but, it should always be performed by an experienced osteologist. Field assessment can be useful for archaeological interpretations, but is by no means sufficient if accurate information on demography is aimed for. Furthermore, field assessment does not allow for any proper description of pathology nor is it suitable if data is to be used in scientific research.

Using an x-ray on site has not only raised the documentation level significantly, it has been an invaluable aid in the documentation of the remains: in the analysis of age, the measurements of the elements as well as documenting pathological conditions. The limited time available prohibited detailed measurements of the field assessed remains and the remains that underwent low resolution. Instead of missing this data completely, the majority of the remains (where completeness allowed it) was radiographed and thereby increased the amount of data obtained for future analysis.

Preservation conditions

There was good preservation of archaeological material at the site with high overall preservation of stratigraphic sequences including an ability to observe archaeologically defined activity that formed the archaeological record. Even when there was evidence for truncation of earlier remains there was enough evidence in many examples to reconstruct the original context.

The conditions for the prehistoric remains of the cemetery were relatively good compared to the normal find conditions of prehistoric remains found within the Municipality of Copenhagen. This is due to the area not being built on or exposed to intensive agricultural activities in the last two hundred years. However, some prehistoric contexts have likely been destroyed by the cemetery use of the area.

The good preservation conditions for the cemetery remains were due to three main factors:

- The **recent date** of the remains: with the exception of the prehistoric remains all archaeology located was of the last *c* 200 years. This relative recent dating allowed a greater survival of contexts and finds.

- Good **preservation conditions**: the underground conditions were good for survival with neither too much nor too little groundwater in the area. Although the soil contains acidic sand that rapidly decays organic remains there was little enough to affect much of the recent dated remains.
- The relative **lack of truncation** activity: the area has undergone little development with no other modern truncations affecting the graves. Where truncating activity took place it was related to the cemetery activity.

Where there was poor preservation this could be related to the earlier graves which had been more truncated. The coffin wood survived only as a dark stain in the soil and the bone was decayed and fragile. Subadult graves were also more commonly poorly preserved, the skeletons were often fragile and small and the wood often very light. This is common to most cemetery excavations.

There were no previous archaeological excavations or observations in the area to compare the results with. General observations from the current cemetery staff told of good preservation conditions and that there was little or no waterlogging in the area of excavation which proved to be correct. There are no planned future excavations on the Assistens cemetery making it unlikely that this project will be repeated. Any future archaeological work in the Nørrebro area would need to be aware of the *in situ* prehistoric contexts on the cemetery. If there are any future necessary works relating to the Metro station, if the works are within the top 1m of ground level then no archaeological remains would be encountered. However if any deeper works were necessary then archaeological work would be necessary. Not all archaeological features were possible to record in the 1m area and areas that seem to have no archaeology may in fact contain graves. It is recommended that for any future works planning and communication with the contractors would be vital to ensure careful excavation.

Finds material

The prehistoric finds from the Assistens cemetery are *per se* by no means unique. However, the prehistory of the Copenhagen area is close to unexplored, and the finds are an important contribution to the overall picture of the prehistory of the area.

Overall the preservation of finds from the cemetery was good; immediate conservation would only have been required by some textile finds, however no conservation was required on the site as in general finds were not being retained by the museum. The amount of cemetery finds exceeded the expectations from the budget planning phase, and consequently finds registration had to be carried out on a very basic level. During the excavation, there was no planned time available for archaeologists to register finds and because all finds were to be reburied during the fieldwork phase of the project they all needed to be registered immediately. This was done by the Excavation Leader as the project was on-going.

Potential of finds

The potential for material analysis of the finds are restricted by the reburial of nearly all finds, however there are potentials for the textiles which form a unique group of clothing fragments from the 19th and 20th century. Few textile fragments have been excavated from burial grounds, and although historical sources might tell us about clothing and fashion at the time, burial clothes are rarely mentioned. In this way, the textiles bring forward new information about the burial habits and use of clothing in the period in question. As all of the textile fragments have been reburied, it will not be possible to make new and large-scale analyses in the future. However, samples of nearly all fragments were taken and these form a collection

that can be potentially used for technical analyses in the future. One project could be analysing the knitwear in detail. Colour analyses could provide interesting information, but as these are expensive just a few samples could be chosen and analysed within the scope of this project.

Some finds have been retained in the Museum collections. However, even for the reburied finds, the images of them can be studied for further analysis, particularly perhaps of the jewellery stamps and decoration relating to the cultural history and aesthetics relating to jewellery display and status. Other finds such as the gravestones can contribute more to the historical studies and contribute in identification of people plus an understanding of why some gravestones were removed and discarded.

Sample analysis

A minimal amount of scientific analytical techniques were undertaken during the project. Soil samples were only taken from prehistoric contexts and analysis on ceramics was only necessary upon prehistoric finds. Considering the small quantities of prehistoric archaeology there is little more considered to be efficient and effective in gaining new results or interpretations. The results from soil analysis were disappointing with no macroscopic plant remains or other remains found within them, preservation conditions perhaps was not favourable for plant or organic remains over a longer period of time.

Of the cemetery period archaeology, only the textiles have received analysis in the form of fibre analysis, the conclusions are due after the completion of this report. It is clear from comparison of clothing fastenings with remnants of textiles that preservation was poor, particularly for more delicate fabrics such as cottons or linens which have not survived.

One major omission was made on the project concerning the scientific analysis and that was the lack of collection of wood samples from the coffins. This could have identified cheaper coffins made of pine and those made of other, more expensive materials. This would be highly recommended in any future project.

Cultural historical assessment

Adding prehistory to the Nørrebro area

The prehistoric finds show that the excavated area likely has been occupied in a prehistoric period of unknown length; but within the Late Bronze Age/Early Iron Age. The settlement likely consisted of a farmstead including a house, and the economy was based on animal husbandry and possibly arable farming. Flint tools and pottery have probably been produced on the site.

A query in the database "*Fund og Fortidsminder*" (Kulturarvsstyrelsen 2011) reveals that 59 localities found within the Municipality of Copenhagen include finds which are dated to the Stone Age, while Bronze Age, Iron Age and Viking Age are only represented on 28 localities all together. The overrepresentation of Stone Age finds shall not be taken as an indication that human activity in the area was more frequent during the Stone Age than during later periods. The representation of finds is likely biased because of preservation differences: Stone Age stray finds are much more frequently recorded during archaeological excavations in the city, than finds from later parts of the prehistory. This is due to the fact that lithics are better preserved than fragile pottery, which are often the only finds from, for instance, late Bronze Age or Iron Age settlements. Furthermore, it is very rare that large areas are archaeologically investigated inside Copenhagen, which is generally a precondition for revealing larger prehistoric structures such as houses. Therefore, the prehistoric finds from Assistens Cemetery show that even though finds from the late

prehistory are scarce, there is evidence to believe that the area of the Municipality of Copenhagen was settled in this period too.

Even though the prehistoric finds from the Assistens Cemetery are relatively modest, the potential of excavations in park areas of Copenhagen is large because these areas generally have not been built on or brought under cultivation for hundreds of years. Therefore similar areas may contain good preservation conditions for prehistoric features. Furthermore, the prehistoric finds shed light on a virtually unexplored chapter of the cultural history of the densest populated area of Denmark. Prehistoric remains found on future excavations in the Municipality of Copenhagen should therefore be highly prioritised.

Assistens Cemetery

The Assistens excavation is the only large scale excavation of a cemetery from this period in Denmark and has provided evidence concerning the wider social attitudes to death and burial traditions. Whilst there have been thorough historical studies into Danish funerary behaviour (Kragh 2003), the burial practice of this particular period has up until now not been focused upon in Danish archaeology. The archaeological approach was able to illuminate new aspects of the period. The main points can be summarised as the following:

- It has revealed that the burial practice and the layout of the cemetery changed over time and that there probably was a change in which social groups were buried at the Assistens Cemetery. The earliest period was dominated by the burial of individuals of lower financial means, with more expensive family plots mostly located along the main pathways. Over time the more expensive family plots took over from the single graves demonstrating a significant shift in the social make-up of the cemetery population. The introduction of cremations in the 20th century marked a major shift in the attitude towards the dead that is also reflected in the excavated material.
- It was possible to define the material culture used for burial traditions over the last almost 200 years. It has been a great opportunity to see what was actually used, not just what was thought to be used, or advertised as being used. This includes the style of coffin that has been used, which has been shown to be different from contemporary cemeteries in other countries such as the UK. At Assistens the general form was a rectangular coffin with limited decoration and no name plate or identifying markers. This excavation has also demonstrated the ways in which individuals and their families presented the dead in the coffin. A tradition of simple dress was revealed in the early years with little in the way of grave gifts. However dress and elaboration of the body increased over time with jewellery and wedding rings not uncommon.
- A great deal of knowledge has been gained concerning the symbolism used in and around the grave. One key aspect of this has been the preservation of plant material which has not only demonstrated the use of floral tributes, but also the extent of use of other plant material, such as pine branches to cover the base of graves and palm leaves to adorn the tops of coffins. The conch shells also show how grave plots were decorated beyond the gravestone and how colonialism resulted in the import of symbolism to the homeland from the colonies as well as its export.
- The excavation has shown how the cemetery worked in practice and not merely in principle as defined by the authorities. It was possible to see how the gravediggers followed protocols and found practical solutions to problems. In particular there has been a great increase in the knowledge of how gravediggers treated existing coffins and skeletons that they disturbed in the

course of digging new graves. Differing methods of the treatment of disturbed human bone have been observed. These have demonstrated attitudes towards human remains by gravediggers and the various techniques they used to disguise the disturbance of existing burials from new mourners. In doing this it has be shown that the chaotic nature of disarticulated bones in many cemeteries can, to some degree be understood and taphonomic processes that have affected those bones can be identified. In some cases it is even possible to identify the individual to whom these bones belonged. This was greatly helped by the stratigraphic and single context method of recording carried out on site. This also reflects the professional attitude to human remains by cemetery staff after the deceased is forgotten and there is nobody to maintain the grave.

- Through the analysis of the extensive skeletal data recovered during the excavation it has been possible to gain an improved understanding of the demographic makeup of Copenhagen over the last 200 years. An insight has been obtained into the lifestyle and health of an urban population during and beyond the period of industrialisation, something unique in Danish research history. This has led to an internationally significant skeletal data set for this period of time and will allow for considerable new research to be carried out in the future.
- By combining the osteological results with archaeological data it was possible to identify changing trends and developments in health care and medical science over the span of the cemetery's use. This also allowed new knowledge to be gained about how bodies, and body parts, that have been altered by medical treatment, such as surgery, are treated after the death of the patient. Good examples of this include the reburial of an amputated limb and the presence of rubber surgical tubes on a number of skeletons.

The potential for future research

Cemeteries encapsulate the complex social behaviour between the living and the dead; this continues in a relationship that can be examined through the results of this excavation. The archaeological and osteological results combined with the historical sources hold a great potential for future research as regards to societal information on burial attitudes but the results also relate to the wider societal perspective (Heilen & Gray 2010).

First and foremost the research on local Copenhagen and Danish perspectives can be extended. Due to the cemetery's relatively short and well defined use period from 1806 to 1988 and the thorough stratigraphical registration, the site has great potential for classic archaeological studies such as establishment of typology and possibly chronologies for grave outline, coffin types and the various ways that people have been commemorating the dead throughout this particular period. Thereby the data from Assistens Cemetery would also combine well with other cemetery excavations in the city to further research into the changing attitudes to death and burial in Copenhagen from the medieval, represented by the Skt. Clemens cemetery (Jensen & Dahlström 2009), the so-called Flourishing Period represented by Vartov (Mosekilde 2011) and the industrialisation represented by the paupers cemetery at Farimagsvejen (Winther 2010) and Holmens Cemetery. An overall study of the chronological aspect of burial traditions could provide an extremely fruitful view on usage of material culture and attitudes to death in the medieval and post-Reformation period.

