Burial practices in early Christian Norway

An osteoarchaeological study into differences and similarities between four burial assemblages

Stian Hamre

Dissertation for the degree philosophiae doctor (PhD)

at the University of Bergen

2011

Dissertation date: 26.08.2011

Contents

List of tables

List of figures

Acknowledgments

There are many people who deserve a mention here. Firstly, I would like to extend my thanks to my two supervisors on this project: Sæbjørg Walaker Nordeide (main supervisor) and Anne Karin Hufthammer (second supervisor). Sæbjørg deserves thanks for steady supervision throughout the work with this thesis. She has always been available for discussions and for answering questions I had and that is greatly appreciated. She believed in this project from the start and made a major contribution in supporting my case during the application process and for that I am greatful.

Anne Karin deserves thanks for valuable feedback on my work with this project. I would also like to extend my appreciation for her support during the years leading up to this PhD project. She has always been available for discussions and answering questions; she has given me access to skeletal material (the St. Mary's church material in this study), and has also provided some work experience to an anthropologist with too few job opportunities.

Martina also deserves recognition for her help with proof reading my work and improving the graphics in this thesis. Her patience has also not gone unnoticed during the, sometimes stressful, final stages of this project when I might have been a smidgeon on the grumpy side.

I would also like to thank the staff at the the Bergen, Trondheim and Tønsberg sections of the Directorate for Cultural Heritage and the people at the archives at the Cultural History Museum in Oslo for their help with getting access to the archaeological documentation for the different sites.

Per Holck at the Anatomical Institute deserves thanks for giving me access to the skeletal material from the Hamar cathedral and the St. Peter's church, and I also appreciate the access to the Public Library site material at Vitenskapsmuseet in Trondheim. At Vitenskapsmuseet, I would like to thank the helpful staff with particular mention of Leena Airola who provided more help than could have been expected and Ole Bjørn Pedersen for all his help with the skeletal material. You will be hard pressed to find a more helpful person.

Last, but by all means not least, I would like to thank everybody at the Centre for Medieval Studies who makes it a very enjoyable place to work. In particular, I would like to thank the Director Sverre Bagge for taking a chance and letting and osteologist into an environment where they are few and far between. Torgeir Landro too deserves a mention for answering all my questions regarding the early Christian laws.

Stian Hamre
Bergen 15.02.2011

Abstract

The main topics of this thesis are the burial practices carried out at the time of early Christianity in Norway and how the burial practices relate to the burial regulations given in the provincial laws (Gulating, Frostating, Eidsivating, Borgarting). The study is based on the data collected from the examination of the skeletal material from four different graveyards and the data collected from the archaeological records from the different sites (St. Mary's church in Bergen, Public Library site in Trondheim, Hamar cathedral and the St. Peter's church in Tønsberg). Questions regarding sexual segregation and social stratification of the graveyards have been the main interest of this research, but other features which could have influenced the place of burial have also been touched upon: age, family relations, foreigners.

It has been shown that the sexes were not treated equally on three of the four graveyards: there was no evidence suggesting that the sexes were ever segregated on the graveyard for the St. Mary's church in Bergen. It has also become apparent that the separation of the sexes was adapted to the individual graveyard and did not necessarily follow the north-south division prescribed in the Eidsivating law and a pattern which has been shown on many graveyards in Sweden, Denmark, Iceland and Greenland.

It has been argued that pathological conditions, especially degenerative changes to the joints and vertebrae, can be good indicators of social differences. Based on the distribution of these pathological conditions, strong evidence has been presented in favour of the graveyards having been socially stratified. It seems very likely that an individual's social status decided a person's placement on the graveyard at the Public Library site in Trondheim and for the St. Peter's church in Tønsberg.

1. Introduction

During the 11th century, Norway got its first ecclesiastical laws[1]. Included in the laws were legislation dealing with Christian morals and way of life, the farmers' practical duties with regard to notification of public holidays, building and maintenance of churches, and regulation of burial, christening and marital practices (Landro, 2005:9-10). At the time in question, Norway was divided into four areas of jurisdiction: Gulating, Borgarting, Eidsivating and Frostating (figure 1). Each of these areas of jurisdiction had their own laws, with many similarities, but also with distinct differences. This thesis will be dealing with the legislation concerned with burial practices: more specifically, how differences in legislation, regarding burials, are reflected in the burial practices that were carried out. All four sets of laws state that every Christian who dies shall be taken to church and buried in sacred ground with the exception of criminals and people who committed suicide. The differences between the laws, however, are related to the division of the graveyards. The Borgarting and Eidsivating legislation both divide the graveyard into four separate areas where people should be buried according to social status. The barons (*lendmenn*) should be buried nearest to the church, further out the landowners (*hauldmenn*), then the freed slaves and closest to the graveyard fence the slaves should be buried. The Eidsivating legislation also divides the graveyard into a northern and a southern section where men should be buried south of the church and women north of the church (E I 50, NGL I:391[2]). The north south division is, however, only mentioned in the first version of the Eidsivating legislation. In the second version of the law, this has been subtracted, but an interesting amendment has been made regarding family relations in the graveyard. It states that "*ingen skal grave i annens ættehaug*", which can be

[1] Although the starting point for the development of the laws can be put in the 11th century, the laws are not likely to have been written down until the beginning of the 12th century and have been continuously updated and further developed after that (Landro *2010*).

[2] This is a reference to the Eidsivating law, version 1, chapter 50 (E I 50), as it is found in Norges Gamle Lover, volume 1, page 391 (NGL I:391). Later references to these law texts will follow this format, but with G standing for the Gulating law, B for the Borgarting law and F for the Frostating law.

translated to “no one shall dig in other man’s family mound” (E II 39, NGL I:405). It would be reasonable to interpret this as the presence of family plots on the graveyards. Meaning that plots on the graveyard were reserved for members of a specific family and only members of that family were allowed to be buried there. The sexual north-south division of the graveyard is not compatible with the presence of family plots, as the former dictates a sexual separation of the family while the latter dictates keeping the family together. This change in the legislation between the first and second version may suggest that family relations became more important than the sexual division of the graveyards. This legislation is not found in the other two sets of laws. The Gulating and Frostating legislation do not mention a division of the graveyards. Taking these laws at face value, one would expect to find regional differences in burial practices between the different areas of jurisdiction, and this is one of the questions dealt with in this study.

1.1 Aims and objectives

The main aim for this project has been to identify patterns on the early Christian graveyards which, in turn, could shed some light on what factors determined an individual’s placement on the graveyard, and to determine whether there were regional differences with regard to burial practices in mediaeval Norway. The early Norwegian Christian laws include regulations regarding burials and the laws also indicate that regional differences may have been present. This project has focused on what practices existed as evident from the examination of the skeletal material from four graveyards, and it has been investigated how these burial practices correspond to the regulations given in the laws.

The study was supposed to be limited to the first few centuries of Christianity in Norway, but has been adjusted by the ability to date the skeletal material included in the project. The majority of the material can be dated to the period between the 11th century to the middle of the 13th century, but a smaller part has an upper limit in the 1500s.

2. Mediaeval graveyard legislation

Mediaeval Norway was divided into four areas of jurisdiction: Gulating (the western part of the country, Agder and some mountain villages), Borgarting (the area around the Oslo fjord), Eidsivating (the inner parts of the east of the country) and Frostating (Trøndelag, Nordmøre and Romsdal) (figure 1). During the Middles Ages there were several sets of laws, some pertaining to a specific judicial area and others being applied on a national level. The different laws contained both secular and ecclesiastical legislation. For the purpose of this research, the emphasis was put on the mediaeval ecclesiastical legislation. There were several different sets of ecclesiastical laws in operation in mediaeval Norway which can be put into two groups: the oldest ecclesiastical laws and the later ecclesiastical laws.

The earliest legislation:

- The ecclesiastical part of the Borgarting provincial law
- The ecclesiastical part of the Eidsivating provincial law
- The ecclesiastical part of the Gulating provincial law
- The ecclesiastical part of the Frostating provincial law

The later legislation:

- The later version of the Borgarting ecclesiastical law
- The later version of the Borgarting ecclesiastical law II
- The later version of the Eidsivating ecclesiastical law
- The later version of the Gulating ecclesiastical law
- The ecclesiastical law of Archbishop Jon Raude
- The ecclesiastical law of King Sverre

The development of the earliest laws is likely to have started in the 11th century, possibly in the first half, but the laws were not written down until the beginning of the 12th century and the preserved manuscripts date to the late 13th and early 14th centuries (Landro, 2010). The later laws came into being during the 13th century (Riisøy and Spørck, 2000, Seip, 1937-1940).

These laws were concerned with a broad aspect of the Christian way of life, but in the context of this research, only a small part of these laws is of particular interest: the legislation dealing with graveyards and the burial of the dead. Therefore, the following discussion of these laws will be concerned with these topics. More specifically, the parts of the legislation providing information about who could be buried on the graveyard and where they should be buried. However, of the above laws, only the four provincial laws provide any information relevant to this discussion and thus, the other laws will not be considered any further. There are also no regulations with regard to where people should be buried on the graveyard in the canonical collections from the 10th century onwards. However, according to canon law, any baptised individual did not only have the right to be buried on the graveyard but was actually legally obliged to (Nilsson, 1989:241).

2.1 The ecclesiastical parts of the early provincial laws

The absolute and relative chronology of these early Christian laws is somewhat uncertain, but it is generally agreed that the Borgarting, Eidsivating and Gulating laws date back to an earlier time than the Frostating law (Rindal, 1995, Rindal, 2004). It is likely that the development of the three earliest laws started in the first half of the eleventh century and possibly around 1020 (Rindal, 2004).

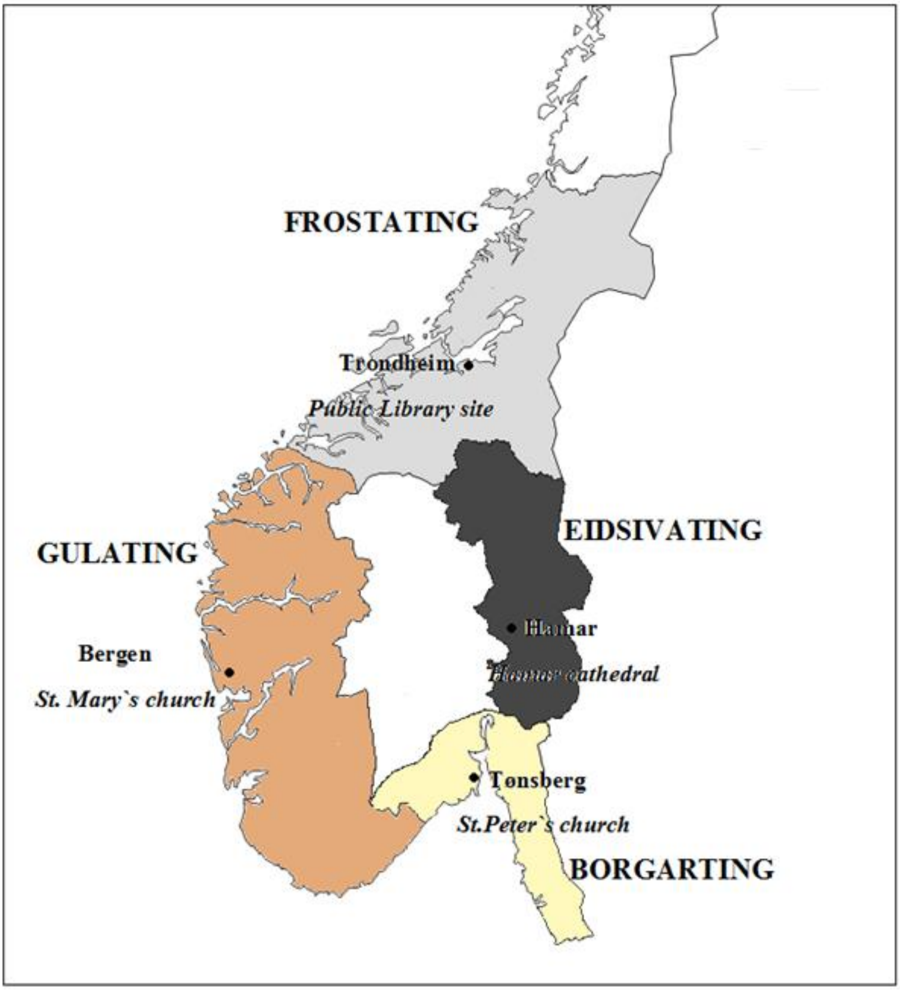


Figure 1. The figure shows the four judicial areas and the sites included in this study. The approximate location of the borders between the different judicial areas have been acquired from Landro (2005:front page).