One of the major areas of potential of the archaeological information is in the development of the next level of phasing of the stratigraphical evidence. This report presents results on groupings of the

archaeological data where it has been formed into groups which represent graves. Some of these have been interpreted as line burials, known from documentary sources and have been discussed as such. However, the majority of the remaining graves are likely to be interpreted as individuals buried in family plots. A more thorough stratigraphical analysis and research, combined with a full overview of the site data including cemetery organisation, coffin designs and the osteological data would widely expand the knowledge of this burial tradition. This would leave a unique insight in the life and death of the 19th and 20th century's middle class population, which the plots might represent. It is this work that can fully create an interface between the archaeological, osteological and documentary sources. Although some individuals have already been identified by the grouping work and been discussed in this report, more could be identified by this process with a higher degree of security. Indeed until this work is completed further interpretation on the osteological and documentary data will be limited as the identification forms the foundation upon which full complementary and integrated research can take place.

Another perspective related to this is that it may be possible to test osteological methods on named samples and identifying and examining osteological differences in various socio-economic groups within Copenhagen as primary themes for the industrial period, in addition to the general research questions common to all cemetery samples (the demographic composition, metric analysis, the prevalence of pathological conditions). As with all post-medieval assemblages, the prospect of comparing documentary records to the physical remains of people and burial practices is invaluable. The written sources and the archaeological data on life in the past will add another dimension to the interpretation and a more detailed investigation of the human bone will enable a far fuller picture of health in this community. Biographic data is particularly pertinent in the subadult group where information on sex will enable infant health to be examined with reference to male and female biases and distribution patterns. Biographic data can also be used to produce comprehensive case studies using osteological and documentary data.

The large sample size from Assistens will allow for the creation of statistically significant data sets that can be further compared with statistical documentary data for Copenhagen during the years in question. Various osteological potential indicators of status can be further examined to determine whether the majority of these individuals were, as indicated by contemporary records and archaeological data, of middle class and of the upper end of the socio-economic scale. Both mortality and pathology rates can be examined in more detail. The assemblage can, furthermore, provide epidemiological evidence of conditions related to social and/or environmental influences. A diet rich in refined sugars is most likely reflected in the high rates of dental diseases and antemortem tooth loss. The rate of dental disease and the factorial nature of dental pathology warrant further investigation. Edentulous individuals and individuals with dentures noted particularly among females may indicate a sex, social and cultural preferences as well as indication of vanity. Further work can address the classification of materials and making of the dentures.

Vitamin deficiency in infants and children has been identified as a major research theme for this period. In the 19th century the traditional view of infantile scurvy was attributed to the consumption of heated milk and proprietary foods deficient in vitamin C (Bradley & Parish 2009). In the early 20th century it was discovered that pasteurized milk results in the loss of vitamin C. Many infants raised by foster parents, or whose mothers could not or did not breast feed their children, were subsequently fed on pasteurized milk. This may have been the case for some of the individuals buried at Assistens. The Assistens assemblage therefore holds an immense potential for providing information regarding infant dietary patterns (suckling and weaning) as well as information on the socio-economic background of these infants.

Population growth and poverty in Copenhagen invariably meant unsanitary living conditions for many of the people in Trinitatis Parish that increase rates of infectious disease. However, many of the infectious diseases, the epidemics that according to national statistics were major contributors to mortality in Copenhagen during this period are not visible skeletally. The rate of observed tuberculosis, for example, appears very low. Unfortunately the potential for examining the rates of sinus infection was obscured due to the large number of complete crania present. Nevertheless, the presence of sinus infections as well as concha bullosa may to some extend allow for an examination regarding pollution and breathing problems.

The rates and patterns of disease and traumatic injury such as fractures can be examined for occupational links in much further detail. That individuals survived serious injuries implies some level of treatment and care, as is also shown by the amputee, mastoidectomy and evidence of dentistry. It would be of great value to find and compare autopsy reports of identified individuals with the skeletal findings made during the osteological analysis. Such analysis may give us new and valuable information on identification as well as interpretation of various diseases and trauma through time. Patterns explaining the use of autopsy may be found based on date, demography or pathology.

The individual with pipe notch and a large number of individuals with nicotine staining on their teeth provides an interesting sub-set for study. They may have the potential to provide information on the effects of smoking on health, as well as social behaviour. Combined with the archaeological data, further investigation on this subject may in turn offer insight into the status of the smokers.

Non metric traits were not examined fully although there appeared to be a large number of individuals with vastus notch. Patterns of traits may be examined for evidence of population relation and distance.

Small quantities of bone and teeth as well as the surviving hair and nail can be used for scientific analyses. These include stable isotope analysis of dietary patterns and elemental analysis for the investigation of poisoning from for example lead and mercury. This in turn will allow an understanding of the daily dietary habits, medical treatments and environmental pollution, which all have a significant influence on health.

The complete and well-preserved nature of many of the individuals increases the potential for further metric analysis. A comparison between the adult stature calculated from the femoral length and the length in graves can be made and the means and desperations evaluated. Furthermore, an investigation of the cranial metrics can add in the analysis of ancestral hereditary and the metrics of the various long bones can add information on the physique and robusticity of individuals from different occupational backgrounds, social status and through time.

The construction of demographic profiles for the group will allow comparison with other contemporary sites in Europe. It would also be interesting to be able to investigate contemporary European collections of human bone in order to get a broader perspective on health and disease in Denmark compared to the rest of Europe.

Kidney/bladder stones were found, associated with specific skeletons, in numbers seldom seen from one individual site. This raises the possibility of research into the aspects of health that cause these stones to form as well as the possibility of collection biases in archaeological excavations. Chemical analysis of the stones would help enormously in any further studies and may help to understand why at Assistens kidney/bladder stones were, unexpectedly, more common with females than males.

There is considerable potential for advancing spatial studies on the landscape and environment of the cemetery, looking at how people used the cemetery, from mourners to gravediggers, and how this changed over time. There is potential to look at the interactions between grave rows, spatial zones and buildings on

the site within core and periphery zones. Combined with the osteology and documentary sources it can provide a glimpse into use by different social strata. One of the major potentials of the cemetery is in charting the development and change within the funeral industry during this time. Specialists, rather than the bereaved families, were burying the dead (Reeve & Adam 1993: 130). How did this industry develop in Copenhagen and how is it seen in changes of material culture excavated on the site?

The results fromAssistens Cemetery have potential beyond Danish research. The results will also be valuable as comparable material for excavated cemeteries in the rest of Scandinavia, Northern Europe and the Western world in general: by using clear methods, project design and research principles the potential of the material to provide new frameworks of research and knowledge into a debate is made clear. For further analysis on the results, suggested comparative data sets include the sites from Skt. Olai Church in Helsingør (Bennike 2002), Holmens Church (Jørkov 2014), Farimagsvejen in Copenhagen (Winther 2010), the remains from the large post-medieval cemeteries in England such as Christ Church, Spitalfields (Molleson et al. 1993), St. Martin's–in-the-Bull Ring, Birmingham (Brickley et al. 2006) and St. George's Church, Bloomsbury (Boston et al. 2009). Comparative data from post-medieval assemblages in other parts of Scandinavia and Europe should also be sought. Furthermore, it would be extremely valuable to investigate a Danish cemetery of the same period containing a rural population, so that possible differences between the rural and the urban populations can be observed as regards to both osteology as well as burial practice. However, suitable archaeological data is missing for the time being.

The excavation of a recent cemetery such as Assistens can bring the city of Copenhagen into the international debate concerning post medieval and historical studies, as it provides answers to the question of why archaeologists should excavate cemeteries, or other types of sites, of this period. In particular, it is clear that the evidence found with its potential contributions to studies of medical research and population, the impact of urbanisation and reflections in the material culture of people's reactions to the new conditions can enhance understanding of wider European changes during the last 200 years.

9 References

Literature

AAGAARD, K. 2002. Det havde de på. *Helsingør Kommunes Museer Årbog* 2001: 99-120. *Helsingør Kommune*.

ACSÁDI, G.Y. & J. NEMESKÉRI. 1970. *History of human life span and mortality*. Budapest: Academiai Kiado.

AHLBURG, D. & C. DE VITA. 1992. New realities of the American family. *Population Bulletin* 47:2–45.

ANDERSEN, A. 1991. Register til familiebegravelser på Assistens kirkegård 1880. Assistens Kirekgårdskontor

ANDERSEN, E. M.B. HUTCHINGS, J. JANSEN & D.L. MARTIN. 1982. Højde og vægt hos danske børn. *Ugeskrift for Læger* 144:1760-5.

ARMSTRONG, D.V. 2003. *Creole transformation from slavery to freedom: Historical archaeology of the East End community, St John, Virgin Islands*. Gainesville: University of Florida Press.

ASMUSSEN, E. 1981. Plastfyldningsmaterialer. *Odontologisk Boghandels Forlag*. København.

ASMUSSEN, E. & E.H. CHRISTENSEN. 1967. *Kompendium i legemsøvelsernes specielle teori*. København: Statens Trykningskontor.

AUFDERHEIDE, A.C. & C. RODRIGUEZ-MARTIN. 1998. *The Cambridge encyclopedia of human palaeopathology*. Cambridge: Cambridge University Press.

BARNES, E. 1994. *Developmental defects of the axial skeleton in paleopathology.* Colorado: University Press of Colorado.

BASS, W.M. 1995. *Human Osteology. Laboratory and field manual* (Fourth Edition). Columbia: Missouri Archaeological Society.

BENNIKE, P. 1985. *Palaeopathology of Danish Skeletons. A comparative study of demography, disease and injury*. Copenhagen: Akademisk Forlag.

BENNIKE, P. 2002. Antropologiske studier af de døde, in *Helsingør Kommunes Museer Årbog 2001*. Restaureringen af Helsingør Domkirke 2000-2001 og undersøgelserne af de borgerlige begravelser. Helsingør: Helsingør Kommunes Museer.

BERLINGSKE. Direktor A.W. Krarup begaaet selvmord, 1 April1913.

BOAS, H. 1950. De veneriske sygdomme i Danmark før under og efter de to verdenskrige. *Ugeskrift for Læger* 112(22): 799-800.

BOSTON, C., A. BOYLE, J. GILL & A. WITKIN (ed.) 2009. *'In the vaults beneath'. Archaeological recording at St George's Church, Bloomsbury.* Oxford: Oxford Archaeology Monograph 8.

BRICKLEY, M., & A. MILES, WITH H. STAINER 1999. *The Cross Bones burial ground, Redcross Way, Southwark, London. Archaeological excavations (1991-1998) for the London Underground Limited Jubilee Line extension project*, London: MOLAS Monograph 3.

BRICKLEY, M. 2000. The diagnosis of metabolic disease in archaeological bone, in M. Cox & S. Mays (ed.) Human osteology in archaeology and forensic science: 183-98. London: Greenwich Medical Media.

BRICKLEY, M. & J. MCKINLEY 2004. *Guidelines to the standards of recording human remains*. Institute of Field Archaeologists, Paper 7. Southampton: BABAO.

BRICKLEY, M. & R. IVES 2008. *The bioarchaeology of metabolic bone disease*. Amsterdam: Elsevier Academic Press.