2.1.1 The Borgarting ecclesiastical legislation

There are three versions of the Borgarting ecclesiastical law (B I, B II, B III, NGL I:337-372). The sections concerned with burials and the graveyard are chapter 9 in version 1, chapter 18 in version 2 and chapter 13 in version 3. There is little difference between these versions. All versions divide the graveyard into different areas where people should be buried according to social status. The barons (*lendmennene*) should be buried east and south of the church, under the eaves of the church, as long as they own a part of the graveyard. If they did not own a part of the graveyard, they should be buried with the farmers (*hauldmenn*). Further from the church should the landowners (*hauldmenn*) and their children be buried, followed by the freed slaves (*løysinger*) and their children, then freed slaves (*frigitte træller*) and their children, and closest to the graveyard fence one should bury slaves and people who had been washed ashore, if they had a Norwegian hair style. In this description of the social division of the graveyard, there are actually five social classes mentioned although the law clearly states that the graveyard should be divided into four areas. This is, however, only the case in the first version of the law. In versions two and three of the law, the second group of freed slaves (*frigitte træller*) has been omitted. Both *løysinger* and *frigitte træller* are freed slaves, but *løysinger* had a higher social standing, as they had been through a ceremony which freed them from slavery while the *frigitte træller* had not (Lárusson, 1965).

If people were buried in the wrong area of the graveyard, there was a fine to be paid. There was also a fine if a body, with hair or still articulated, was dug up while burying another individual. If bones were dug up during a burial, they should be put next to the coffin, and if the bones were left out in the sun there was a fine to be paid.

2.1.2 The Eidsivating ecclesiastical legislation

There are two versions of the Eidsivating ecclesiastical law (E I, E II, NGL I:373-406). The sections concerned with burials and the graveyard are chapter 50 in version 1 and chapter 39 in version 2. Both versions divide the graveyard into different areas where people should be buried according to social status. Version 1 states that the barons and the barons' children and wives should be buried closest to the church, further out the landowners and their wives and children, then the freed slaves (*løysinger*) and their children, then freed slaves (*frigitte træller*), and closest to the graveyard fence the male and female slaves should be buried. Version 2 has a very similar division of the graveyard, but only four social strata are present. The freed slaves (*frigitte træller*) and female slaves have been put into one group and should be buried closest to the graveyard fence.

The Eidsivating law also divides the graveyard into a northern and a southern section where men should be buried south of the church and women to the north. This sexual division of the graveyard is only present in the first version of the law and has been omitted in the second version.

Both versions state that everyone should be buried in the graveyard with the exception of criminals, people who committed suicide and children who had not been baptised before death. There are also several other rules which would result in a fine if broken. Firstly, a person should be buried in a way that others were not dug up as long as the body had hair or was articulated. Secondly, the grave should be deep enough to allow one ell of soil on top of the coffin. One ell, in mediaeval Norway, corresponded to two different length measurements: one shorter (47.4cm) and a longer (55.3cm) (Stigum, 1956:74) which is somewhat shorter than the modern standard for an ell which is 62.77cm. Thirdly, there was a fine for throwing another man's bones out of the graveyard.

Another rule is present with regard to wrong placement of the body in the graveyard. This rule changes between the two versions of the law and will be discussed in the following. In the first version of the law, it is stated that no one shall dig in others' place (…*ingen skal grava i annans plass*…) and in the second version it is stated that no one shall dig in others' family mound (…*ingen skal grava i annans ættehaug*…). This rule and the change in words can be interpreted in several ways. The key words here are place (*plass*) and family mound (*ættehaug*). That no one shall dig in others' place could just mean that a person should not be buried where another person is already buried, but this incidence is already covered by the law when stating that one should not dig up another person. Another, more likely explanation is that place refers to the social areas of the graveyard. Meaning that, for example, a slave should not be buried in the area reserved for another social class and vice versa. Family mound, which is used in the second version of the law, could refer to the same social areas of the graveyard, but there are other possible explanations. Family mound could refer to family plots meaning that certain areas of the graveyard were reserved for or bought by specific families and only members of that family were allowed to be buried there. It could also refer to the pre-Christian tradition of burying people in mounds. If the latter is the case, the law makes a distinction between the old and the new religion, but it would be more reasonable to think that such a distinction should be made in the earliest version of the law when the old religion was closer in time. It seems most likely that family mound refers to the social areas of the graveyard or to family plots. If family mound refers to family plots, it could explain why the sexual division has been omitted from the second version. Family plots are not compatible with a sexual segregation of the graveyard as this would mean splitting up the family.

In addition to the above, the earliest version describes who could and who could not be buried on the graveyard. It states that a man who wounds himself and regrets it and goes to confession can be buried on the graveyard if he dies from the wound. If he wounds himself on purpose and does not regret it, he cannot be buried on the graveyard. Likewise, the following could not be buried on the graveyard: murderers, arsonists, convicted thieves, traitors, robbers, the excommunicated, those who committed suicide and several other groups. Also people who promote wrong teaching and people and children who are not baptised are prohibited from being buried on the graveyard. All these people should be buried on the foreshore. In the later version this is no longer specified, but this is rather covered by the statement that one shall bury every person who is eligible for burial.

With regard to the difference between the two versions of this law, it is particularly interesting to know when the regulations regarding sexual segregation were omitted from the legislation. One thing that can provide a clue to the answer to this question is another difference between the versions. The ordeal (*jernbyrd*) is mentioned in several instances in the first version of the law, but all traces of this divine proof of guilt or innocence has been removed in the second version. The ordeal was forbidden in Scandinavia at the time of the visit of cardinal Wilhelm of Sabina in 1247 (Landro, 2010:181). The fact that the ordeal has been removed in the second version of this law can be seen as this illegalisation was reflected in the law and thus, the second version of the Eidsivating law is likely to date to later than 1247. It can, therefore, be suggested that the removal of the sexual segregation of the graveyards could have happened around the same time.

2.1.3 The Gulating ecclesiastical legislation

The Gulating ecclesiastical law gives no instructions as to the organisation of the graveyards. It is not mentioned whether sex, social status or anything else should affect an individual's placement on the graveyard. However, the law gives direction as to who was eligible for burial on the graveyard. It states that every human being who dies shall be taken to church and buried in sacred ground with the exceptions of criminals, murderers, thieves and people who commit suicide and several other groups. These individuals who were not eligible for burial on the graveyard should be buried at the water's edge, where the sea meets the green turf.

2.1.4 The Frostating ecclesiastical legislation

The Frostating legislation provides no regulations as to placement of the body on the graveyard. It states that every Christian shall be buried at the church unless the person had committed suicide or had been separated from Christianity while alive (Fr II 15, NGL I:135-136). The law also says that if a pregnant woman dies, she shall be buried on the graveyard as anyone else and the child shall not be removed from the body (Fr II 15, NGL I:136).

2.2 Summary of the legislation

The regulations regarding who should be buried on the graveyards and where they should be buried on the graveyard have not been given much attention in the mediaeval legislation, but some glimpses into this topic are found in the Norwegian provincial laws. The Borgarting and Eidsivating legislation give detailed regulations about where people should be buried on the graveyard while the other two laws do not mention this in their paragraphs on graveyard legislation. When it comes to who should and who should not be buried on the graveyard, the different laws also differ in some respects. With the exception of the Borgarting law, all the laws provide some information about this. The Eidsivating and the Gulating laws give detailed accounts of who was not eligible for burial on the graveyards while the Frostating law provides much less detail about this. The lack of information in the Frostating law is in correspondence with the later version of the Eidsivating law. Even though one would expect that being a Christian was a prerequisite for burial on the graveyard, only two of the laws explicitly state this: the Eidsivating and Frostating laws.

3. Materials

The material for this study consists of the skeletal collections from four different mediaeval graveyards: the St. Mary's church in Bergen, the Public Library site church in Trondheim, the Hamar cathedral, and the St. Peter's church in Tønsberg. The skeletons and the archaeological documentation from these sites were examined by the author over several periods during 2008 and 2009.

The selection of these graveyards was done after certain criteria. Firstly, it was necessary to have one graveyard from each geographical region corresponding to the judicial areas to which the, above discussed, provincial laws pertained. Secondly, the excavational documentation had to be up to a certain standard. Every skeleton had to be well enough documented so that its location on the graveyard could be determined and it had to be possible to locate and get access to the physical remains of these individuals. Thirdly, it would have been ideal if the material came from a fully excavated graveyard with a well established burial chronology, and the samples should be of a reasonable size (100+ individuals).

The material included in this study does not fulfil all these criteria and is not ideal, but it is the best suited material available. The included graveyards are from the four different judicial areas. The excavation documentation is sufficient, large parts of the material can be dated and the sample sizes are large enough to draw valid conclusions from. The graveyards are, however, not fully excavated which means that all questions cannot be dealt with properly for all graveyards and the methodology had to be somewhat adapted to each case. In spite of some limitations, all things considered, the osteoarchaeological material chosen for this study was appropriate for answering the proposed questions.

When analysing this sort of material, there are a few things one should be aware of: methods of excavation and documentation, the representativity of the skeletal material, and the dating of the burials. This will be discussed in the following, for each of the four graveyards separately.

3.1 The St. Mary's church graveyard, Bergen, Gulating

The St. Mary's church was centrally located and one of many churches in mediaeval Bergen (figure 2). Around year 1300 there were more than 20 churches in Bergen and 11 of these, including the St. Mary's church, can be dated back to the 12th century (Øye, 2009). Further details about the St. Mary's church and the skeletal material from its graveyard will be discussed in the following.

3.1.1 The excavation

The graveyard for the St. Mary's church was excavated during the period of 1966-1969 (Herteig, 1990a:12) as part of the extensive "Bryggen" excavation (1955-1972). The excavation revealed 188 articulated or semi-articulated skeletons found in their original graves, and also a large amount of commingled human remains of individuals which had been moved from their initial place of burial. The graveyard was excavated stratigraphically and care was taken to describe and draw each skeleton in addition to photographing each burial in situ. Each skeleton was also exhumed and boxed individually. This excavation took place in the early days of stratigraphic mediaeval excavations and the care and level of accurate documentation, shown here, was not a given at the time. Due to the quality of the excavation and documentation it was possible to acquire all the information needed to carry out this project, although some of the skeletons had to be excluded as it could not be determined where they were located on the graveyard. Altogether, 119 individuals could be included in this study.

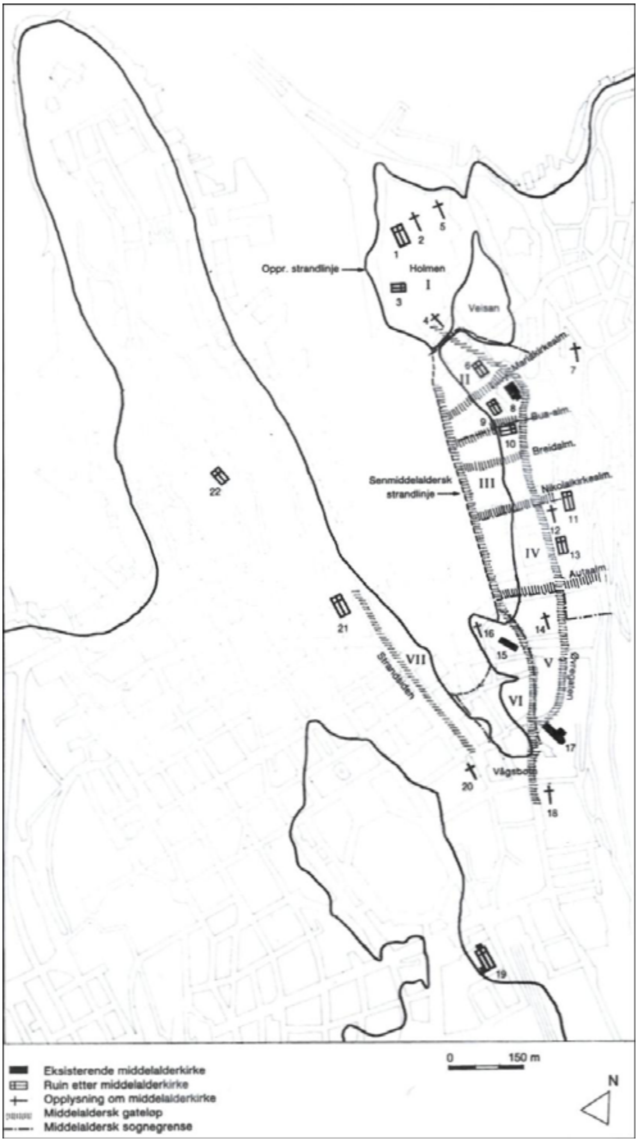


Figure 2. Map of mediaeval church sites in Bergen. Map reproduced from Lidén and Magerøy, 1990.

1. Christ church cathedral
2. Christ church minor
3. The 1st and 2nd church of the apostles
4. The 3rd church of the apostles
5. St. Olaf's church in the Dominican priory
6. The 1st St. Catherine's church
7. St. Olaf's church on the hill
8. **St. Mary's church**
9. St. Lawrence's church
10. St. Peter's church
11. St. Nicholas' church
12. St. Columba's church
13. St. Martin's church
14. St. Hallvard's church
15. St. Cross' church
16. St. Michael's church in Vågsbunnen
17. St. Olaf's church in Vågsbunnen
18. The 2nd St. Catherine's church
19. The convent church of St. Mary's at Nonneseter
20. All saints church
21. The Augustinian abbey church of St. John's
22. The Benedictine abbey of St. Michael's church at Munkeliv (Øye, 2009)

3.1.2 The documentation

The majority of the information about the skeletons and the excavation and exhumation of these have been gathered from the excavation diaries and plans located at the Bergen section of the Directorate for Cultural Heritage. In addition to this, the following publications have provided the necessary information about this site: Hansen, 1994, Hansen, 2005, Herteig, 1990a, Herteig, 1990b, Lorvik, 2007, Lorvik, 2009.

3.1.3 Representativity

Only a limited part of the cemetery for the St. Mary's church has been excavated. The excavated area comprises an area of approximately 400m^2 to the south of the church and stretches from the southernmost limitation of the graveyard, 40 metres from the church, to approximately 20 metres from the church. This seems to be the greatest extent of the graveyard, as the western, northern and eastern parts of the graveyard only stretch 10 to 20 metres from the church (Hansen, 1994:72). This limitation of the graveyard is based on an absence of burials from archaeological excavations in the area surrounding the church, and not on the presence of an actual graveyard boundary. Thus, there is little exact knowledge about which areas around the church were used for burials. As probably only a relatively small part of the graveyard has been excavated, this skeletal sample may not be fully representative of the total number of individuals having been buried at the site.

To what extent the people buried at this graveyard were representative of the population in Bergen at the time, is another question which has to be considered. The function of the church can influence who was allowed to be buried in the graveyard. According to Helle (1982:590), the St. Mary's church was possibly built to serve one of the more influential guilds in town, but he continues to say that this may not exclude that the church was also meant to serve a wider congregation as it is known that it later did. This does not necessarily give a conclusive answer as to who was buried on the St. Mary's church graveyard, but it seems most likely that this cemetery was open to a wider part of the population. Thus, this skeletal sample is probably not significantly biased towards any particular social group.

The taphonomic influences on the material have to be considered with regard to how it can affect the analyses of the skeletons. Judging from what is known about the possible differential preservation of osseous remains (see discussion below, chapter 5), a skewed age composition can be a real problem. This should, however, only affect skeletal samples of very poor preservation. As with most, if not all, skeletal collections in Norway, the preservational and representational status of this skeletal sample has not been thoroughly examined and described. The skeletal material from the St. Mary's church graveyard has, however, been described as being of "varied completeness and preservation, but generally acceptable to permit further osteological analyses" (Lorvik, 2009:36). The author's own examination of the material also gave the impression that the skeletons were well enough preserved for a proper analysis to be carried out and that the chances for differential preservation are considered to be small.

3.1.4 Chronology

The construction of the St. Mary's church could have started earliest in the 1130's and probably around 1140 and the graveyard dates back to this time (Lidén, 2000:6). This sets the lower limit for dating the burials from this site. The dating of these skeletons is somewhat complicated and very little attention has been given to this part of the Bryggen site. Some of the skeletons have, however, been dated in recent years (Lorvik, 2009) and these dates will be applied in this study. The dating of this material is based on the skeletons relation to the Bryggen fire layer chronology (Herteig, 1990a) and the two stone buildings on the site (building 48: the guild hall and building 50: the St. Lawrence chapel (Herteig, 1990a:73)) (figure 3), and inter skeletal relations.

The dates for the skeletons at the St Mary's church graveyard are presented in table 1. Seventy three of the skeletons are dated to before 1332. Only seven skeletons have been estimated to be younger than this and probably date to the 15th or 16th century and have been excluded from this study. The last 46 skeletons have not been dated and it is not possible to give accurate dates for these as they are situated in an area of the graveyard with very little datable material and structures. This leaves 119 skeletons to be included in this study. The distribution of the skeletons on the graveyard is presented in figure 3.

Table 1. Dates for the skeletons from the St. Mary's church graveyard

Time period	**N**
Pre 1170	7
1170-1198	39
1198-1248	20
1248-1332	7
Post 1332	7
Undated	46

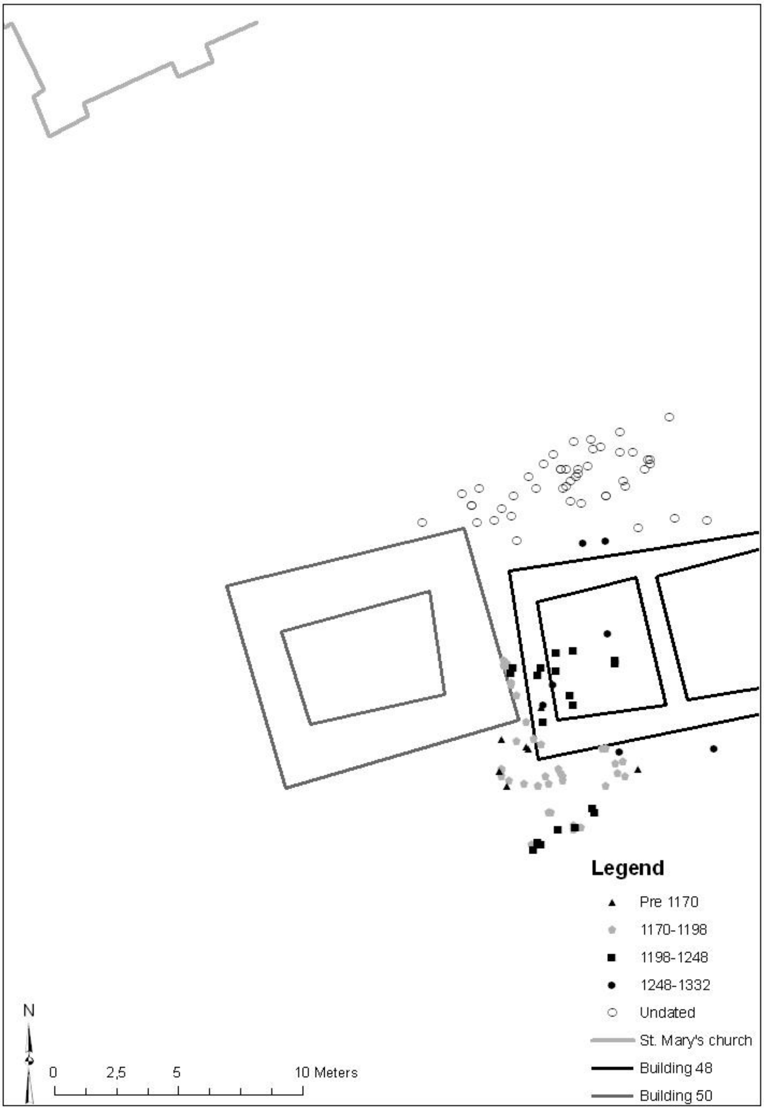


Figure 3. Distribution of the skeletons on the St. Mary's church graveyard.

3.2 The Public Library site graveyard, Trondheim, Frostating

The Public Library site church was one of 14 churches in mediaeval Trondheim (figure 4). The church was located in the middle of the town. The details concerning this church and its graveyard will be discussed in the following.

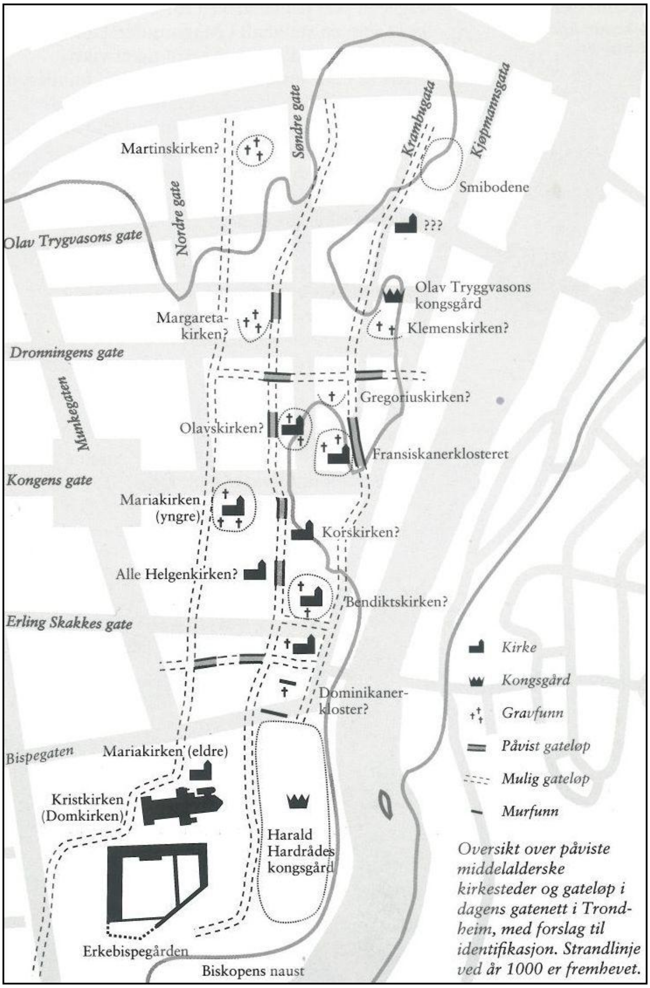


Figure 4. Map of mediaeval church sites in Trondheim.
The Public Library site church is marked "Fransiskanerklosteret" on the map. Map reproduced after Nordeide, 1997:55.

3.2.1 The excavation

The graveyard for the Public Library site church was excavated during 1984-1985 and the skeletal remains of 389 individuals were exhumed (Anderson and Göthberg, 1986). As shown in figure 5, all the excavated graves were located to the north of the church. Whether there were burials, and to what extent the other sides of the church were used for burials is somewhat uncertain, but it is likely that people were buried to the east and to the west of the church, while it is unlikely that the area south of the church was used for this purpose (Christophersen and Nordeide, 1994:102-103). Towards the east, the graveyard probably stretched as far as to Kaupmannastrete and to the west no burials have been shown west of the foundations for the church tower (Christophersen and Nordeide, 1994:103). Generally, there was no need for physical barriers at the churchyard boundary, as the churchyard was limited by buildings on the neighbouring properties. However, with the expansion of the graveyard, corresponding to the beginning of burial phase B, a dry wall appears to have been erected at the northern border of the burial ground (Christophersen and Nordeide, 1994:103). The remains of that wall are marked on figure 5.

3.2.2 The documentation

The information about the skeletons and excavation of the Public Library site graveyard was gathered from the skeletal forms and the excavation plan drawings located at the Trondheim section of the Directorate for Cultural Heritage. In addition to this, the following publications have provided the necessary information about this site: Anderson and Göthberg, 1986, Christophersen et al., 1988, Christophersen and Nordeide, 1994, Forsåker and Göthberg, 1986.

Figure 5. The distribution of the skeletons from the Public Library site graveyard.

3.2.3 Representativity

This graveyard has not been fully excavated and skeletons have only been recovered from the northern side of the church and it is thus possible that the sample is not fully representative of the total population having been buried at the site. However, the excavated area stretches from the church wall to the outermost limit of the graveyard, so any possible differences between burials with regard to distance from the church building should be covered. On the basis of this, although the sample might have been slightly different if the graveyard had been fully excavated, it is reasonable to assume that the present sample composes a fair representation of the buried population.