BRICKLEY, M., H. BERRY, G. WESTERN, A. HANCOCKS & M. RICHARDS 2006. The people: physical anthropology, in M. BRICKLEY, S. BUTEUX, J. ADAMS & R. CHERRINGTON 2006. *St Martin's Uncovered: investigations in the churchyard of St Martin's-in-the-Bull Ring, Birmingham, 2001*. Oxford: Oxbow Books.

BRICKLEY, M., S. BUTEUX, J. ADAMS & R. CHERRINGTON 2006. *St Martin's Uncovered: investigations in the churchyard of St Martin's-in-the-Bull Ring, Birmingham, 2001*. Oxford: Oxbow Books.

BROOKS, S.T. & J.M. SUCHEY 1990. Skeletal age determination based on the os pubis: comparison of the Acsádi-Nemeskéri and Suchey and Brooks method. *Journal of Human Evolution* 5: 227-38.

BROTHWELL, D.R. 1981. *Digging up bones: The excavation, treatment and study of human skeletal remains* (Third Edition). London: British Museum (Natural History).

BUCKBERRY, J.L. & A.T. CHAMBERLAIN 2002. Age estimation from the auricular surface of the ilium: A revised method. *American Journal of Physical Anthropology* 119: 231-39.

BUIKSTRA, J.E. & D.H. UBELAKER. (ed.) 1994. Standards. For data collection from human skeletal remains. Proceedings of a seminar at the Field Museum of Natural History. Indianapolis: Arkansas Archaeological Survey Research Series No. 44.

BUCHLI, V. & G. LUCAS (ed.) 2001. The absent present: archaeologies of the contemporary past. In V. Buchli & G. Lucas Archaeologies of the contemporary past, 3-18 London: Routledge.

COHEN, R.A. 1975. Messrs Wedgewood and porcelain dentures correspondence 1800-15, *British Dental Journal* 139: 27-31 & 69-71

CONNELL, B. & P. RAUXLOH. 2003. A rapid method for recording human skeletal data. London: Museum of London.

CONNELL, B. & A. MILES. 2010. *The City Bunhill burial ground, Golden Lane, London. Excavations at South Islington schools, 2006*, London: MOL Archaeology, Archaeology Studies Series 21.

CORRUCCINI, R.S., E.M. BRANDON & J.S. HANDLER. 1989. Inferring fertility from relative mortality in historically controlled cemetery remains from Barbados. *American Antiquity* 54 (3): 609-14.

COUGHLAN, J. & M. HOLST. 2007. Health status, in V Fiorato, A. Boylston & C. Knüsel (ed.). Blood red roses. The archaeology of a mass grave from the battle of Towton, AD 1461: 60-76. Oxford: Oxbow Books.

COWIE, R., J. BAKVALAC & T. KAUSMALLY. 2008. *Late 17th- to 19th-century burial and occupation at All Saints, Chelsea Old Church, Royal Borough of Kensington and Chelsea*, London: MOLAS Archaeology Studies Series 18.

COX, M. 1996. Life and Death in Spitalfields: 1700-1850. York: Council for British Archaeology.

COX, M. 1996b. St Pancras Church crypt: evaluation report. Bournemouth University.

DAGBLADET. Et morddrama i Berlin, 5 January 1910.

DAHL, B.W. 2010. Assistens Kirkegård og Norrebros udbygning, in *Assistens 250*: 17-73. København: Center for Kirkegårde.

DANN ,S. 1951. Metabolic craniopathy: a review of the literature with report of a case with diabetes. *Annals of Internal Medicine* 34:163-202.

DELACY, M., 1989. Puerperal fever in eighteenth-century Britain. *Bulletin of the History of Medicine*. 63 (4): 521-56.

DOHERTY, M. & P. DIEPPE. 1986. Crystal deposition disease in the elderly. *Clinical Rheumatoid Disease* 12: 97-116.

DOWNES, J. Cremation: a spectacle and a journey, in J. Downes & T. Pollard. (ed.) The loved body's corruption. Archaeological contributions to the study of human mortality: 19-29. Glasgow: Cruithne Press.

ETHELBERG, P.E., D. JØRGENSEN, D. MEIER & D. ROBINSON. 2000. *Det Sønderjyske Landburgs Historie. Sten- og Bronzealder.* Haderslev: Haderslev Museum.

ETHELBERG, P., N. HARDT, B. POULSEN & A.B. SØRENSEN. 2003. *Det Sønderjyske Landburgs Historie. Jernalder, Vikingetid & Middelalder.* Haderslev: Haderslev Museum.

FAHEY, V., K. OPESKIN, M. SILBERSTEIN, R. ANDERSON & C. RIGGS. 1998. The pathogenesis of Schmorl's nodes in relation to acute trauma. An autopsy study. *Spine* 23: 2272-5.

FÉDÉRATION DENTAIRE INTERNATIONAL. 1971. Two-digit system of designating teeth. *International Dental Journal* 21:104-6.

FOLLIS, R.H., & E.A. PARK.1952. Some observations on bone growth, with particular respect to zones of increased density in metaphysic. *American Journal of Roentgenology, Radium Therapy and Nuclear Medicine* 68: 709-24.

FRANCE, D. 1983. Sexual dimorphism in the human humerus. Unpublished Ph.D. dissertation, Department of Anthropology, University of Colorado.

FRASER, D.R. 1995. Vitamin D. *Lancet* 345: 104-5.

GILCHRIST, R. & B. SLOANE. 2005. *Requiem: The Medieval Monastic Cemetery in Britain*. London: Museum of London Archaeology Service.

GOODMAN, A.H. & J.C. ROSE. 1990. Assessment of systemic physiological perturbations from dental enamel hypoplasias and associated histological structures. *Yearbook of Physical Anthropology* 33: 59-110.

GOTTLIEB, S. 2002. High protein diets brings risk of kidney stones. British Medical Journal 325(7361):408.

GUSTAFSON, G. & G. KOCK. 1974. Age estimation up to 16 years of age based on dental development. *Odontologisk Revy* 25:296-306.

HACKER-NORTON, D. & M. TRINKLEY. 1984. *Remember man thou art dust: coffin hardware of the early 20th century*. Columbia, South Carolina: Chicora.

HANSEN, S. 1907-1911. Om hovedets størrelse hos voksne mænd og kvinder. *Meddelelser om Danmarks Antropologi* 1: 69-83.

HATIPOĞLU, H.G., M.A. CETIN & E. YÜKSEL. 2005.Concha Bullosa types: their relationship with sinusitis, osteomeatal and frontal recess disease. *Diagnostic Intervention of Radiology* 11: 145-9.

HEILEN, M. & M.A. GRAY. 2010. *Deathways and lifeways in the American southwest. Tucson's historic Alameda-Stone cemetery and the transformation of a remote outpost into an urban city. Vol. 1. Context and synthesis from the Joints Courts Project, Tucson, Arizona*. Technical report 10-95, Tucson, Arizona: Statistical Research Inc.

HELWEG, S. 2010. Et kort rids af Assistens Kirkegårds historie, in *Assistens 250:* 75-118. København: Center for Kirkegårde.

HERSHKOVITIZ, I., C. GREENWALD, B.M. ROTHSCHILD, B. LATIMER, O. DUTOUR, L.M. JELLEMA & S. WISH-BARATZ. 1999. Hyperostosis frontalis interna: An Anthropological Perspective. *American Journal of Physical Anthropology* 109:303-25.

HILLSON, S. 1996. Dental anthropology (Second Edition). Cambridge: Cambridge University Press.

HOWARTH, G. 1997. Professionalising the funeral industry in England 1700-1960, in P. Jupp & G. Howarth (ed.). *The changing face of death. Historical accounts of death and disposal*: 120-34. London: Macmillan.

HVASS, L. 2002. Borgernes begravelse. *Helsingør Kommunes Museer Årbog 2001*: 69-98.

HYLDTOFT, O. 1984. Københavns industrialisering 1840-1914. Systime, Herning.

HYLDTOFT, O. 2012. Mad, drikke og tobak 1800-1835. Forbrugsmønstre, kultur og diskurser. Museum Tusculanums Forlag. Københavns Universitet.

ISCAN, M.Y., S.R. LOTH & R.K. WRIGHT. 1984. Age estimation from the rib by phase analysis: white males. *Journal of Forensic Science* 29:1094-1104.

ISCAN, M.Y., S.R. LOTH & R.K. WRIGHT. 1985. Age estimation from the rib by phase analysis: white females. *Journal of Forensic Science* 30: 853-63.

JANE, J.A. JNR, K.Y. KANT & J.A. JANE SNR. 2000. Saggital synostosis. *Neurosurgery Focus* 9 (3): 1-6.

JENSEN, J. 1998. *Manden i kisten*. Gyldendal.

JOHANSEN, H.C. 2002. *Danish Population History 1600-1939*. Odense: University Press of Southern Denmark in History and Social Sciences: vol. 254.

JOHANSEN, M.G.K. 2001. Udgravningerne på Klingenberg. *Fynske Minder* 2001: 97-114.

JOHNSON, M. 1999. Rethinking historical archaeology, in P.P. Funari, M. Hall & S. Jones (ed.). *Historical archaeology: Back from the edge*, 24-36. London: Routledge.

JONSSON, K. 2010. Moderna tider? Dödsuppfatningar och folkliga traditionnr från medeltid till 1800-tal, in A. Lihammer & M. Jonas (ed.) *Modernitetens materialitet. Arkeologiska perspektiv på det moderna samhällets framväxt*, 113-29. Museum of National Antiquities Stockholm Studies 17. Stockholm: Statens Historiska Museum.

JUEL, K. & CHRISTENSEN, K. 2007. Kønsforskelle i dødelighed i Danmark 1840-2005. Videnskab og Praksis. *Ugeskrift for Læger* 169: 2398-2403.

JULKUNEN, H., O.P. HEINONEN & K. PYÖRÄLÄ. 1971. Hyperostosis of the spine in an adult population. *Annals of the Rheumatic Diseases* 30: 605-12.

JØRGENSEN, C.A. 2007. Assistens Kirkegård i brændpunktet, in *Danmarksbilleder 1807 – før, under og efter*: 5-13. København: Kulturcentret Assistens.

JØRGENSEN, K.D. 1976. Dentale amalgamer. 2. udgave. *Odontologisk Boghandels Forlag*. København.

JØRKOV, M.L.S. 2014. Diet and dental health in 19th and 20th century Copenhagen. An investigation of the Assistens cemetery. Presentation at the 16th Annual Conference of the British Association for Biological Anthropology and Osteoarchaeology, Durham: Durham University.

JØRKOV, M.L.S. 2015. Stature in 19th and early 20th century Copenhagen. A comparative study based on skeletal remains. Economics and Human Biology 19:13-26.

KARG 2002 Blomster til de døde, urter og blomster fra 14 renæssance-, barok- og rokokobegravelser i Helsingør, in L. Hvass (ed) *Restaueringen af Helsingør Domkirke 2000-2001 og undersøgelserne af de borgerlige begravelser* Helsingør Kommunes Museer Årbog 2001:133-142.

KNUDSEN, B.M. 2009. Madvareindkob ved det russiske hof i Horsens 1780-1807, in O. Hyldtoft (ed.). *Kost og spisevaner i 1800-tallet*: 11-40. Købehavns Universitet: Museum Tusculanums Forlag.

KNÜSEL, C. 2000. Bone adaptation and its relationship to physical activity in the past, in M. Cox & S. Mays (ed.) *Human osteology in archaeology and forensic science*. London: Greenwich Medical Media.

KNÜSEL, C.J., GOGGEL, S. & LUCY, D. 1997. Comparative degenerative joint disease of the vertebral column in the Medieval monastic cemetery of the Gilbertine Priory of St. Andrew, Fishergate, York, England. *American Journal of Physical Anthropology* 103: 481-95.