The nature of the church at the Public Library site is not clear. It has traditionally been believed that the church at this site was the St. Olav's church, but this has later been challenged (Christophersen, 1994, Nordeide, 1997) and at present there is no agreement as to the name of this church. What is known, however, is that this church dates back to the early 12th century and that it became part of the Franciscan monastery in the late 13th century (Christophersen, 1994). From this it can be assumed that this was not a monastic church before this point and that during the period dealt with in this project it is likely to have been a parish church. Anderson and Göthberg (1986) also concluded that this was a parish church based on the age composition in the sample. Thus, there is no reason to assume that the people buried on this cemetery are not representative of the general population in Trondheim at the time.

A thorough examination of this material with regard to preservation has not been carried out, but judging from the authors work with these skeletons it seems unlikely that taphonomic processes should have created preservational biases in the sample.

3.2.4 Chronology

The skeletons from this site had been put into three groups according to the burial phases identified at the site and these phases have been applied to this research. The author has not attempted to verify the validity of this information, but has rather just accepted the phases and dates presented by the archaeologists. Burial phase A contains 22 skeletons and dates from approximately 1100 to 1150/1175; phase B contains 198 skeletons and dates from approximately 1175 to 1275; and phase C contains 169 skeletons and dates from approximately 1275 to 1600+ (Christophersen and Nordeide, 1994). For the purpose of this research, the skeletons from phase C were excluded due to the recent dates for this burial phase. This left 220 skeletons to be included.

To determine the horizontal distribution of the graves, the skeletal recording forms and drawings from the site were studied to get the coordinates for each of the skeletons. During this process it was found that five of the skeletons, all from phase B, could not be located on the plans and thus, no coordinates could be determined. These five skeletons were therefore excluded. In addition, two more skeletons were excluded as they could not be found and thus, the final number of skeletons included in this sample was 213: 22 from phase A and 191 from phase B. The distribution of the graves is shown in figure 5 and the phases are listed in table 2.

Table 2. Dates for the skeletons from the Public Library site church graveyard

Burial phase	**Time period**	**N**
A	1100-1150/1175	22
B	1175-1275	191

3.3 Hamar cathedral, Eidsivating

Hamar was one of the smallest of Norway's mediaeval towns and a town dominated by the cathedral and the bishop's palace (Sellevold 2001:214). The town probably had a more agrarian than urban character and, in this respect, sets itself apart from the other towns in this study. There were two other ecclesiastical institutions in the area: the Church of the holy cross and the St. Olav's monastery (figure 6).

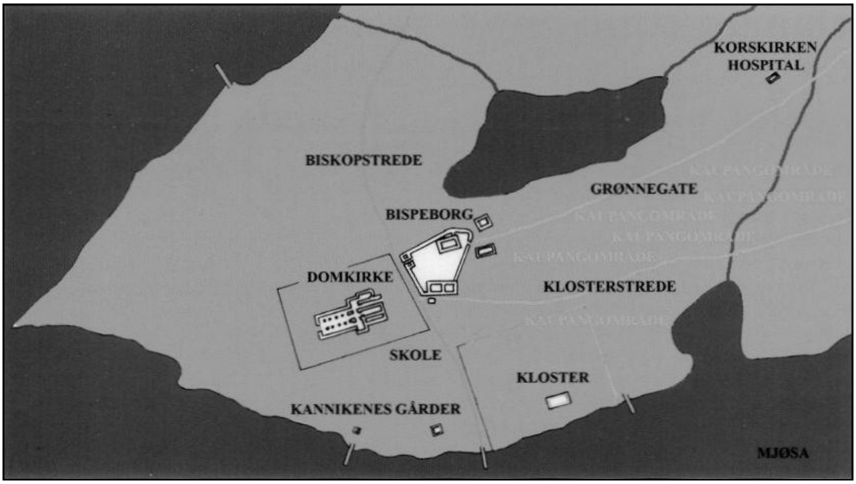


Figure 6. Map of mediaeval church sites in Hamar.
Map showing Hamar cathedral (*Domkirke*), the St. Olav's monastery (*Kloster*) and the Church of the holy cross (*Korskirken hospital*). Map reproduced from Sæther, 2005:20.

3.3.1 The excavation

The construction of the Hamar cathedral probably started in 1152/53 when the Episcopal see was founded and was largely completed by 1200 (Sæther, 1998); the cathedral was in use until 1567 when it was ruined during the Nordic seven year war (Sæther, 2005:29). It is therefore reasonable to assume that the graveyard for the Hamar cathedral was in use from around 1200, or slightly before, to the middle of the 16th century. In 1991 and 1992, this graveyard was archaeologically excavated and skeletal material from both disturbed and undisturbed graves was exhumed. The skeletal material from the undisturbed graves will be considered in this study and this sample comprises 482 skeletons (Sellevold, 2001).

The Hamar cathedral graveyard was excavated as four main areas (A, B, C, D) and four trenches (E, H, J, M) connecting the main excavation areas (see figure 7). In the reports for this excavation, the different areas and trenches are treated separately and will also be discussed separately here.

3.3.2 The documentation

The information available for the excavations at the Hamar cathedral was not quite as good as one could have wished for. The main sources of information are the two excavation reports, one for the excavation in 1991 (Koch, 1992) and one for the excavation in 1992 (Pedersen, 1994). Although the reports are comprehensive and discuss in great detail the different aspects of the excavations, they are not finished and have never been published. Thus, they are not available to the public or the research community; and, only due to the kindness of the staff at the archives at the Cultural History Museum in Oslo, were the report manuscripts released to the author in September 2008. The fact that there were two separate reports, one for each year of excavation, by two different authors, also complicates the use of this material for further research. Only the excavators have the full knowledge of the site and will be able to piece together a complete picture of the site and it is therefore unfortunate that a combined report from the different excavations never has been produced.

Figure 7. Distribution of the skeletons around the Hamar cathedral.

3.3.3 Representativity

The graveyard for the Hamar cathedral has not been fully excavated, but it has been excavated with the purpose of covering all areas of the cemetery and nearly a quarter of the total burial area has been examined (Sellevold, 2001:161). Excavations have been carried out on all sides of the cathedral and areas close to the cathedral building have been covered; but, unfortunately, the excavated area did not stretch to the outermost limits of the burial area. The lack of the individuals buried close to the graveyard fence could produce a slightly skewed sample and this has been taken into account during the further analyses of this material. With this exception in mind, the individuals in this sample are likely to be representative of the population buried on this graveyard.

The question of who was the supporting population for this graveyard has been thoroughly discussed by Sellevold (2001:203-221) and will only briefly be reiterated here. This being a cathedral, one would expect the ecclesiastical community to be buried here in addition to other people from the upper social classes. Following Sellevold's (2001) argument, the number of people with this background would not have been large enough to support the number of burials on this graveyard and thus, the cemetery at the Hamar cathedral was also used by the general public and the individuals buried there are representative of the wider population in Hamar at the time.

A detailed description of the preservational status of these skeletons does not exist, but judging from the author's examination of the material, the skeletal material seems to be reasonably well preserved and it is not very likely that taphonomic factors should have created preservational biases in this sample.

3.3.4 Chronology

All the graves excavated at the Hamar cathedral site have been dated according to the information provided in the two excavation reports (Koch, 1992, Pedersen, 1994). As a general rule, the author has not questioned the dates and information provided by the archaeologist, but has rather tried to use the information available in the reports to group the graves according to time of burial. An additional source of information about the different construction phases of the cathedral, which aided in the dating of the burials, has been the publication by Sæther (1998). In the following, the graves will be presented according to time of burial; the reasons behind the dating of each burial will, however, not be discussed in any great detail as the information can be found in the excavation reports.

3.3.4.1 Area D

Area D was the excavation area to the west of the cathedral, north (D I) and south (D II) of the cathedral stairs. Twenty six skeletons were excavated from this area: eight north of the stairs and 18 to the south of the stairs. The burials were situated in two rows with six graves situated relatively close to the Cathedral with the foot end of the graves only one to two metres from the cathedral wall. The other burials were situated further out with the foot end of the graves between three and four metres from the cathedral wall.

The 26 burials excavated from this area were given the identification numbers DG1-DG26. Among these 26 graves, 21 can be dated to before 1350 and three of these are probably older than 1250 (table 3). Of the remaining five graves, two have been dated to between 1350 and 1450 and three graves were probably buried after 1450.

Table 3. Dates for the Hamar cathedral skeletons from area D

Time period	**N**
Older than 1250	3
1250-1350	18
1350-1450	2
Younger than 1450	3

3.3.4.2 Area J

Area J was the trench to the north-west of the cathedral, connecting excavation areas D and A. Eight graves were registered in trench J, but skeletal material was only collected from five of the graves. These five graves were given the identification numbers JG1-JG5. All five graves were probably buried after 1350 (table 4).

Table 4. Dates for the Hamar cathedral skeletons from area J

Time period	**N**
Younger than 1350	5

3.3.4.3 Area A

Area A was the area excavated to the north of the northern transept and north-west of the chapter house. Five graves were excavated from this area and they were given the identification numbers AG1-AG5. All five graves were probably buried after 1350 (table 5).

Table 5. Dates for the Hamar cathedral skeletons from area A

Time period	**N**
Younger than 1350	5

3.3.4.4 Area M

Area M was the trench north-east of the cathedral connecting excavation areas A and B. Only one grave was excavated from this area and this was given the identification number MG1. The grave from this excavation area was probably buried before 1350 (table 6).

Table 6. Dates for the Hamar cathedral skeletons from area M

Time period	**N**
Older than 1350	1

3.3.4.5 Area B

Area B was the area excavated to the east of the cathedral, next to the chancel. Eighty-four skeletons were excavated from this area and these were given the identification numbers BG1-BG87. Three skeletons were numbered more than once; so, although the identification numbers count to 87, there were only 84 skeletons excavated from area B.

Among the 84 graves in area B, 49 can be dated to before 1350. Only one of these can, with certainty, be said to have been buried before 1250, but it is not unlikely that some of the other graves may be that old as well. Among the remaining graves, 10 were buried between 1350 and 1450, and 26 graves have been dated to be older than 1450 (table 7).

Table 7. Dates for the Hamar cathedral skeletons from area B

Time period	**N**
Older than 1250	1
1250-1350	47
1350-1450	10
Older than 1450	26

3.3.4.6 Area C

Area C was the area excavated south of the southern transept and 149 graves were excavated from this area. The graves were given the identification numbers CG1-CG150, but one number was omitted due to a grave being numbered twice and thus there were 149 skeletons excavated from this area. None of the skeletons from area C could be dated with any certainty.

3.3.4.7 Area E

Area E was the excavated trench to the south-east of the cathedral, connecting excavation areas B and C. The graves were given the identification numbers EG1-EG95, but due to several skeletons being numbered twice, the final number of skeletons is 84. Among the 84 skeletons from trench E, 34 were buried around 1350 or earlier with two graves probably being older than 1250. Of the remaining 50 skeletons, 15 have been dated to be younger than 1350 and this leaves 35 skeletons for which the date could not be determined (table 8).

Table 8. Dates for the Hamar cathedral skeletons from area E

Time period	**N**
Older than 1250	2
1250-1350	23
Older than 1350	5
Around 1350	4
1250-1450	1
Older than 1450	1
Younger than 1250	4
1350-1450	12
Younger than 1350	3
Unknown date	29

3.3.4.8 Area H

Area H is the excavated trench south-west of the cathedral, connecting excavation areas C and D. The graves in this area were given identification numbers HG1-HG126, but three numbers are not valid due to skeletons being numbered twice. However, two numbers from area B were added and thus there are 125 excavated skeletons from area H. Among the 125 skeletons from area H, 29 have been determined to have been buried around or before 1350, and four of these were probably buried before 1250. Of the remaining 96 graves, 52 have been determined to be younger than 1300 and one to be younger than 1250 while the remaining 43 skeletons could not be dated (table 9).

Table 9. Dates for the Hamar cathedral skeletons from area H

Time period	N
Older than 1250	4
Older than HL58/21 deposited around 1300	4
Older than HL19 deposited around 1300	16
1300-1350	3
Around 1350	2
Younger than 1250	1
Younger than HL58/21	22
Younger than HL19	26
Younger than 1300	4
Unknown date	43

3.3.5 The total sample

There are 131 skeletons which can be dated to before or around 1350, and from these, 10 can be dated to before 1250. These 131 skeletons have been included in this study as well as all the material from area C. As excavation area C was the largest area yielding the most skeletons, of which neither could be dated accurately, all of the 149 skeletons from this area have been included regardless of this lack of information about when they were buried. These skeletons will, however, be treated separately from the rest of the material.

3.4 The St. Peter's church graveyard, Tønsberg, Borgarting

The St. Perter's church was one of eleven ecclesiastical institutions in mediaeval Tønsberg (Wienberg, 1991:16). The church was located in the centre of the town. The details concerning this church and its graveyard will be discussed in the following.

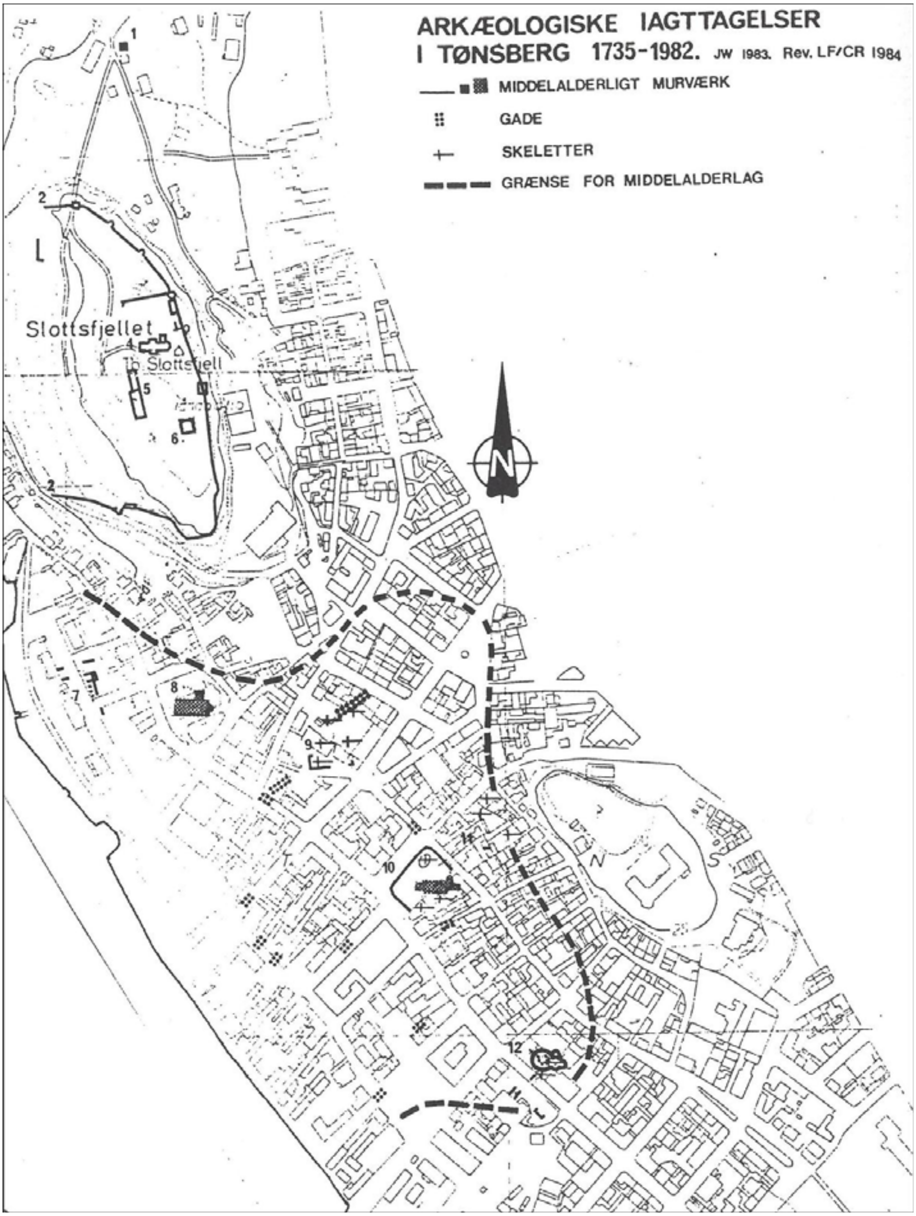


Figure 8. Map showing the location of the St. Peter's church.
The St. Peter's church is located at the number 9 on the map. Map reproduced from Flodin and Runeby, 1986b.

3.4.1 The excavations

The St. Peter's church graveyard was excavated during six periods. The first excavation was carried out in 1930 by Gerhard Fischer where parts of the church wall were discovered (Brendalsmo, 1989). Two skeletons were also found during this first investigation of the St. Peter's church. The next excavation was carried out in 1972 by Inger Helene Vibe Müller. Although, parts of the graveyard were affected by this investigation, the emphasis was put on the church ruins and the culture layers within the church. Thus, the western part and parts of the southern area of the cemetery were excavated mechanically and a lot of graves were lost: 3-4 levels of well preserved coffin graves (Brendalsmo, 1989). In addition to this, about 15 graves were excavated during these excavations (Karlberg, 1992:20). In 1981, excavations were carried out in the most northern part of the cemetery and 6 graves were found during these investigations. Two years later, in 1983, 192 graves were excavated in the northern part of the cemetery. In 1985, 480 graves were found when three areas on the northern part of the cemetery were excavated. Excavations were also carried out in 1986 when 8 graves were recorded and 1987 when no graves were found, but a part of what is believed to be the graveyard boundary was excavated (Brendalsmo, 1989). Thus, 703 graves have been registered in the cemetery since the first excavations in 1930. Of these 703 graves, the author has only managed to find coordinates and identification numbers for 454, all from the excavation in 1985, and therefore, the initial number of skeletons available for this project was 454.

3.4.2 The documentation

Many documents have been published regarding the excavations and the anthropological material from the St. Peter's church cemetery in Tønsberg and the information about this site comes from these: Blohme and Runeby, 1986a, Blohme and Runeby, 1986b, Brendalsmo, 1989, Flodin et al., 1986, Flodin and Runeby, 1986a, Flodin and Runeby, 1986b, Holck, 1989, Sælebakke, 1985. The information regarding the placement of the individual skeletons on the graveyard has been gathered from the excavation documents (skeletal recording forms and plan drawings) which are located at the Tønsberg section of the Directorate for Cultural Heritage.

3.4.3 Representativity

The skeletal material from the St. Peter's church does not come from the full extent of the burial area, but is limited to the area north of the church. Because of this, it is possible that this skeletal sample may not be fully representative of the total population having been buried at the site. However, the excavated area stretches from close to the church wall to the outermost limit of the graveyard (as it was until the final extension of the burial area in the middle of the 13th century); so, any possible differences between burials with regard to distance from the church building should be covered.

The St. Perter's church was one of eleven ecclesiastical institutions in mediaeval Tønsberg: 6 churches, 2 monasteries and 3 hospitals (Wienberg, 1991:16). Three of the churches were classified as parish churches and the St. Peter's church was one of them (Wienberg, 1991:16). Being a parish church, the St. Peter's church would have catered for the general public in Tønsberg and this is likely to have been reflected in people being buried at its graveyard. Thus, it is reasonable to assume that the skeletons in this study give a fair representation of the people in mediaeval Tønsberg.

A detailed description of the preservational quality of this material does not exist but this is the worst preserved material of samples included in this study. Holck (1989:15) describes the preservational quality of this material as being exceptionally poor with hardly any skeletons being complete. As discussed below (chapter 5), poor preservation can have an effect on the age composition of skeletal samples, and this has been considered in the discussion about the age distribution in this material.

3.4.4 Chronology

Three phases have been identified at this graveyard. It has been claimed that phase 1 dates from the latter half of the 10^{th} century (Brendalsmo, 1989), but this date is probably somewhat early. The radiocarbon dates from the site do not support such an early date and the foundation of this graveyard should be put to the 11^{th} century (Nordeide, 2011, in press). Phase 2 dates from the middle of the 12^{th} century, and phase 3 dates from the middle of the 13^{th} century (Brendalsmo, 1989). These phases correspond to extensions of the burial area and not to burial phases as such (figure 9). Thus, the upper time limit could be the same for all phases and people may have been buried on all areas of the graveyard until the church burned down in 1536. The age ranges for the different phases are given in table 10. Only skeletons from phase 1 and 2 have been included in this study and this amounts to 212 individuals. In addition to these, there are 11 individuals which have been determined to predate the stone church. Although, these 11 skeletons are not included in most of the analyses, they have been examined and are mentioned when found appropriate.

Table 10. Burial phases for the St. Peter's church graveyard

Burial phase	**Time period**
Phase 1	11^{th} century – 1536?
Phase 2	Middle of 12^{th} century – 1536?
Phase 3	Middle of 13^{th} century – 1536

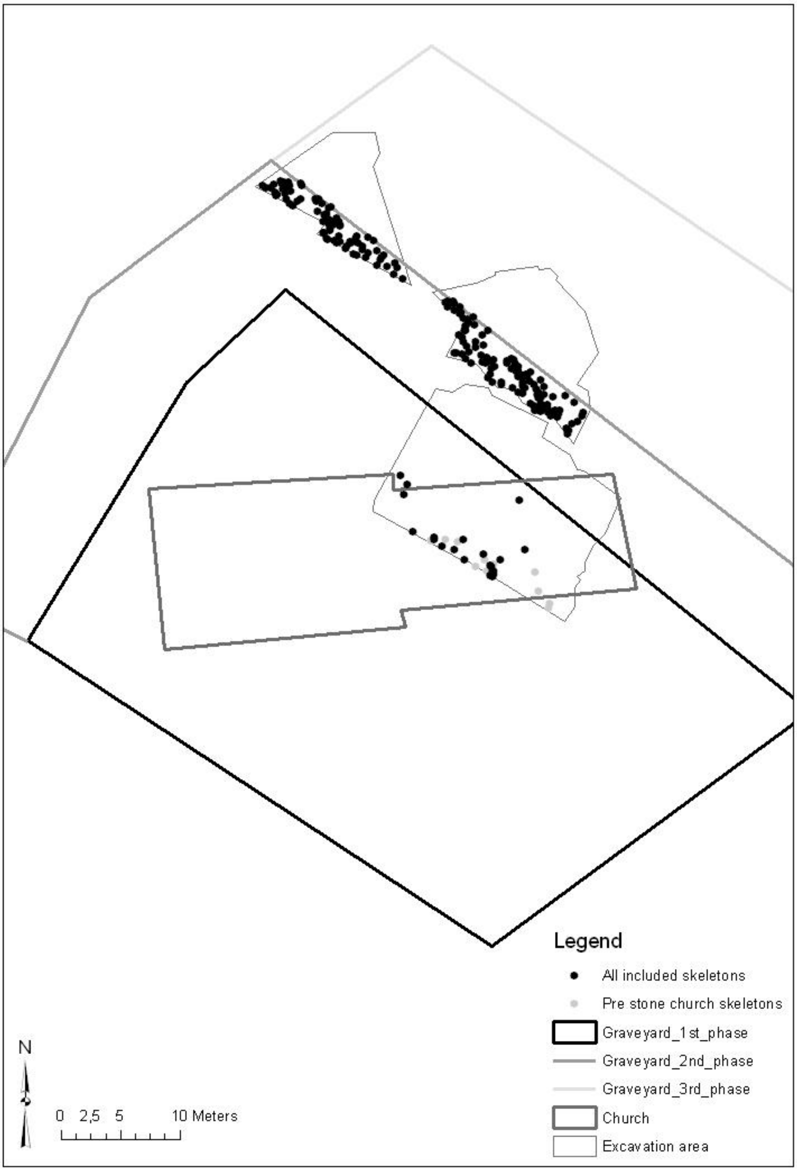


Figure 9. Distribution of the skeletons on the St. Peter's church graveyard.