KOMLOS, J., 1987. The height and weight of West Point cadets: dietary change in antebellum America. *The Journal of Economic History*. 47: 897-927.

KRAK. 1950. Danmarks ældste forretninger:141. København.

LAI, P. & LOVELL, N.C. 1992. Skeletal markers of occupational stress in the fur trade: A case study from Hudson's Bay Company fur trade post. *International Journal of Osteoarchaeology* 2: 221-34.

LARSEN, H.V. 1960. En tur på Assistens Kirkegård. *Historiske Meddelelser om København:* 1-198.

LEVY, C.E.M. 1848. De nyeste forsög i födselsstiftelsen i Wien til oplysning om barselfeberens ætiologie. *Hospitals-Meddelelser 1: 199-211.*

LEWIS, M.E., 2002. Impact of industrialization: comparative study of child health in four sites from medieval and postmedieval England (A.D. 850-1859). *American Journal of Physical Anthropology.* 119: 211-23.

LEWIS, M.E. 2007. *The bioarchaeology of children. Perspectives from biological and forensic anthropology*. Cambridge: Cambridge University Press.

LITTEN, J. 1998. The English Funeral 1700-1850, in M. Cox (ed.) *Grave concerns: Death and burial in England 1700 to 1850*. Council for British Archaeology research report 113. York: Council for British Archaeology.

LINDBERG, K. 2010. Bygninger på Assistens Kirkegård 1760-2010, in *Assistens 250*: 121-31. København: Center for Kirkegårde.

LØKKE A. 1998. Døden i barndommen. Spædbørnsdødelighed og moderniserings-processer i Danmark 1800 til 1920. Gyldendal.

MACKESPRANG, E.P. 1907-1911. De værnepligtiges højde i Danmark. *Meddelelser om Danmarks Antropologi* 1: 11-69.

MADSEN, H. A. & SØVSØ, M. 2010. Liv og død i Ribe omkring år 1700 – de gravlagte i processionsgangen syd for Ribe Domkirke: 56-75. *By, marsk og geest. Kulturhistorisk årbog for Sydvestjylland.* Sydvestjyske Museer

MAAT, G.R.J. 2004. Scurvy in adults and youngsters: The Dutch experience. A review of the history and pathology of a disregarded disease. *International Journal of Osteoarchaeology* 14(2): 77-81.

MAAT, G.J.R., 2005. Two millennia of male stature development and population health and wealth in the Low Countries. *International Journal of Osteoarchaeology* 15: 276-90.

MERBS, C.F. 1995. Incomplete spondylolysis and healing: a study of ancient Eskimo skeletons. *Spine* 20: 2328-34.

MILES, A.E.W. 1963. Dentition and the estimation of age. *Journal of Dental Research* 42: 255-63.

MILES, A. & W. WHITE WITH D. TANKARD. 2008. *Burial at the site of the parish church of St Benet Sherehog before and after the Great Fire,* London. London: MOLAS Monograph 39.

MILES, A., N. POWERS & R. WROE-BROWN WITH D. WALKER. 2008. *St Marylebone Church and burial ground in the 18th to 19th centuries. Excavations at St Marylebone School, 1992 and 2004-6*. London: MOLAS Monograph 46.

MILES, A. In press. Sheens Burial Ground, Deverell Street, Bow Baptist, MOL Archaeology Studies Series. London Museum of London Archaeology.

MILES, A. & J. CONHEENEY. 2002. Excavations in the St. Bride's lower churchyard, 75-82 Farringdon Street, London. Museum of London Archaeology Report.

MOLLESON, T., M. COX, A.H. WALDRON & D.H. WHITTAKER. 1993. *The Spitalfields project. Volume 2. The anthropology: The middling sort.* Council for British Archaeology Research Report 86. York: Council for British Archaeology.

MORREES, C.F.A., E.A. FANNING & E.E. HUNT. 1963. Age variation of formation stages for ten permanent teeth. *Journal of Dental Research* 42: 1490-1502.

NIELSEN, A. 1939. Assistens Kirkegaard. *Historiske Meddelelser om København:* 95-172.

NIELSEN, M. L. 2010. Afdeling G, in *Assistens 250*: 553-85. København: Center for Kirkegårde.

ORTNER, D.J. & S.MAYS. 1998. Dry-bone manifestations of rickets in infancy and early childhood. *International Journal of Osteoarchaeology* 8: 45-55.

ORTNER, D.J., E. KIMMERLE & M. DIEZ. 1999. Skeletal evidence of scurvy in archaeological skeletal samples from Peru. *American Journal of Physical Anthropology* 114: 343-51.

ORTNER, D.J. 2003. *Identification of pathological conditions in human skeletal remains* (Second Edition). Amsterdam: Academic Press.

PETERSEN, C.G. 2011. Klosterkirkegården i Horsens. Lecture given on the annual meeting Byarkæologisk møde i Ribe. Ribe, 30-31 May 2011.

PORTER, R. 2001. Bodies Politic. Disease, death and doctors in Britain, 1650-1900. Reaktion Books: London.

POURBAGHER, A., M.A. OURBAGHER, L. SAVAS, T. TURNUNC, Y.Z. DEMIROGLU, I. EROLI & D. YALCINTAS. 2006. Epidemiologic, clinical and imaging findings in brucellosis patients with osteoarticular involvement. *American Journal of Roentgenology* 187:873-80.

RASMUSSEN, R.P. 1939. *Almindelig Hospitals Historie 1769-1892.* København: Berlingske.

REEVE, J. & M. ADAMS. 1993*. The Spitalfields Project. Volume. 1: The Archaeology: Across the Styx*. Council for British Archaeology research report 85. York: Council for British Archaeology.

RESNICK, D. & G.NIWAYAMA (ed.) 1988. *Diagnosis of bone and joint disorders* (Second Edition). Philadelphia: WB Saunders.

RICHMOND, M. 1999. Archaeologia Victoriana: the archaeology of the Victorian funeral, in J. Downes, J. & T. Pollard (ed.). *The loved body's corruption. Archaeological contributions to the study of human mortality:* 145-58. Glasgow: Cruithne Press.

RING, M.E. 1985. *Dentistry. An illustrated history.* New York: Abradale Press.

ROBERTS, C. & K. MANCHESTER. 2001. *The archaeology of disease* (Second Edition). Phoenix Mill: Sutton Publishing Limited.

ROBERTS, C. 2009. *Human remains in archaeology: a handbook*. CBA Practical Handbook 19. Council for British Archaeology. Cambridge: Cambridge University Press.

ROBERTS, C. & M. COX. 2003. *Health and disease in Britain from prehistory to present day*. Stroud: Sutton Publishing.

ROED*, C*. 2004*.* The development of hospital care in Copenhagen from around 1700 until the late 1880s. *Dan Medicinhist Arbog : 133-56.*

ROGERS, J. & T. WALDRON. 1995. *A field guide to joint disease in archaeology*. New York: John Wiley & Sons.

ROGERS, J. & T. WALDRON. 2001. DISH and the monastic way of life. *International Journal of Osteoarchaeology* 11: 357-65.

RUGG, J. 1997. The origins and progress of cemetery establishment in Britain, in P. Jupp & G. Howarth (ed.). *The changing face of death. Historical accounts of death and disposal*: 105-19. London: Macmillan.

SAGER, P. 1969. *Spondylosis cervicalis: A pathological and osteoarchaeological study of osteochondrosis intervertebralis cervicalis, arthrosis uncovertebralis, and spondylarthrosis cervicalis*. København: Munksgaard.

SCHEUER, L. & S. BLACK. 2000. *Developmental juvenile osteology.* New York: Academic Press.

SCHOUR, I. & M. MASSLER. 1941. The development of the human dentition. *Journal of the American Dental Association* 28: 1153-60.

SCRIMSHAW, N.S. & J.P. SAN GIOVANNI. 1997. Synergism of nutrition, infection and immunity. *American Journal of Clinical Nutrition* 66(2): 464-77.

START, H. & L. KIRK. 1998. The bodies of friends –the osteological analysis of a Quaker burial ground, in M. Cox (ed.) *Grave concerns: Death and burial in England 1700 to 1850*. Council for British Archaeology research report 113. York: Council for British Archaeology.

STEINBOCK, R. T. 1993. Rickets and osteomalacia, in K.F. Kiple (ed.). *The Cambridge world history of human disease*: 978-80.

STEVENSON, J.C. (ed.). 1991. *Osteoporosis*. Guildford: Reed Healthcare.

STEWART, T.D. 1979. *Essentials of forensic anthropology, especially as developed in the United States*. Springfield, Illinois: Charles C. Thomas.

STIRLAND, A. 1991. The diagnosis of occupationally related paleopathology. Can it be done?, in D.J. Ortner & A.C. Auferderheide (ed.). *Palaeopathology: Current synthesis and future options:* 40-47. Washington D.C.: Smithsonian Institute Press.

STIRLAND, A. 1997. Musculoskeletal evidence for use of the medieval longbow from King Henry VIII's flagship, the Mary Rose (abstract). *American Journal of Physical Anthropology* (Suppl 24):220.

STUART-MACADAM, P.L. 1991. Anemia in Roman Britain: Poundbury Camp, in H. Bush & M. Zvelebil (ed.) *Health in past societies: biocultural interpretations of human skeletal remains in archaeological contexts*. (British Archaeological Reports International series 567): 101-13. Oxford: Archaeopress.

SCHWARTZ, J.H. 1995. *Skeleton Keys: An introduction to human skeletal morphology, development and analysis*. New York: Oxford University Press.

SECHER, K. 1956. *Ligbrænding i Danmark*. København: Dansk Ligbrændingsforening.

SWEET, D. & J. MADEWELL. 1995. Osteonecrosis: Pathogenesis, in D. Resnick (ed.) *Diagnosis of bone and joint disorders* (Third Edition): 3445-94. Philadelphia: Saunders.

SØLVER, A. 1929. Danske Guldsmede og deres Arbejder gennem 500 Aar. Et festskrift ved Københavns guldsmedelaugs 500 aars jubilæum 1429-1929.: 191.København: Larsen & Larsen TAMM, D. 1992. *Dødens Triumf: mennesket og døden i Vesteuropa fra middelalderen til vore dage*. København: Gad. København: G.E.C. Gad.

THOMSEN, J.L. (ed.) 2004. *Retsmedicin. Nordisk lærebog*. København: FADL's Forlag.

THOMSEN, T. 2007. Gensyn med Kirkepladsens nedlagte kirkegård, in L. Malmgart (ed.). *Livet i og omkring Holstebro Kirke i 100 år 1907-2007*: 119-24. Holstebro.

THOMSEN, T. 2008. Udgravningen af Holstebro Kirkeplads: 10-24. *Holstebro Museum årsskrift*.

TROTTER, M. 1970. Estimation of stature from intact limb bones, in T.D. Stewart (ed.), *Personal identification in mass disasters*: 71-97. Washington DC: Smithsonian Institute.

UBELAKER, D.H. & E.B. JONES. 2003. *Human remains from Voegtly cemetery, Pittsburgh. Pennsylvania*. Smithsonian contributions to anthropology 46. Washington: Smithsonain Institute.

VALLGÅRDA, S. 1996. Hospitalization of deliveries: the change of place of birth in Denmark and Sweden from the late nineteenth century to 1970. *Medical history* 40: 173-196.

VALLGÅRDA, S. 1999. Who went to a hospital in the eighteenth and nineteenth centuries in Copenhagen? *European journal of public health* 9(2): 97-102.

VEDSTED, P. 2007. Kønsforskelle i brug af sundhedsvæsnet. *Videnskab og Praksis. Ugeskrift for Læger* 169: 2403-08.