4. Previous research regarding sexual segregation and social stratification on mediaeval graveyards

Two of the main issues investigated in this book are the questions of whether or not the Christian graveyards in mediaeval Norway were sexually divided and/or socially stratified. These questions have not yet been thoroughly investigated in a Norwegian context, but a good number of studies have dealt with this in other countries and these will be discussed below. But before that, a brief presentation of the Norwegian situation will be given. Although never thoroughly investigated, the topic of the sexually segregated graveyard has been touched upon in a Norwegian context. Comments have been made about the sex distribution on three of the sites included in this study. Holck (1989:62) found that there were considerably more female burials north of the St. Peter's church in Tønsberg, but still concluded that there was no sexual segregation as there were many men buried there as well. It is also concluded that there are no clear social differences on the graveyard, a statement based on an examination of the stature distribution (Holck, 1989:63). Two major studies have been concerned with the material from the Hamar cathedral graveyard (Risan, 1998, Sellevold, 2001). Sellevold describes a situation where there is a notably large majority of men buried on the southern side of the cathedral and the only place with a relatively equal number of men and women was on the east side. This difference in sex composition between different areas of the graveyard is not seen as evidence of sexual separation. "Male and female graves are intermingled in the churchyard, and a principle of sex segregation does not seem to have been in operation" (Sellevold, 2001:198). Regarding social differences, Sellevold looks at the stature distribution and tentatively suggests that high status people were buried in prestigious places. It is, however, stated that the evidence from the stature distribution is not strong (Sellevold, 2001:193). Risan (1998) also makes claims about the sex distribution; this is discussed in more detail below (page 146) and will not be dealt with here.

No direct statements have been made about the sexual and social arrangements on the Public Library site graveyard, but Göthberg points out that the majority of the women were buried on the western and middle parts of the graveyard while most of the men and children were buried on the southern part (Anderson and Göthberg, 1986:24).

4.1 Sexual segregation

The first place where a sexual segregated cemetery was noted was at the Skeljastađir site in þjórsádalur county on Iceland (Steffensen, 1943). The skeletal remains of 66 individuals were excavated from this site, of which 27 were determined to be male and 28 to be female. With the exception of two, all the individuals buried north of the church were female and all but two of the individuals buried south of the church were male. Thus, this graveyard displayed a nearly complete sexual segregation of the buried individuals.

After this first discovery, there have been many other sites where this burial pattern has been shown. Six of these claims are based on the discovery of graveyards were the sexes are just about fully segregated and these sites will be discussed briefly in the following.

Another site on Iceland where the sexual segregation seems to have been strictly enforced is Keldudalur in the county of Hegranesi (Zoëga, 2008). Fifty graves were excavated at this site of which 11 were determined to be female and 9 to be male. All the males were excavated from the southern side of the church while the females were found north and north-west of the church. This graveyard was in use from the first half of the 11th century to sometime during the 12th century (Skagfirðinga, 2007).

Further to the west on Greenland, the early Christian graveyard for the Thjodhilds church in Brattahlid, which was in use for a relatively short period during the 11th century (Krogh, 1967:29), shows clear evidence of sexual segregation. One-hundred and forty-four skeletons were excavated at this site and

39 of these were female, 65 male, 24 children and 16 were adults which could not be sexed accurately (Krogh, 1967:38). Krogh (1967) does not present accurate details for the division of the graveyard, but judging from the graphic representation of the cemetery, only five of the women were buried south of the church and only three of the males were buried to the north (Krogh, 1967:40-41).

Moving back to the mainland, there are four examples from Sweden. The first to show this burial practice in Sweden was Gejvall (1960) in his study of a graveyard in Västerhus in the county of Jämtland. A cemetery which was in use from the 11th century to the latter half of the 14th century (Vretemark, 1992). The graveyard was completely excavated and about 400 skeletons were exhumed and sexual segregation was evident during the whole period the cemetery was in use. With the exception of only a few graves, sexual division was strictly implemented (Gejvall, 1960:43).

The other Swedish sites to display this burial pattern are from Försäter in Uppland, Karleby in Västergötland and Tygelsjö in Skåne. The Försäter claim is based on a very small sample of only 11 skeletons, where 2 were determined to be male and 4 to be female (Vretemark, 1982b). Of the other 5 skeletons, 3 were children and the sex could not be determined for the last two. The 4 females were excavated from the northern side of the church and the 2 males from the southern side (Vretemark, 1982b). These burials should date to sometime between the late 13th century to the middle of the 15th century when this graveyard was in use (Vretemark, 1992).

About 100 (of at least 1000) graves were excavated at the Karleby site and there were only females buried to the north of the church, but there were both male and female skeletons to the south (Vretemark, 1992, Vretemark, 1998). The oldest church on the site was in use from the middle of the 11th century to the beginning of the 12th when the new church was built. During the time of the older church, people were buried on both the northern and southern part of the graveyard while it seems like only the area south of the church was used for burials after the later church was built. Thus, at the time of the older church, the cemetery was completely segregated and the presence of both sexes to the south is due to this side having been used after the practice of sexual segregation had ended (Vretemark, 1992).

The last site which shows evidence of complete segregation is the one from Tygelsjö, a graveyard which probably was in use from around 1100 until the latter half of the 13th century (Kieffer-Olsen, 1993:80). Only the southern part of this graveyard has been excavated, but the evidence of sexual segregation is quite clear. Among the 75 sexed skeletons from the site, only 4 were determined to be female (Kieffer-Olsen, 1993:110). Thus, this site displays the evidence of a strictly enforced separation of the sexes.

These graveyards which show a complete separation of the sexes are definitely the best starting point for a discussion of when this burial practice was carried out. The practice of separating the sexes on the graveyard is likely to have started with the introduction of Christianity to Scandinavia in the 11th century but it is more uncertain how long this practice lasted. In this respect, the graveyards in Västerhus and Försäter are of particular interest. These two sites show that sexual segregation was practiced up until the 15th century, at least at those two sites. Kieffer-Olsen (1993), in his study of mediaeval burial practices, presents claims for sexual segregation on Danish graveyards. None of these graveyards show complete segregation, but they all present evidence that sexual separation had been practiced at some point. In his discussion of the development of the burial practice during the Middle Ages, it is suggested that this practice was abandoned during the 13th century (Kieffer-Olsen, 1993:162-176). Further evidence supporting a general end to this practice can be found in the Eidsivating law. As already mentioned above, there are two preserved versions of this law and the regulations regarding sexual separation on the graveyards have been omitted from the younger version of the law. The dating of these laws is somewhat uncertain but one important piece of information is known. There is information within the law which suggests that the later version was created after year 1247 and possibly during the latter half of the 13th century (see page 23 for discussion). This does not mean that the part about sexual segregation could not have been changed at an earlier time, but it makes it likely that this practice was abandoned, at least in the eyes of the law, during the latter half of the 13th century.

With the exception of the two, above mentioned, sites (Västerhus and Försäter), the archaeological evidence also support an end to this practice by the beginning of the 14th century. To the author's knowledge, there are no other graveyards which have been claimed to have been sexually segregated after the beginning of the 14th century. Thus, it seems like the practice of separating the sexes on the graveyard largely ended during the 13th century, but that the tradition lived on in a few places for maybe a century longer.

What about the geographical distribution of this practice? Table 11 lists the places where it has been claimed that sexually segregated graveyards were present. It is clear that this practice was in use over a relatively large geographical area from Gotland in the east to Greenland in the west and from Jämtland in the north to Schleswig in the south. Even though the distribution shows that this was a practice carried out over a relatively large area, it still seems to be restricted to Scandinavia, Iceland and Greenland (Schleswig was part of Denmark and was thus, included in Scandinavia). It is, of course, possible that sexual segregation of graveyards was practiced elsewhere, but the author has not been able to find any evidence of this.

Another type of sexual segregation was, however, practiced in Ireland (Hamlin and Foley, 1983) and Scotland (O'Sullivan et al., 1994). This was a practice were different groups were buried in separate graveyards. This could be separate graveyards for women and men, or graveyards for children or for soldiers fallen in battle etc. In this way the sexes were separated in death, but it is quite a different practice from the sexually segregated graveyard discussed above. All the evidence suggests that the tradition with the sexually divided graveyard was restricted to a relatively small part of northern Europe and practiced during a relatively short period of time of a few hundred years. What may have been the reason for separating the sexes on the graveyard?

The sexual segregation of the graveyards seems to have been a Christian custom, as there is no pre-Christian tradition for this (Vretemark, 1992). It seems that the most likely explanation for the graveyard being divided into a northern section for women and a southern section for men is to be found inside the church building. The segregation on the graveyard could be seen as a continuation of the sexual segregation within the church where women were seated to the north and men to the south (Nilsson, 1989:141). An explanation for this segregation can be found in the symbolism around the crucifixion. When Christ was hanging on the cross, Mary stood below to the right while John was on the left side of the cross (Vretemark, 2009). If this is transferred to the church building where the building is a symbol for the body of Christ, the right side is to the north (Mary's side) and the left side is to the south (John's side). Seeing this in connection with the cult of St. Mary which was well established within Christianity by the time of the mission in the Nordic countries (Vretemark, 1998:23), the separation of the sexes can be explained. Most churches would have had a special altar dedicated to St. Mary which was always situated in the northern part of the church while an altar dedicated to either St. Olav or St. Michael was to be found in the southern part of the church (Vretemark, 1998:23). Thus, it is suggested that the northern part of the graveyard was connected to St. Mary and was, therefore, reserved for female burials. Bertil Nilsson (1989) presents a similar explanation for sexually segregated graveyards. Nilsson (1989:141) stresses that there is nothing to suggest that there were any negative connotations connected to the northern side of the church or graveyard and that this should not be seen as a reason for women being buried on that side. The segregation should rather be seen as going back to Jewish practices and that the north-south division was not as important as the right-left and back-front divisions. The division is also connected to the celebration of

Eucharist where the peace kiss was to be delivered between members of the same sex only. Men and women were also seen as having different tasks in the fight against evil; and the segregation of the sexes, thus, gave a balance which secured salvation (Nilsson, 1989:141).

Table 11. List of sites having shown evidence of sexually segregated graveyards

Site	County	Country	References
Refsehale	Maribo	Denmark	Kieffer-Olsen, 1993:110
Gl. Grenå	Randers	Denmark	Kieffer-Olsen, 1993:106
Tirup	Vejle	Denmark	Kieffer-Olsen 1993:108
Karleby	Västergötland	Sweden	Vretemark, 1992, Vretemark, 1998
Löddeköpinge	Skåne	Sweden	Cinthio and Boldsen, 1984
Nödinge	Västergötland	Sweden	Vretemark, 1982a, Vretemark, 1992
Varnhem	Skara	Sweden	Vretemark, 2009
Försäter	Uppland	Sweden	Broberg, 1990 in Vretemark, 1992, Vretemark, 1982c
Västerhus	Jämtland	Sweden	Gejvall, 1960
Tygelsjö	Skåne	Sweden	Kieffer-Olsen, 1993:110
Gotland		Sweden	Trotzig, 1969, Vretemark, 1992
Keldudalur	Hegranesi	Iceland	Zoëga, 2008
Skeljastaðir	Þjórsádalur	Iceland	Steffensen, 1943
Thjodhilds church	Brattahlid	Greenland	Krogh, 1967:40-41
Rathausmarkt	Schleswig	Germany	Kieffer-Olsen, 1993:116

The information about the location of the sites is given according to the different countries' modern borders, although the borders would have been somewhat different during the Middle Ages.

4.2 Social stratification

The question of whether or not the mediaeval graveyard was socially stratified has been touched upon in several publications (e.g. Cinthio and Boldsen, 1984, Gejvall, 1960, Kjellström, 2005, Krogh, 1967, Sellevold, 2001). Cinthio and Boldsen (1984), Gejvall (1960) and Sellevold (2001), all use stature estimations in their attempts to discover different social groups. The theory behind this is that the higher social classes had better access to quality food and better nutrition than the lower classes and, therefore, the upper classes should generally be of taller stature. Gejvall (1960:51-52) argues for a socially stratified graveyard at Wästerhus because he found that the tallest individuals generally were buried closer to the church building. Cinthio and Boldsen (1984) also concluded that an individual's social status determined a person's place of burial. They did not find a difference between people buried close to church compared to those buried further away, but rather that the shorter individuals were buried north of the church and the taller on the south side. Sellevold's (2001) examination of the stature distribution at the Hamar cathedral concludes differently. It is found that "tall males are distributed around the church, with a tendency for clusters south of the south transept" (Sellevold, 2001:193), but the distance to the church is not a strong factor. On the basis of this, she states that it can be tentatively suggested that high status people were buried in prestigious places, but that the correlation with stature is not strong (Sellevold, 2001:193). Krogh (1967:42) makes his conclusions about a socially stratified graveyard on different grounds. He concludes that the same social differences which were present in the villages on Greenland could also be seen on the graveyard for the Thjodhilds church. He states that the burials were less elaborate, the body positions more coincidental and the graves shallower further away from the church. The few coffin burials were also found close to the church. Kjellström et al. (2005) introduces another criterion for investigating social groups from skeletal material. Through the analysis of isotopes and trace elements from the human skeletal material, it is shown that there were clear dietary differences between different groups of people. It is concluded that there is a difference between the lower status groups with a diet based on vegetable foods and the higher classes with a more meat and fish based diet.