WALDRON, T. 2009. *Palaeopathology.* Cambridge Manuals in Archaeology. Cambridge: Cambridge University Press.

WALTON, P. & G. EASTWOOD. 1983. *A brief guide to the cataloguing of archaeological textiles*. York: Wordplex Wordprocessing Bureau.

WALTON, P. 2006. Textiles, in BRICKLEY, M., S. BUTEUX, J. ADAMS & R. CHERRINGTON 2006. *St Martin's Uncovered: investigations in the churchyard of St Martin's-in-the-Bull Ring, Birmingham, 2001: 163-78*. Oxford: Oxbow Books.

WILSON, A. D. & R. F. BATCHELOR. 1967. Dental Silicate Cements. I. The Chemistry of Erosion. *Journal of Dental Restoration* 46: 1075-85.

WINTHER, S.D. 2009. Af jord er du kommet. En analyse af Kirkegården ved Farimagsvejen set i et kulturhistorisk og tværfagligt perspektiv samt en vurdering af nyere tids arkæologi. Unpublished M.Sc. dissertation. Københavns Universitet.

WOOD, J.W., MILNER, G.R., HARPENDING, H.C. & WEISS, K.M. 1992. The osteological paradox: problems of inferring prehistoric health from skeletal samples. *Current Anthropology* 33(4): 343-370.

WHITE, T.D. & P.A. FOLKENS. 2000. *Human osteology (Second Edition)*. San Diego: Academic Press.

Archaeological reports and archive material

HALD, M.M. 2011. Report on soil and botanical analysis from Assistens Kirkegård, KBM3830. Københavns Museum.

JENSEN, J. & DAHLSTRÖM, H. 2009. Beretning for Skt. Clemens I og III. Udgravning af den nordlige del af kirkegården tilhørende den middelalderlige Skt. Clemens kirke. Københavns Bymuseum

JØRKOV M.L.S. 2014. Antropologisk analyse af skeletterne fra Homen Kirke NM538/2013. Antropologisk Laboratorium, Københavns Universitet.

KEENAN, S. & J. MOSEKILDE. 2011. KBM3951 Vartov 2011. Osteologisk rapport. Københavns Museum.

KØBENHAVNS BYMUSEUM. 2009. Redegørelse for den arkæologiske udgravning på Assistens Kirkegård i forbindelse med Metro Cityringen. Københavns Museum.

MOSEKILDE, J. 2010. KBM 3914 Pladsen ved Vartov. Københavns Museum.

MOSEKILDE, J. 2011. KBM 3951 Vartov/Lavendelstræde. Københavns Museum.

POULSEN, L. 2006. Kirkegården ved Farimagsvejen. Arkæologisk udgravning af en kirkegård fra midten af 1800-tallet i Upsalagade og Malmøgade. KBM 3313 Upsalagade. Københavns Bymuseum.

RIMSTAD, C. 2011. Textiles from Assistens Kirkegård, KBM3830. Københavns Museum.

SIMONSEN, R. 1994. Beretning vedrørende arkæologiske undersøgelser I Vigerslev Parken, matr. Nr. 1849, Vigerslev Kvarter. KBM 1204. Københavns Bymuseum.

WIENE, I. 2010. Assistens Kirkegård. Rapport om skrevne kilder med relation til den arkæologiske gravning på Assistens Kirkegård. KBM 3830. Københavns Museum.

ZANDER, K. 2009. Assistens Kirkegård. Københavns Bymuseum.

Museum of Copenhagen strategy documents

Feature Typology. 2010. Københavns Museum.

Field Manual. 2010. Københavns Museum.

Finds Handbook. 2010. Københavns Museum.

Projekthåndbog. 2009. Københavns Museum.

Report Management. 2010. Policy, Management and structure regarding reports at Copenhagen Museum. Københavns Museum.

Thomasson, J. 2010. Guidelines for contextual documentation. Definitions and typology for contexts, subgroups and groups. Principles for contextual grouping of contexts. Københavns Museum.

Thomasson, J. & Høst-Madsen, L. 2009. Project design for archaeological investigations to be carried out on the Cityring Metro, stage 4 project in Copenhagen. Introductory report on the background knowledge, objectives, organisation and methodology. Københavns Museum.

Internet references

AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS, 2011: Total hip replacement. Available at http://orthoinfo.aaos.org/topic.cfm?topic=a00377 (accessed 19 September 2011).

ANDERSEN, H.T. & S, ENGELSTOFT. 2004. The end of urbanization? Transformation of the urban concept. Paper presented at the International Geographical Union conference, Ljubljana, Slovenia. Available at: doi: 10.1.1.111.8895

BRADLEY, B.S. & A. PARISH 2009. Scurvy. Available at: http://emedicine.medscape.com/article/985573 (accessed 1 April 2011).

COE, F.L., A. EVAN & A. WORCESTER. 2005. Kidney stone disease. *The Journal of Clinical Investigation.* 115 (10). Available at: http://www.jci.org/articles/view/26662 (accessed 1 September 2011).

CONNELL, B. 2008. Preservation and archaeological data, in N. Powers (ed.) *Human Osteology Method Statement.* Museum of London. Available at: http://www.museumoflondon.org.uk/NR/rdonlyres/2D513AFA-EB45-43C2 - AEAC30B256245FD6/0/MicrosoftWordOsteologyMethodStatementMarc h2008.pdf (accessed 1 February 2010).

FORSVARET REKRUTTERING n.d. Available at: http://forsvaretsuddannelser.dk/ForsvaretsDagOgVaernepligt/Pages/de_vaernepligtiges_gennemsnitshoejde.aspx (accessed 1 August 2011).

KOMLOS, J., 1993. The secular trend in the biological standard of living in the United Kingdom, 1730-1860. *The Economic History Review* 46 (1): 115-144. doi: 10.1111/j.1468-0289.1993.tb01325

KUAS Vejledning 2010. Vejledning om gennemførelse af arkæologiske undersøgelser, kapitel 6. Konservering og Naturvidenskab, Antropologiske analyser. Kulturarvsstyrelsens hjemmeside per 11. Available at: http://www.kulturarv.dk/fortidsminder/forvaltning-og-tilsyn/arkaeologi-paa-land/vejledning-om-arkaeologiske-undersoegelser/kap-6-konservering-og-naturvidenskab/ (accessed 2.10.2009).

KULTURARVSSTYRELSEN. 2011. *Fund og Fortidsminder.* Available at: http://www.kulturarv.dk/fundogfortidsminder/ (accessed 27 July 2011).

NHS. 2010. Kidney stones. Available at http://www.nhs.uk/conditions/Kidney-stones/Pages/Introduction.aspx (accessed 1 September 2011).

POWERS, N. (ed.) 2008. Human Osteology Method Statement. Museum of London. Available at: http://www.museumoflondon.org.uk/NR/rdonlyres/2D513AFA-EB45-43C2-AEAC30B256245FD6/0/MicrosoftWordOsteologyMethodStatementMarch2008.pdf (accessed 1 February 2010).

TRINITATIS HISTORISKE KILDER 2010. Available at: http://kilder.rundetaarn.dk (accessed October 2010).

SOMMER, A.L. Mariebjerg Kirkegårds Krematorium. Available at: http://www.kulturarv.dk/1001fortaellinger/da_DK/mariebjerg-kirkegaards-krematorium/stories/ligbraending-vinder-frem (accessed 1 August 2011).

SANDBERG L. G.& R. H. STECKEL 1987. Heights and economic history: the Swedish case. *Annals of human* biology. 14 (2): 101-109. doi:10.1080/03014468700006842

UBELAKER, D. H., JONES, E. B. & LANDERS, D.B. 2003. *Human remains from Voegtly Cemetery, Pittsburgh, Pennsylvania*, Smithsonian Contributions to Anthropology; 46. Available at: http://hdl.handle.net/10088/1349 [Accessed on 1.8.2011]

Abbreviations

F: Finds objects number, refer to IntraSIS database

Fig: Figure

G: Group identity, refer to IntraSIS database

KBM: Museum of Copenhagen (Københavns Museum) also used as Archive reference numbers to cases from 1988. Museum of Copenhagen

P: Sample analysis identity, refer to IntraSIS database

S: Stratigraphical object identity, refer to IntraSIS database

SB: Skeleton context number

SK: Coffin context number

KUAS: (Kulturarvsstyrelsen) Danish Agency for Culture

10 Appendices

Appendix 1 Subclass data for stratigraphical objects in IntraSIS

Appendix 2 Subclass data for finds objects in IntraSIS

Appendix 3 Data from cremation tags

Appendix 4 Data from rings with inscriptions or dates

Appendix 5 Data from gravestones

Appendix 6 Preservation and completeness according to type of analysis: Full analysis, low resolution analysis and field assessed

Appendix 7 Demographic overview of sub-grouped sex categories for all data (N=854)

Appendix 8 Demographic overview of fully analysed skeletons (N=338)

Appendix 9 Demographic overview of skeletons with low resolution analysis (N=111)

Appendix 10 Demographic overview of field assessed skeletons (N=405)

Appendix 11 Combined demographic overview of fully analysed skeletons and skeletons of low resolution analysis (N=449)

Appendix 12 IVD recorded in adults at vertebral interface level

Appendix 13 Prevalence of SN recorded in adults at the vertebral interface level

Appendix 14 Prevalence of OA in individual extra spinal joints of the upper limbs seen in males and females. No OA observed in upper limb joints among unsexed adults

Appendix 15 Prevalence of OA in individual extra spinal joints of the lower limbs seen in males and females. No OA observed in lower limb joints among unsexed adults

Appendix 16 Summary of fractures by element (N=36). The prevalence is calculated based on number of injured individuals and not based on frequency of element present. Elements in hand and feet relate to metacarpals/metatarsals and phalanges

Appendix 1 Subclass data for stratigraphical objects in IntraSIS

Stratigraphic objects	Attributes	
Coffin	Internal features	
	External features	
	Placement within grave plot	
	Lid	
	Head	
	Sides	
	Foot	
	Base	
	Preservation	
	Type	
	Coffin lid	
	Material	
	Shape	
	Treatment	
	Intact	Tick
	Unusual features	
Cut	**Attributes**	
	Interpretation	
	Shape in plan	
	Break in slope	
	Side	
	Base	
	Truncated	Tick
	Truncated notes	
Deposit	**Attributes**	
	Interpretation	
	Colour	
	No finds	Tick
	Composition	
	Compact	
	Boundaries and interface	
	Truncated	Tick
	Truncated notes	
	Charnel deposit	Tick
	Occasional inclusions	
	Moderate inclusions	
	Frequent inclusions	
Disturbance	**Attributes**	
	Type	
	Side	
Skeleton	**Attributes**	
	Skull	
	Torso	
	Pelvis	
	Arms and hands	
	Legs and feet	
	Preservation	
	Soft tissue	Tick
	Position in coffin	
Structure	**Attributes**	
	Interpretation	
	Material	
	Brick dimensions	
	Brick colour	
	No. of courses	
	Material	
	Timber setting	
	Cross section	
	Condition	
	Preservation	
Urn	**Attributes**	
	Lid	
	Base	
	Sides	
	Preservation	
	Type of urn	
	Material	
	Shape design	