Although, few studies have been primarily concerned with determining social differences from cemetery remains, judging from the above studies, it seems likely that such a burial practice was carried out.

5. The influence of taphonomy

The examination of human skeletal remains has the potential of providing a lot of information about both individuals and populations of the past and it can easily be argued that there is no better material to serve this purpose (Gowland and Knüsel, 2006). There are, however, some problems which should always be of concern to anyone working with human remains. Are the individuals in the skeletal sample representative of the living population from which they came? Is it possible to draw valid population wide conclusions from the material? Are there biases in the sample?

One often sees that different skeletal elements are unevenly represented and also that the age distribution in some assemblages appear to be unnatural and not likely to be representative of the population from which it came. In cases like that it might be wise to look for taphonomic explanations for the discrepancies or at least rule out possible natural causes before reaching for cultural solutions. There are many factors which can influence to what extent a skeletal sample is representative of its population, but a sensible starting point is to always consider if taphonomic processes could have created biases in the sample? It is a reasonable approach to try and determine what taphonomic processes have affected the material and to create an understanding of how the taphonomic processes have influenced the material before one starts looking for further cultural influences on the composition of the sample. Such an understanding will strengthen any cultural theory drawn from the sample and it can also avoid complicated cultural theories folding because someone later discovers biases in the sample due to natural taphonomic processes.

Taphonomy was first described as an own field of study by Efremov in 1940 and was defined as “the science of the laws of embedding” and referred to the study of what happens to an organism from death to fossilisation. In the strictest sense of the word, taphonomy is thus devoted to the analysis of postmortem processes affecting organic remains, but in archaeological terms the definition has been extended to include, not only living organisms, but all materials and can be said to be the study of the transformation of materials into the archaeological record (Bahn, 1992:489). The discussion here will, however, be entirely concerned with the taphonomy affecting the human body and skeleton.

The human body, to which the bones under examination once belonged, has undergone tremendous changes and been subjected to a vast number of deteriorative and altering processes from the time the individual was alive many centuries ago to the time of examination by the anthropologist. During this process, a lot of information about the individual is lost and other information is added to the remains. This transformation of the human body has good potential for obscuring and distorting the information drawn from the remains, but has also great potential for providing information which initially was not available. To access this information and to avoid possible problems, it is absolutely necessary to have a working knowledge of how the decomposing body behaves and what effect the different taphonomic agents have on the remains.

In the case of the research discussed in this thesis, skeletal remains are used to determine factors influencing an individual's placement on the mediaeval Christian graveyard. This type of research can be vulnerable to potential biases created by taphonomic processes, especially as age, sex and pathology can influence a skeleton's preservation. This project uses all these criteria to determine if and how the graveyards were divided between different groups of society and it is thus, necessary to consider the influence of taphonomy with regard to these questions.

The following will be concerned with different biases which can be the result of natural taphonomic processes and how this can affect conclusions drawn from this kind of material. The importance of taking taphonomy and preservation into account when analysing skeletal samples will be highlighted.

5.1 What can create a biased sample?

Before one starts the examination of a skeleton or a skeletal sample, and preferably before one even starts excavating the remains, it is important to be familiar with, and understand, the processes affecting the skeletal material from the time of death until the time of examination.

Bone is one of the strongest biological materials in existence (White and Folkens, 2000:20) and is, with the exception of teeth, the only part of the human body available for examination in archaeological contexts. This is, of course, not entirely true as one does find the odd brain and lock of hair in archaeological contexts and there are mummified remains and bog bodies where there is no osseous material preserved. Anyway, the vast majority of human remains from archaeological contexts are bone and teeth, and this is where this discussion will have its main focus. In spite of bone being about as strong as biologically possible, bone is vulnerable to a wide range of taphonomic processes and agents and different skeletal elements vary in their susceptibility to degradation. To understand how bone interacts with its environment and why skeletons from some sites are very well preserved while completely disintegrated at others, it is necessary to be aware of the basic structure of bone.

Bone is a composite of two different kinds of materials: an organic component and an inorganic mineral component. The first component is primarily the protein collagen which constitutes about 90% of the organic part of bone (White and Folkens, 2000:25). Collagen molecules intertwine to form flexible, slightly elastic fibres in bone. The collagen of mature bone is stiffened by a dense inorganic filling of hydroxyapatite, which is the second main component of bone. Crystals of this mineral, a form of calcium phosphate, impregnate the collagen matrix and it is this weave of protein and minerals which give bone its amazing properties (White and Folkens, 2000:25) of incredible strength and flexibility. To illustrate the value of the combination of these materials and to understand the effect on bone when subjected to different environments, one can imagine two simple experiments. The mineral component gives bone its hardness and rigidity. When soaked in acid to dissolve these minerals, a bone becomes a flexible, rubberlike structure. On the other hand, when a bone is heated to combust the organic collagen, or leached out in some archaeological contexts, it becomes extremely brittle and crumbles (White and Folkens, 2000:25).

So, what factors influence the preservation of bone? Bone preservation is influenced by both intrinsic and extrinsic factors. Intrinsic factors include the chemistry, size, shape, structure and density of bone, along with pathological changes to bone structure. Extrinsic factors include ground water, soil type, temperature and air, along with the nature of local flora and fauna, and human activity. Of all the intrinsic factors, bone mineral density is considered to be the most significant and soil chemistry is considered to be the most influential extrinsic factor in bone diagenesis (Buckberry, 2000). In an archaeological context, the bones will in the vast majority of cases be buried or otherwise covered with soil, which will thus have the greatest influence on bone preservation. Soils are made up of mineral and organic matter, water and air, with differing soil types composed of differing ratios of these elements. Of the different properties of soil, the pH value has the biggest influence on bone preservation (Gordon and Buikstra, 1981), with preservation generally being better in soils with a neutral or slightly alkaline pH. Acidic, free draining soils such as sand and gravel result in bad skeletal preservation, as it dissolves the inorganic mineral component of bone. In extreme cases, this may result in the human remains only being detectable as shadows in the sand.

Grave depth is another variable that will affect the preservation of bone. With bodies buried at depths of less than a foot, decompositional odours will penetrate the soil and reach the above ground, and thus attract insects and other animals (Rodriguez, 1997). Carrion scavenging animals will dig up and expose corpses buried at such shallow depths in order to feed on the soft tissues and bones (Rodriguez, 1997). Carnivores and small burrowing animals may remove or disturb bone, or destroy it by gnawing (Haglund, 1997a, Haglund, 1997b, Klippel and Synstelien, 2007), which may cause the bone to be more susceptible to decay. In cases where scavenging has taken place, it has been noted that the smaller bones are most often disturbed, and that spongy, marrow rich bone is generally preferred for gnawing (Gill-King, 1997). Another way bone may be lost or damaged is through modern ploughing. The shallower graves will naturally be more at risk for this kind of damage which could possibly cause biases in a skeletal sample. It might be worth investigating burial depths to see if differences exist. Small children's graves may not always have been dug as deep as the larger adult graves. Wilson and Hurst (1967) mention a couple of cases were burials have been damaged by ploughing, but no real evidence of any bias is evident from these reports, but Buckberry (2000) mentions an example from the Watchfield cemetery in Oxfordshire, where many juvenile graves were shallower than those of adults, and therefore more likely to be damaged by ploughing or machine stripping before archaeological excavation.

As mentioned above, intrinsic factors also play an important role in bone preservation. Structural properties inherent in the bones themselves can determine the rate of preservation for certain skeletal elements and in this respect, age and sex biases may also be present. To start with biases due to differentiated preservation, this mainly affects the skeletal elements with low bone density and particularly fragile areas of the skeleton. Due to their fragile nature, facial bones are often very poorly preserved and the same applies to the subscapular fossa of the scapula. Two other elements which are generally poorly preserved are the sternum and the sacrum. This can be explained by the low bone density and high proportion of cancellous bone of these elements (Boaz and Behrensmeyer, 1976). The last element for which poor preservation often is a problem is the os coxa. The pelvic bones are usually well represented but often in a fragmented state. The best represented parts of the os coxae are the acetabulum and the greater sciatic notch (Bello and Andrews, 2006), while the pubic area is much more poorly preserved and also shows low representation. These preservational problems with the pelvic region are causing the greatest amount of problems as these bones are central in the determination of sex and estimation of age at death. This is contrary to the other less well preserved elements mentioned. The above mentioned skeletal elements are the ones which are poorly preserved or fragmented, but generally well represented. The exception being the sternum which also shows low representation, probably due to its poor preservational qualities.

Some other elements are normally well preserved when present, but are often poorly represented. This is especially the case for the patella and the bones of the hand and feet (Bello and Andrews, 2006), with the possible exception of the calcaneus and talus. There are two likely explanations for the underrepresentation of these bones: excavational bias and animal scavenging. It is well documented that different animals scavenge on, and move bones from the decomposing corpse (e.g.Haglund, 1997a, Haglund, 1997b, Klippel and Synstelien, 2007, Ubelaker, 1997). This is, however, most applicable when the body has been left exposed during the period of decomposition. It has already been mentioned that shallow graves can be affected by carrion scavenging animals, but the animal removal of bones from graves in a cemetery contexts is not likely to have been a problem. Especially with coffin burials, this is likely to be of very little significance. In spite of this, the representation of different skeletal elements in cemetery samples is not equal. Some of this can be explained by the difference in the preservational qualities inherent in different skeletal elements, but not all, as some interesting observations made about the preservation and representation of the hand and foot bones show. Hand and foot bones generally show a low representation in cemetery samples and this cannot be explained by their preservational qualities. In fact, these bones are generally very well preserved and usually complete when present. The good state of preservation of the hand and foot bones has been associated with the reduction of the medullary cavity (Guthrie, 1967) which facilitates the complete preservation of these bones even in very fragmented and damaged collections (Bello and Andrews, 2006). Differential representation also occurs between the different bones of the hands and feet. In the collections examined by Bello and Andrews (2006), they found that metacarpals and metatarsals were generally better represented than carpal and tarsal bones and that the frequency of the different phalanges was directly related to their dimensions, with proximal phalanges being more abundant than middle phalanges, and middle phalanges being more abundant than distal phalanges. This observation may suggest a consistent relationship between size and recovery and that the size of a bone could, to a greater extent, be a determining factor in its representation than preservational factors. On the background of this, one will probably have to look at excavational and curatory practices to explain why these bones are missing.

This misrepresentation does not only affect different skeletal elements, but may also affect groups of individuals. Several studies have shown that sub-adult skeletons are less well preserved and possibly underrepresented in different skeletal samples (Bello and Andrews, 2006, Bello et al., 2006, Buckberry, 2000, Guy et al., 1997, Walker et al., 1988). In Guy et al.'s (1997) discussion of infant taphonomy, it is argued that there is a difference in the structure and composition of bones between infants and older individuals, and this is suggested as a reason for an underrepresentation of infants in archaeological cemetery samples. They (Guy et al., 1997) base this on infant bones being poorly structured, having a low mineral and high water content and therefore being poorly protected against chemical and mechanical degradation. The situation is, however, likely to be somewhat more nuanced than this. Another study of bone density during childhood and adolescence (Rauch and Schoenau, 2001) shows that the bone mineral density in cortical bone decreases after birth to a low point during the first year of life and thereafter increases towards adulthood. A study of the Spitalfields skeletal sample (Bello and Andrews, 2006) also suggests that this should not be seen as a difference between infant and adult remains, but rather as continuous and age progressive. They divided the sample into three age groups: 0-4 years, 5-19 years, and adults, and used six classes grading a skeleton's level of preservation. The study found that the individuals in the youngest age group had the highest representation among the worst preserved remains. The representation got gradually less as one considered skeletons of better preservation and was nearly absent in the group containing perfectly preserved skeletons. The skeletons of the older individuals showed a different pattern as they had a high representation in the groups of good preservation. These studies suggest that sub-adults, and maybe especially children less than a year old, may be underrepresented in skeletal collections, but there is other evidence that preservational biases also affects other age groups. Walker et al. (1988) compared the burial records with data from the skeletal remains excavated from a cemetery and made a very interesting discovery. According to the burial records, the majority of the buried individuals were infants, children and elderly adults. The skeletal remains, on the other hand, show a clear majority of young adults. This is in agreement with the other studies with regard to sub-adult individuals being underrepresented, but it also seems clear that elderly individuals are underrepresented due to poor preservation. This is explained by skeletal mass starting to decrease after the age of about 40-50 years (Garn, 1970).