	Position in grave plot	
	Treatment	
	Intact urn	Tick
	Unusual features	
	Cremation tag	
Group/ Charnel	**Attributes**	
	Interpretation	
	Selective bones	Tick
	Grave plot position	
	Placement	
	Completely excavated	Tick
	Carefully dug grave	Tick
	Dating	
Group/ Construction	**Attributes**	
	Form	
	Grave plot position	
	Dating	
	Positive ID source	
	Completely excavated	Tick
	Indication of ownership	
	Internal fittings	
	Reused materials	
	Coursing /roof	
	Coursing/walls	
	Coursing/floor	
Group/ Cremation	**Attributes**	
	Grave plot position	
	Positive ID source	
	Placement	
	Completely excavated	Tick
	Carefully dug	Tick
	Dating	
	Structure associated with burial	
	Indication of ownership	
	Cremation tag	Tick
Group/ Inhumation	**Attributes**	
	Grave plot position	
	Single burial?	Tick
	Positive ID source	
	Osteo gender	
	Placement	
	Completely excavated	Tick
	Carefully dug	Tick
	Dating	
	Structure associated with burial	
	Indication of ownership	
	Ritual inside coffin	
	Ritual outside coffin	
	Coffin details	
Group/ Other	**Attributes**	
	Phase	
	Subtype	
	Interpretation	
	Dating	
	Material	
	Finds	Tick
	Intact	Tick
	Completely excavated?	Tick
	Coursing/walls	

Appendix 2 Subclass data for finds objects in IntraSIS

Find Subclasses	Attributes	
Button	Type	
	Colour	
	No. of holes	
	Textile	Tick
	Decorated?	Tick
	Found at?	
Ceramics	**Attributes**	
	Ware	
	Subtype ware	
	Colour	
	Primary technique	
	Secondary technique	
	Internal decoration	
	External decoration	
	Internal glaze	
	External glaze	
Clay pipe	**No specific attributes**	
Coin	**Attributes**	
	Coining year?	
Glass	**No specific attributes**	
Gravestone	**Attributes**	
	Colour	
	Name?	Tick
	Area	
	Name	
	Year birth	
	Year death	
	Other text?	
	Decoration	
Human bone	**Attributes**	
	Charnel deposit?	**Tick**
	No. of bones	
	Preservation	
	Adult MNI	
	Juvenile MNI	
	Male	
	Female	
	Skull	
	Torso and pelvis	
	Arms and hands	
	Legs and feet	
Prehistoric	**No specific attributes**	
Jewellery	**Attributes**	
	Condition	
	Decoration	
	Inscription?	Tick
	Year	
	Name	
	Stamps	
Leather	**No specific attributes**	
Metal	**No specific attributes**	
Textile	**Attributes**	
	Location	
	Found at?	
	Type	
	Material	
	Colour	
	Evidence of fastenings?	Tick
	Edge preserved	Tick
	Weave	
	Spinning	
	Decoration	
	Thread thickness	
	Thread per cm	
	Stitches	

Appendix 3 Data from cremation tags

ID	Fragmentation	Number	Weight	Description
200229	Intact	1	42,5	Pink oval tag 2719 B/1967
200230	Fragment	1	39	Pink tag fragments no ID visible
200231	Intact	1	25	Oval cream white tag stamped as 4853 nothing on other side
200232	Intact	1	43,5	Pink oval tag 1111 B/XX69 XX is obscured by fused mud
200233	Intact	1	34	Pink rectangular tag with rounded edges 344 1928
200235	Intact	1	37,8	Cream white rectangular tag with rounded edges and corners 1302 1930
200236	Intact	1	27,5	Pink oval tag 2256 B1939
200237	Fragment	1	30,5	Cream grey oval tag, only partially complete 394X B195X Also found near these urns was a piece of wire with small copper alloy round tag but with no inscription. Presumably similar to those found around urns but disturbed
200238	Intact	1	48	Cream white circular tag stamped within a rectangle 20782
200239	Intact	1	40,5	Pink oval tag 1791 B/1978
200286	Fragment	1	25	Pink oval tag B1940/ 2144 stamp
200386	Intact	1	38	Grey rectangular tag with rounded corners and edges 1934/ 156 (or 8) 2 1934 side and the edges are scorched
200387	Fragment	1	27	Pink tag, writing difficult to see and scorched by fire 669/ ?1929
200388	Fragment	1	39	Cream white tag with encrusted lime on edges making writing difficult to see B19 (3?) 1063
200932	Intact	1	32	Pinkish rectangular tag with rounded edges 626/ B1936
201123	Intact	1	20	Cremation tag. cream white, circular ceramic fired tag. One side blank, the other stamped with 2640. Found in cemetery soil of Area 1 where there were a lot of cremations but was not physically near any of them
201126	Intact	1	25,5	Pink oval tag B1938 379
201127	Intact	1	32	Pink rectangular tag 1927 224
201147	Intact	1	34	Pink oval tag B1957 2017
201489	Intact	1	28	Cream white oval tag B1945/ 2321 (The 3 could be an 8)
201490	Intact	1	41	Rectangular pink tag B1936/ 1709 stamped clearly Also came with a lead disc and wire, the disc is plain and shows some stamp that cannot be read clearly
201662	Intact	1	23	Pinkish cream oval tag 3471 stamped

				W or M engraved, clear signs of a tool used to create it. This is so far unique for the cremation tags in the collection
201917	Intact	1	39	Tag in good condition, pinkish on one side (1751), light grey on the B1936 side. It has a small piece of lead fused to one side, unknown shape, possibly fused during cremation from the coffin? B1936 1751
203431	Intact	1	10	Oval pinktag B1948 1694
203806	Intact	1	12	Grey oval ceramic tag with ID of 9988. No year
201125	Intact	1	2	Paper tag, written in black ink: 185/1956 Carl Brorson

Appendix 4 Data from rings with inscriptions or dates

ID	Fragmentation	Weight	Diameter	Description	Decorated	Year	Name	Stamps
200099	Complete	5	19			0	Thomy van Jessen	5
200209	Intact	4	22,5	29th April 1844	Plain	1844	Caroline Kirketorp	2
200213	Intact	2,5	19,5	1st Octbr 1866		1866	Johan	4
200214	Intact	3	20	1st Octbr 1866 Pair of wedding rings Johan and Anna	Plain	1866	Anna	4
200215	Intact	2	18,8		Plain	1869	AL?	4
200216	Intact	3	21,3		Plain	1893	JM	5
200217	Intact	3	19,8	30-06-09	Plain	0	TBK	2
200218	Intact	2	22,7	d. 18. [damage) 1863		1863	AB	4
200220	Intact	4,5	22			0	Hanne Tidemann	4
200565	Intact	2,5	0	6 Juli 1861	Plain	1861	Nathalie Hertel	4
200566	Intact	1,5	0	6 Juli 1861	Plain	1861	Alke Bentzen	4
200567	Intact	2	0	d 18 Jan 1852	Plain	1852	CJ	5
200780	Intact	2,5	0	25/ 5. 1902		1902	A. O. Saarbye	4
200781	Intact	5,5	23	5/8 03	Plain	0	JH	4
201042	Intact	2,5	0	d. 2 April 1847	Plain	1847	BL	5
201043	Intact	3	19,5	Found with F201056	Stones	0	HB	1
201050	Intact	3,5	23			0	Heimburger	4
201053	Intact	4,5	24	24 Juli 1851		1851	LW	4
201054	Intact	0,5	18,7	19 Januari 1816	Decorated	1816	KH	0
201055	Intact	4	21	27 de Mai 1874 Two are matching wedding rings, which have later been cut and fixed together to be worn by one person, possibly the heavier ring was too big to be worn and attaching it to the smaller made it easier to wear without coming off. In cutting the rings, the inscriptions were slightly cut off at the top		1874	A. M.	4
201056	Intact	3	19,8	Found with F201043 26/3	Stones	0	H Bomditz	2
201057	Intact	7,5	21	d. 29 Marts 1875		1875	CNL	4
201375	Intact	2,5	17,5	Ring modified to fit together with another F203817 d.7th Apr. 1828		1828	CO	6
201376	Intact	3,5	23,4	d. 18. August 1842		1842	KW	1
201377	Intact	2	18,5			0	P Hjorth	3
201379	Intact	3,5	19,8	d. 27 Januar 1873		1873	OC Groth...id	4
201727	Intact	1,5	20			0	KH	2
201784	Complete	2,5	19	d. 7t Decb 1858 Found with F203815		1858	henriette	0
201904	Intact	4,5	22	11/3 1912		1912	Elizabeth	2
201909	Intact	4,5	21	d. 6 October 1864		1864	ER	4
201915	Intact	2	20	1874		1874	J[S orP] N	0
201916	Intact	3,5	0	Din Sine Lina d. 21 [uncertain - 21 Janr?]		1858	Sine, Line	1
202393	Complete	3	19,5	Apr 1849	Plain	1849	Mathilde	5
202394	Intact	2	0	29 Juli 1860	Plain	1860	LCP	4

202479	Intact	2	18	d 17 Octbr 1868	Plain	1868	EP	2
202600	Complete	4	23	d. 27 October: 1867	Plain	1867	A.S.	4
203817	Intact	2	17,5	Modified on the interior on both the top and bottom of the ring with a bevelled edge. This suggests that there was a third ring to which these were attached but were not placed in with the burial Found with F201375		1828	unreadable	4
203819	Intact	3,5	21			1874	F or J??	4

Appendix 5 Data from gravestones

ID	Name	Material	Description	Colour	Area	Name	Year of birth	Year of death
203824	Reused	Marble	In three pieces, no grey colour left in letters, reused as a structure OTTO KYHN * 18 2 1893 CROSS 14 10 1918 CAROLINE KYHN * 7 7 1864 CROSS 24.....	White	2	Otto & Caroline Kyhn	1893	1918
203825	Reused	Marble	In pieces, no family name is visible	White	2	Gabrielle, Frederik	184x	187x
203826	Reused	Marble	4 individuals from the same family, the earliest death is from 1863, latest is 1897 Reused in structure	White	2	Kummerlehn	1817	1897
203827	Reused	Stone	Polished stone reused as structure ' housewife' the only text	Black	2	Hassenau Petersen	1855	1885
203828	Redeposited	Marble	The gravestone found residual in deposit, measured 610 x 350 x 20 mm. The text: HER UNDER HVILER STØVET AF IOHANNE DORTHEA PAULSEN FØDT DEN 14 MAI 18XX DØD DEN 16. OKTOBER 1823 (93?) OG N: PAULSEN FØDT DEN XX SEPTEMBER 1766 (86?) DØD DEN XX APRIL 18XX FRED MED DIT STØV ELLEN SOPHIE PAULSEN FØDT DEN 2. FEBRUARI 1777 DØD DEN 15. MAI 1860 This person is possibly identified as Enkemadam Poulsen buried on 21-05-1860 in plot 32 which is at the far end of the cemetery site	White	2	Paulsen	1777	1860
203829	Redeposited	Marble	Polished stone with willow branch in top right hand corner, gold lettering. Found in Area 5 within the 1m zone, approximately over plots 56-55 within the cemetery soil, found by machine	Black	5	Groth	1833	1904
203830	Reused	Stone	Many other fragments some with small amounts of text were found in this repair, so clear reuse of the stones, either for structural purposes or drainage (preventing soil blocking up the drain)	Natural stone	3	Hansen & Rabe	1889	1920
203831	Redeposited	Marble	Found in August 2010 excavation of Area 2 - deeper section for graverbolig. Approximately	Black	2	Lillian	1914	1918

			over plots 497-502, children's graves, found with many others. Branch motif.					
203832	Redeposited	Marble	Found in August 2010 excavation of Area 2 - deeper section for graverbolig. Approximately over plots 497-502, children's graves, found with many others	White	2	Vånsgaard	1911	1918
203833	Redeposited	Marble	Found in August 2010 excavation of Area 2 - deeper section for graverbolig. Approximately over plots 497-502, children's graves, found with many others	White	2	Ludwig & Kirstine Stein	1815	1897
203834	Redeposited	Marble	Found in August 2010 excavation of Area 2 - deeper section for graverbolig. Approximately over plots 497-502, children's graves, found with others.	White	2	Many fragments		
203835	Reused	Marble	Found in topsoil strip of Area 2 garden by the greenhouse, used as some kind of footing.	White	2	Hansen	1792	
203836	Reused	Marble	Unusual stone - black with pink marbling and unusual shape, it has rough edges. Aksel - first name only. Found by footings, so possibly repair around graverbolig during excavation and lifting of the building, used as some kind of drainage or structural repair	Black	3	Aksel		
203837	Redeposited	Marble	VED FORÆLDRES OG HUSTRUS SIDE, NEDLAGDES HERAF SINE SØRGENDE BØRN DEN AF LIVET TR\'c6TTEOLDNING J.S. AARESTRUP HAN VAR FLITTING OG RETSINDING I AL SINE FØRD MANGE VELSINGE HANS MINDE HAN HAR NU EJENFUNDET SIN HUSTRU SINE 4 BØRNS MODER, VED HVIS TIDLIGE BORTGANG HANS HJERTE BRAST There are no dates on this stone, only found in database in grave plot 739, died in 1862. A second stone found in fragments, also in Area 4 den kjærlige foder, hørkræmmer ...aarestrup mar... hviler... fred vær...	White	7	J.S. Aarestrup		1862
203838	Redeposited	Marble	...JANUAR 1866 11 MARTS 1926 MARIE BOLINE ANDREASEN	White	6	Marie Boline Andreasen	1869	1943

			*24 OKTOBER 1869 CROSS 24 SEPTEMBRE 1943 Found in topsoil strip in Area 6					
203839	Redeposited	Marble	CROSS HER HVILER M.M. SCHMIDT FOD MORK [UNCERTAIN] FØDT? D:29 DE JANUARI AAR 1749 DOD D: 1TE FEBRUARI AAR 1821 Unusually thick, with chiselled edges, unusual style	White	4	M. M. Schmidt	1749	1821
203840	Redeposited	Stone	CROSS TOLDASSISTENT CARL HENRY DELCOMYN M\'d8LLER * 28-2 1871 CROSS 1-5 1916 Found in topsoil strip of Area 4, exact position unknown but individual has been identified in Plot 677	Black	4	Carl Delcomyn Møller	1871	1916
203841	Redeposited	Marble	...RISTIAN HOLMSTEDT 1 AAR CROSS 1858 ...RISTIAN HOLMSTEDT r 5 AAR CROSS 1865 ...A MARIE ELISABETH 3 AAR CROSS 1865 Unknown location of this stone, thought to be Area 5	White	5	Christian Holmstedt	1862	1865
203842	Redeposited	Marble	CROSS HER HVILER MOR K\'c6RE MAND OG FADER TYPOGRAF ANTON NIELSEN * 18.2 1842, CROSS 5.12 1918 VOR KÆRE MODER OG BEDSTEMODER ANE MARIE NIELSEN F. SØRENSEN ...9.3 1840, CROSS 7.4 1923 ...FRED Unknown location, thought to be Area 5	White	0	Anton & Anne Marie Nielsen	1840	1923
203843	Redeposited	Marble		White	5	Møller	1854	1887
203844	Redeposited	Marble		White	0	Hvalsoe	1871	1925
203845	Redeposited	Marble	Cross	White	0	Petersen	1890	1921
203846	Redeposited	Marble		White	0	Dahl	1788	1864
203847	Redeposited	Marble		White	0	Pedersen	1861	1928

203848	Redeposited	Marble	Scroll at base of the stone	White	0	Luplow	1831	1876
203849	Redeposited	Stone	Cross	Black	0	Anton		
203850	Redeposited	Marble		White	0	Jørgensen		
203851	Redeposited	Marble		White	0	J.G.H Jørgensen	1860	1928
203852	Redeposited	Marble		White	0	Niels W		
203853	Redeposited	Marble		White	0	Melchiorsen		
203854	Redeposited	Marble		White	0	F. Dinesen		
203855	Redeposited	Stone	Headstone part, shaped, curved at top -uschlag -uschlag German? Unusual colour and mottled pink-red granite		0			
203856	Redeposited	Marble	Round inset for a larger gravestone. Consisting of winged angel carrying two infants and some kind of bird. Bertil Thorvaldsen sculpture.	White	2			
203857	Redeposited	Stone		Natural stone	0	Else		
203858	Redeposited	Stone		Natural stone	0	Ingeborg /Sophus		
203859	Redeposited	Stone		Natural stone	0	Daniel Jensen	1871	1947
203860	Redeposited	Stone	Unusual pinkish grey colour	Natural stone	0	Mor		
203861	Redeposited	Stone		Natural stone	0	Får og Mor		
203862	Redeposited	Marble	Cross	Black	0	Matilda -rtvig		
203863	Redeposited	Stone	Long block of grey granite, no markings or decoration. part of the 'body' of the cross	Natural stone	0			
203864	Redeposited	Stone	Pink grey colour /Branch motif	White	0	Emil Egeso		
203865	Redeposited	Marble		White	0	Adolph-/-riksen		
203866	Redeposited	Marble		White	0	Karl o.		

Appendix 6 Preservation and completeness according to type of analysis: Full analysis, low resolution analysis and field assessed

Full analysis

	Preservation									
	Good		Moderate		Poor		Unknown		Total	
Completeness	n	%	n	%	n	%	n	%	n	%
Group 1 (<25%)	5	35.7	7	50.0	2	14.3	0	0.0	14	4.1
Group 2 (<50%)	7	58.3	3	25.0	2	16.7	0	0.0	12	3.6
Group 3 (<75%)	20	46.5	20	46.5	3	7.0	0	0.0	43	12.7
Group 4 (<95%)	201	74.7	66	24.5	2	0.7	0	0.0	269	79.6
Unknown	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	233	68.9	96	28.4	9	2.7	0	0.0	338	100.0

Low resolution analysis

	Preservation									
	Good		Moderate		Poor		Unknown		Total	
Completeness	n	%	n	%	n	%	n	%	n	%
Group 1 (<25%)	1	7.1	3	21.4	10	71.4	0	0.0	14	12.6
Group 2 (<50%)	0	0.0	3	37.5	5	62.5	0	0.0	8	7.2
Group 3 (<75%)	2	13.3	8	53.3	5	33.3	0	0.0	15	13.5
Group 4 (<95%)	32	44.4	34	47.2	6	8.3	0	0.0	72	64.9
Unknown	0	0.0	0	0.0	0	0.0	2	0.0	2	1.8
Total	35	31.5	48	43.2	26	23.4	2	1.8	111	100.0

Field assessed

	Preservation									
	Good		Moderate		Poor		Unknown		Total	
Completeness	n	%	n	%	n	%	n	%	n	%
Group 1 (<25%)	12	18.8	32	50.0	20	31.3	0	0.0	64	15.8
Group 2 (<50%)	12	29.3	10	24.4	19	46.3	0	0.0	41	10.1
Group 3 (<75%)	11	30.6	17	47.2	8	22.2	0	0.0	36	8.9
Group 4 (<95%)	57	45.6	51	40.8	17	13.6	0	0.0	125	30.9
Unknown	0	0.0	0	0.0	0	0.0	139	0.0	139	34.3
Total	92	22.7	110	27.2	64	15.8	139	34.3	405	100.0

Appendix 7 Demographic overview of sub-grouped sex categories for all data (N=854)

		Male		Possible male		Ambiguous		Possible female		Female		Unknown sex		Total	
Age group	**Years**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Infant	≤36gw-<1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	51	100.0	51	6.0
Child	1-11	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	52	100.0	52	6.1
Adolescent	12 - 17	1	7.7	1	7.7	1	7.7	0	0.0	4	30.8	6	46.2	13	1.5
Young adult	18 - 25	12	48.0	2	8.0	0	0.0	2	8.0	9	36.0	0	0.0	25	2.9
Middle adult	26 - 45	65	40.4	16	9.9	3	1.9	16	9.9	59	36.6	2	1.2	161	18.9
Mature adult	46 - 55	63	47.4	12	9.0	2	1.5	13	9.8	43	32.3	0	0.0	133	15.6
Old adult	56+	69	35.9	9	4.7	2	1.0	23	12.0	89	46.4	0	0.0	192	22.5
Adult	18+	39	17.4	31	13.8	33	14.7	31	13.8	33	14.7	57	25.4	224	26.2
Subadult	<18	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	100.0	3	0.4
Total		249	29.2	71	8.3	41	4.9	85	10.0	237	27.8	171	20.0	854	100.0

Appendix 8 Demographic overview of fully analysed skeletons (N=338)

		Male		Female		Unknown sex		Total	
Age group	**Years**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Infant	≤36gw-<1	0	0.0	0	0.0	41	100.0	41	12.1
Child	1-11	0	0.0	0	0.0	35	100.0	35	10.4
Adolescent	12 - 17	0	0.0	2	28.6	5	71.4	7	2.1
Young adult	18 - 25	6	42.9	8	57.1	0	0.0	14	4.1
Middle adult	26 - 45	22	43.1	29	56.9	0	0.0	51	15.1
Mature adult	46 - 55	36	55.4	29	44.6	0	0.0	65	19.2
Old adult	56+	45	42.1	59	55.1	2	1.9	107	31.7
Adult	18+	7	38.9	9	50.0	2	11.1	18	5.3
Subadult	<18	0	0.0	0	0.0	0	0.0	0	0.0
Total		117	34.6	136	40.2	85	25.1	338	100.0

Appendix 9 Demographic overview of skeletons with low resolution analysis (N=111)

		Male		Female		Unknown sex		Total	
Age group	**Years**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Infant	≤36gw-<1	0	0.0	0	0.0	1	100.0	1	0.9
Child	1-11	0	0.0	0	0.0	8	100.0	8	7.2
Adolescent	12 - 17	1	33.3	2	66.7	0	0.0	3	2.7
Young adult	18 - 25	4	100.0	0	0.0	0	0.0	4	3.6
Middle adult	26 - 45	13	43.3	17	56.7	0	0.0	30	27.0
Mature adult	46 - 55	11	61.1	7	38.9	0	0.0	18	16.2
Old adult	56+	11	37.9	18	62.1	0	0.0	29	26.1
Adult	18+	6	37.5	6	37.5	4	25.0	16	14.4
Subadult	<18	0	0.0	0	0.0	2	100.0	2	1.8
Total		46	41.4	50	45.0	15	13.5	111	100.0

Appendix 10 Demographic overview of field assessed skeletons (N=405)

		Male		Female		Unknown sex		Total	
Age group	**Years**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Infant	≤36gw-<1	0	0.0	0	0.0	9	100.0	9	2.2
Child	1-11	0	0.0	0	0.0	9	100.0	9	2.2
Adolescent	12 - 17	1	33.3	0	0.0	2	66.7	3	0.7
Young adult	18 - 25	4	57.1	3	42.9	0	0.0	7	1.7
Middle adult	26 - 45	46	57.5	29	36.3	5	6.3	80	19.8
Mature adult	46 - 55	28	56.0	20	40.0	2	4.0	50	12.4
Old adult	56+	21	37.5	35	62.5	0	0.0	56	13.8
Adult	18+	57	30.0	49	25.8	84	44.2	190	46.9
Subadult	<18	0	0.0	0	0.0	1	100.0	1	0.3
Total		157	38.8	136	33.6	112	27.7	405	100.0

Appendix 11 Combined demographic overview of fully analysed skeletons and skeletons of low resolution analysis (N=449)

		Male		Female		Unknown sex		Total	
Age group	**Years**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Infant	≤36gw-<1	0	0.0	0	0.0	42	100.0	42	9.3
Child	1-11	0	0.0	0	0.0	43	100.0	43	9.6
Adolescent	12 - 17	1	10.0	4	40.0	5	50.0	10	2.2
Young adult	18 - 25	10	55.6	8	44.4	0	0.0	18	36.7
Middle adult	26 - 45	35	43.2	46	56.8	0	0.0	81	18.0
Mature adult	46 - 55	47	56.6	36	43.4	0	0.0	83	18.5
Old adult	56+	57	41.9	77	56.6	2	1.5	136	30.3
Adult	18+	13	38.2	15	44.1	6	17.6	34	7.6
Subadult	<18	0	0.0	0	0.0	2	100.0	2	0.4
Total		163	36.3	186	41.4	100	22.3	449	100.0

Appendix 12 IVD recorded in adults at vertebral interface level

Vertebral interface	Total no. of vertebrae registered	Males		Females		Unsexed adults		Total no. of vertebrae with IVD	
	N	n	%	n	%	n	%	n	%
C1-C2	230	0	0.0	0	0.0	0	0.0	0	0.0
C2-C3	268	10	37.0	16	59.3	1	3.7	27	10.1
C3-C4	265	16	27.6	31	53.4	2	3.4	58	21.9
C4-C5	266	38	45.8	52	62.7	3	3.6	83	31.2
C5-C6	268	43	48.3	55	61.8	3	3.4	89	33.2
C6-C7	261	43	44.8	50	52.1	3	3.1	96	36.8
C7-T1	262	16	40.0	23	57.5	1	2.5	40	15.3
T1-T2	254	10	40.0	14	56.0	1	4.0	25	9.8
T2-T3	247	9	37.5	14	58.3	1	4.2	24	9.7
T3-T4	240	7	31.8	15	68.2	0	0.0	22	9.1
T4-T5	230	7	35.0	13	65.0	0	0.0	20	8.7
T5-T6	233	15	48.4	16	51.6	0	0.0	31	13.3
T6-T7	232	12	36.4	21	63.6	0	0.0	33	14.2
T7-T8	239	9	28.1	23	71.9	0	0.0	32	13.4
T8-T9	241	13	34.2	25	65.8	0	0.0	38	15.8
T9-T10	239	12	41.4	17	58.6	0	0.0	29	12.1
T10-T11	239	12	35.3	21	61.8	1	2.9	34	14.2
T11-T12	245	16	40.0	23	57.5	1	2.5	40	16.3
T12-L1	249	9	36.0	16	64.0	0	0.0	25	10.0
L1-L2	243	12	35.3	22	64.7	0	0.0	34	14.0
L2-L3	242	10	34.5	19	65.5	0	0.0	29	12.0
L3-L4	241	12	33.3	24	66.7	0	0.0	36	15.0
L4-L5	242	13	35.1	24	65.0	0	0.0	37	15.3
L5-S1	244	21	42.0	29	58.0	0	0.0	50	20.5

Appendix 13 Prevalence of SN recorded in adults at the vertebral interface level

Vertebral interface	Total no. of vertebrae registered	Males		Females		Unsexed adults		Total no. of vertebrae with SN	
	N	n	%	n	%	n	%	n	%
C1-C2	264	0	0.0	0	0.0	0	0.0	0	0.0
C2-C3	264	0	0.0	1	100.0	0	0.0	1	0.3
C3-C4	262	0	0.0	1	100.0	0	0.0	1	0.4
C4-C5	262	0	0.0	1	100.0	0	0.0	1	0.4
C5-C6	262	0	0.0	1	100.0	0	0.0	1	0.4
C6-C7	259	0	0.0	0	0.0	0	0.0	0	0.0
C7-T1	257	1	50.0	1	50.0	0	0.0	2	0.8
T1-T2	251	0	0.0	0	0.0	1	100.0	1	0.4
T2-T3	245	1	50.0	1	50.0	0	0.0	2	0.8
T3-T4	237	4	100.0	0	0.0	0	0.0	4	1.7
T4-T5	230	10	83.3	1	8.3	1	8.3	12	5.7
T5-T6	231	23	71.9	8	25.0	1	3.1	32	13.9
T6-T7	231	28	66.7	14	33.3	0	0.0	42	18.2
T7-T8	237	43	63.2	23	34.3	1	1.5	67	28.3
T8-T9	267	47	62.7	27	36.0	1	1.3	75	28.1
T9-T10	236	49	65.3	25	33.3	1	1.3	75	31.8
T10-T11	236	46	59.0	31	39.7	1	1.3	78	33.1
T11-T12	241	52	63.4	29	35.4	1	1.2	82	34.0
T12-L1	246	30	56.6	23	43.4	0	0.0	53	21.5
L1-L2	239	28	60.9	18	39.1	0	0.0	46	19.2
L2-L3	239	18	60.0	12	40.0	0	0.0	30	12.6
L3-L4	241	13	59.1	8	36.4	1	4.5	22	9.1
L4-L5	239	6	40.0	9	60.0	0	0.0	15	6.3
L5-S1	241	3	100.0	0	0.0	0	0.0	3	1.2

Appendix 14 Prevalence of OA in individual extra spinal joints of the upper limbs seen in males and females. No OA observed in upper limb joints among unsexed adults

Joint	Side	Total no. of joints recorded (N)	Male		Female		Total no. of joints with OA	
Upper limbs		**N**	**n**	**%**	**n**	**%**	**n**	**%**
Cran TMJ	R	253	0	0.0	3	100.0	3	1.2
	L	252	1	50.0	1	50.0	2	0.8
Mandib TMJ	R	217	1	50.0	1	50.0	2	0.9
	L	212	1	50.0	1	50.0	2	0.9
Manu stern-clav	R	175	0	0.0	0	0.0	0	0.0
	L	169	0	0.0	0	0.0	0	0.0
Clav stern-clav	R	240	1	100.0	0	0.0	1	0.4
	L	242	0	0.0	0	0.0	0	0.0
Clav acro-clav	R	209	5	71.4	2	28.6	7	3.3
	L	195	4	80.0	1	20.0	5	2.6
Scap acro-clav	R	295	4	80.0	1	20.0	5	2.6
	L	191	4	66.7	2	33.3	6	3.1
Scap glen-cavity	R	228	0	0.0	2	100.0	2	0.9
	L	224	0	0.0	1	100.0	1	0.4
Hum glen-hum	R	214	1	16.7	5	83.3	6	2.8
	L	205	2	50.0	2	50.0	4	2.0
Hum dist trochlea	R	249	1	100.0	0	0.0	1	0.4
	L	236	1	50.0	1	50.0	2	0.8
Hum dist capitate	R	245	4	44.4	5	55.5	9	3.7
	L	242	1	20.0	4	80.0	5	2.1
Rad prox head	R	226	6	54.5	5	45.5	11	4.9
	L	220	1	16.7	5	83.3	6	2.7
Rad prox rad-uln	R	242	0	0.0	0	0.0	0	0.0
	L	232	0	0.0	0	0.0	0	0.0
Rad dist rad-uln	R	230	0	0.0	2	100.0	2	0.9
	L	219	1	25.0	3	75.0	4	1.8
Rad rad-scaphoid	R	227	3	75.0	1	25.0	4	1.8
	L	221	4	66.7	2	33.3	6	2.7
Rad rad-lunate	R	227	0	0.0	2	100.0	2	0.9
	L	221	0	0.0	0	0.0	0	0.0
Uln prox trochlea	R	260	0	0.0	0	0.0	0	0.0
	L	250	0	0.0	0	0.0	0	0.0
Uln prox rad-notch	R	260	0	0.0	0	0.0	0	0.0
	L	249	0	0.0	0	0.0	0	0.0
Uln dist rad-uln	R	195	0	0.0	4	0.0	4	2.1
	L	197	0	0.0	3	0.0	3	1.5

Appendix 15 Prevalence of OA in individual extra spinal joints of the lower limbs seen in males and females. No OA observed in lower limb joints among unsexed adults

Joint	Side	Total no. of joints recorded (N)	Male		Female		Total no. of joints with OA	
Lower limbs		**N**	**n**	**%**	**n**	**%**	**n**	**%**
Pelvis sacro-iliac	R	245	1	100.0	0	0.0	1	0.4
	L	244	0	0.0	2	100.0	2	0.8
Pelvis acetabulum	R	248	3	30.0	7	70.0	10	4.0
	L	237	1	16.7	5	83.3	6	2.5
Femur fem-head	R	254	3	30.0	7	70.0	10	3.9
	L	250	1	16.7	5	83.3	6	2.4
Femur fem-pat-ant	R	244	4	25.0	12	75.0	16	6.6
	L	243	2	14.3	12	85.7	14	5.8
Femur fem-tib-med	R	236	0	0.0	4	100.0	4	1.7
	L	236	2	50.0	2	50.0	4	1.7
Femur fem-tib-lat	R	228	1	100.0	0	0.0	1	0.4
	L	226	1	100.0	0	0.0	1	0.4
Patella fem-pat	R	196	4	36.4	7	63.6	11	5.6
	L	205	2	20.0	8	80.0	10	4.9
Tibia fem-tib-med	R	220	0	0.0	2	100.0	2	0.9
	L	216	1	50.0	1	50.0	2	0.9
Tibia fem-tib-lat	R	206	1	33.3	2	66.7	3	1.5
	L	203	0	0.0	1	100.0	1	0.5
Tibia prox tib-fib	R	157	0	0.0	0	0.0	0	0.0
	L	150	0	0.0	0	0.0	0	0.0
Tibia tibio-talus	R	242	0	0.0	1	100.0	1	0.4
	L	228	0	0.0	0	0.0	0	0.0
Fibula prox fib-tib	R	92	0	0.0	0	0.0	0	0.0
	L	89	0	0.0	0	0.0	0	0.0
Fibula dist fibio-talus	R	179	0	0.0	1	100.0	1	0.6
	L	187	0	0.0	0	0.0	0	0.0

Appendix 16 Summary of fractures by element (N=36). The prevalence is calculated based on number of injured individuals and not based on frequency of element present. Elements in hand and feet relate to metacarpals/metatarsals and phalanges

		Male		Female		Total	
Fracture site	**Side**	**n**	**%**	**n**	**%**	**n**	%
Nose		5	100.0	0	0.0	5	13.9
Clavicle	R	1	100.0	0	0.0	1	2.8
	L	1	100.0	0	0.0	1	2.8
Ribs	R	4	100.0	0	0.0	4	11.1
	L	4	100.0	0	0.0	4	11.1
Humerus	R	1	100.0	0	0.0	1	2.8
	L	0	0.0	2	100.0	2	5.6
Radius	R	0	0.0	3	100.0	3	8.3
	L	0	0.0	0	0.0	0	0.0
Ulna	R	0	0.0	1	100.0	1	2.8
	L	0	0.0	0	0.0	0	0.0
Hand	R	1	100.0	0	0.0	1	2.8
	L	0	0.0	0	0.0	0	0.0
Pelvis	R	0	0.0	1	100.0	1	2.8
	L	0	0.0	0	0.0	0	0.0
Femur	R	1	100.0	0	0.0	1	2.8
	L	0	0.0	2	100.0	2	5.6
Tibia	R	2	100.0	0	0.0	2	5.6
	L	1	100.0	0	0.0	1	2.8
Fibula	R	3	100.0	0	0.0	3	8.3
	L	2	100.0	0	0.0	2	5.6
Foot	R	0	0.0	0	0.0	0	0.0
	L	1	100.0	0	0.0	1	2.8