Based on these studies there seems to be a strong correlation between age-related changes in the skeleton and the likelihood of an individual's remains being represented in the archaeological record. This correlation is generally related to the mineral content in bone fluctuating with age and thus making the bones more susceptible to degradation. Although, this will be the case under any burial condition, independent of external factors influencing the preservation of the bones, this will not necessarily have a significant effect on the representation of the different age groups. In situations where the burial environment is favourable for skeletal preservation, one will see a difference in preservational quality corresponding to different age groups, but there will be little or no influence on the representation of the different age groups. The problem only becomes evident when the preservational environment is less favourable. Then, the skeletons showing the worst preservation under good conditions will be very poorly preserved or completely disintegrated. Thus, significant biases towards a skeletal population of young to middle aged adults may be created.

It has also been suggested that preservational factors may affect the sexes differently (Bello and Andrews, 2006, Bello et al., 2006, Bennike, 1985). Weiss (1972) demonstrated a systematic sexual bias in skeletal samples of about 12% in favour of males. This has been partly explained by the comparatively rapid disintegration of lightly built female skeletons (Bennike, 1985) and it has also been suggested that the disappearance of female skeletons from the archaeological record is particularly affecting postmenopausal women who experience osteoporosis after the cessation of ovarian function (Raisz, 1982). A study by Walker et al. (1988), however, suggests that this claimed expedited disintegration of the elderly female skeleton does not affect the sex composition of skeletal samples. Their study comparing the skeletal record and the burial records of a cemetery shows a good correspondence between the sex distribution presented in the burial records and the sex distribution in the skeletal sample. The sexual bias in skeletal samples as reported by Weiss (1972) is more likely to be the product of biases inherent in the sexing techniques rather than sexual differences in bone composition.

With regard to osteoporosis, it is well established that postmenopausal women are prone to developing this condition, but men also suffer similar effects in old age. Osteoporosis is defined as a condition of reduction of total bone mass per unit volume while retaining a normal ratio of bone mineral to bone matrix (Krane and Holick, 1991). This definition will fit several different circumstances and conditions, and this will be discussed later. Osteoporosis is, however, generally used to describe a form of age related bone loss without any obvious aetiology (Aufderheide and Rodriguez-Martin, 1998:314). This affects both sexes above the age of 60 and features loss of both trabecular and cortical bone. In general, bone mass peaks in the mid thirties. Thereafter bone remodelling continues but the bone formation/resorption ratio is gradually altered from its previous equilibrium by continued resorption but lagging formation (Aufderheide and Rodriguez-Martin, 1998:314). Women normally suffer a substantial acceleration of this phenomenon during the postmenopausal state while the change in men is more gradual. Over a lifetime women lose about 35% of their peak cortical bone mass and about half of their trabecular bone while men lose about two thirds of these values (Aufderheide and Rodriguez-Martin, 1998:315). On the basis of this and the study by Walker et al. (1988) there is no reason to suggest that factors inherent in bone should cause sexual biases with regard to preservation of the adult and elderly skeleton. For the sub-adult skeleton, however, the evidence seems to be different. In the Spitalfields sample, female skeletons in the 0-4 years age group, are generally less well preserved and represented than male skeletons (Bello and Andrews, 2006). The study suggests that the threshold between poorer and better states of preservation, probably due to bone mineralisation, should be set to around 1 year for males and around 4 years for females (Bello and Andrews, 2006).

Having gone through various processes affecting the human body from death to recovery as skeletal remains, it becomes clear that one of the major factors creating biases in a skeletal sample is inherent in the bones themselves. There seems to be no factor more influential with regard to bone preservation than a bone's mineral content and bone mass. Although, this is related to age, and to some extent sex, and may have a significant influence on the age composition of skeletal samples, there are several other factors, mainly pathological, which can cause similar alterations to bone chemistry. Thus, pathology can also influence preservation. There are many pathological conditions which are interesting in this respect, but possibly the most important group of medical conditions here are conditions related to the parathyroid glands. These glands produce parathyroid hormone which maintains the blood calcium level within the normal range by stimulating the release of calcium and phosphorous from bone, increasing phosphorus excretion and calcium reabsorption in the kidneys, and stimulating the kidneys to synthesise vitamin D which, in turn, increase calcium and phosphate absorption from the intestines (Kronenberg, 1993 in Aufderheide and Rodriguez-Martin, 1998:330).

The most obvious condition to be caused by a malfunction of the parathyroid glands is hyperparathyroidism where there is an increased production of parathyroid hormone. Other relevant conditions are vitamin D deficiency which causes rickets and ostemalacia, and osteogenesis imperfecta which is caused by defective collagen formation. Haematological disorders are also relevant as they cause cortical thinning which can make bones vulnerable to degradation. Other conditions can indirectly have similar effects on bone. These are conditions which lead to immobilisation, like strokes, spinal injuries and other diseases and injuries which cause paralysis. Prolonged immobilisation will lead to bone resorption and demineralisation (Demirbag et al., 2005).

6. Methodology

6.1 Osteology

Human skeletal material is the most direct source of knowledge about single individuals in archaeological contexts and also an invaluable source of information on a population level at any given time in history. The human skeleton is the only source of primary information about past individuals and populations; when studied in combination with the artefacts left behind by these past individuals and populations (the archaeological and historical material), have the potential of giving a fair reconstruction of the past. However, to be able to extract as much and accurate information as possible, it is important to approach the material with a proper methodology. Making the methods as clear and transparent as possible is of utmost importance as it is the only way the results can be reproduced or the quality of the results tested by other researchers. The aim for the osteological examinations in this project is to produce demographic information and information about social status and biological relationships between individuals. The different methods applied to extract this information will be discussed in the following.

6.1.1 Biological affiliation

The importance of determining the biological affiliation of an individual depends on the context in which the skeletal remains were recovered. This information can aid the identification process in a forensic context and can also be influential when determining which methods to apply for determination of sex, age at death and stature.

The biological affiliation of an individual can either be determined by visually examining a series of accepted morphological traits of the skull (e.g. Gill, 1998:293-315, Stewart, 1979a:227-238), or one can apply cranial measurements to discriminant functions. A visual examination of the skull could possibly classify an individual as part of one of six very broad groups: East Asian, American Indian, Caucasian, Polynesian, Negroid and Australian Aboriginal. But, as such an examination will be of limited value for this project, it will not be carried out. A metric analysis of biological affiliation may, however, be more interesting. There are two widely used computer programs for distinguishing between different biological groups by the means of discriminant function analysis: Fordisc and Cranid. Cranid 6a will be used in this study and will be discussed in the following.

The Cranid program was developed by Richard Wright and was first described in 1992 (Wright, 1992). It has been improved many times since then and the version 6a which is used here was released in 2009 (Wright, 2009). The Cranid program compares the size and shape of an unknown cranium to the 3163 crania in the Cranid database, through the analysis of 29 cranial measurements (table 13). The 3163 crania in the database come from 74 samples from around the world (table 12) (for a description of the different samples, see Howells, 1989, Wright, 2009). The Cranid program produces the results of two different analyses: Linear Discriminant Analysis (LDA) and Nearest Neighbour Discriminant Analysis (NNDA). The LDA produces a figure between 0 and 1 which is the probability of the unknown individual belonging to a particular sample in the database. The LDA measures the distance of the unknown cranium to the mean of the different samples and the probability figure shows how likely it is that the cranium comes from a particular sample based on its distance from the mean of that sample. There are, however, several assumptions underlying this analysis which affect the estimation of the probabilities. The two key assumptions for linear discriminant analysis are that the variables are multivariately normal and that the dispersion and covariance matrices for the groups are equal (Wright, 2009). There is, however, no reason to suggest that these assumptions are not fulfilled by the data in the Cranid database (Wright, 2009). Another method which avoids these assumptions is the nearest neighbour discriminant analysis which compares the unknown cranium to all the other crania in the database to see which crania it most resembles. It then produces a list of the 56 crania which are most similar to the cranium in question. The different samples in the database are then listed according to a weighted score based on the number of hits a sample has among the 56 crania which are morphologically nearest to the unknown cranium. The reason for using a weighted score and not the actual number of hits is that the sample sizes are different and this adjusts for that.

The discriminant analysis has the potential of discriminating between biological groups on a more specific level than a visual morphological analysis and could provide information, or at least a suggestion, about whether or not an individual was an immigrant to Norway. Thus, when the skull was complete enough for a metric analysis to be carried out, the Cranid program was used (Wright, 2009). The Cranid measurements are listed in table 13.

Although, the Cranid program produces easily understandable output, it requires a good amount of interpretation and a clear idea of what one is looking for to make sense of the results. For this study, the main interest was to try and determine which individuals were immigrants to the studied communities and to see if these individuals were treated any differently from the rest of the population. Such a determination of a foreign origin is solely based on differences in cranial morphology and cannot take the cultural components of being a foreigner into account. There are, of course, problems with such an approach as it will never be able to differentiate between people who have recently arrived in the community and people of a foreign background which have been there for generations and may have been considered to be local in cultural terms. Another problem is that there is a significant overlap in morphology between different groups of people. It is generally agreed that the old racial divisions of Caucasian, Mongoloid, Negroid and Australoid do not really exist (e.g. AAPA, 1996) with its clear differences between the races. Instead what you have is a series of genetic clines, with a gradual change in gene frequencies from one geographic region to the next. This does not, however, mean that there are no differences between people and that it is an impossibility to suggest a geographic origin for an individual based on morphology. It rather means that there are morphological differences between different groups of people, but that there are significant overlaps between the groups and this has to be taken into account when trying to determine an individual's biological origin. A last consideration is the representativity of the skeletal samples in the Cranid database to which the unknown skeletons will be compared. In the context of this study, it is important to be aware of the nature of the Norse Norway samples in the database. These samples consist of 55 males (Norse Norway M) and 55 females (Norse Norway F) from different graveyards in Oslo. "The sample is about 85% from the graveyard of St. Nicolaus, with some from St. Halvard, fewer from St. Olav, and two of each sex from the early period of the Maria Kirche" (Howells, 1989:Appendix A1). The reason for choosing this material was that it was considered to be less cosmopolitan than other samples and was thought to contain fewer individuals of foreign origin (Howells, 1989:Appendix A1). It is hard to assess the validity of these statements, but the sample has been chosen as diligently as possible with regard to making it representative of a Norwegian, Northern European population. Thus, it can be valid to consider individuals with a clearly different morphology from the individuals in the Cranid samples as individuals of a likely foreign origin.

The first thing to consider when starting to interpret the Cranid output is to check how well the cranium under examination is covered by the Cranid database. The Cranid program evaluates the unknown cranium with regard to Mean Nearest Neighbour Distance (MNND) and Mean Distance From Centroid (MDFC) (for more information about this, see Wright, 2009). Any cranium with a score of more than two standard deviations from the mean for either MNND and MDFC is not considered to be catered for by the Cranid database. There are several possible reasons for the lack of fit to the database, including that one or more of the measurements were wrongly taken or wrongly entered into the program, or

- “The geographical area from which the cranium came is poorly represented in the database”
- “The cranium is morphologically atypical of its group, for example because of unusual growth or artificial deformation”
- “The cranium is not deformed, but is an extreme member of its group – that group being itself at the extreme of the distribution of the samples in 29 dimensional space”
- “The person is of mixed ancestry”

(Wright, 2009:22)

Any cranium not thought to be well catered for by the Cranid database should be re-examined before any conclusions are made. With the exception of checking if the measurements had been correctly entered into the program, it has not been possible to re-examine ill fitting crania for this project and these skeletons have instead been excluded from this study of ancestry.

The further interpretation of the Cranid output depends, to a large degree, on what one is looking for. Considering the significant overlap between the different samples it is hard to justify the use of Cranid to distinguish between closely situated populations, but should rather be used on a much broader level, distinguishing between bigger geographical areas. Thus, fairly strict criteria have been applied when attempting to determine if an individual was foreign to the Norwegian population. It is impossible to give a proper definition of these criteria as it is a matter of subjective interpretation in each case, but, in general, for an individual to be suggested as an immigrant to Norway the scores for both the LDA and NNDA should be reasonably low on the list for possible matches and there should preferably be no representatives from the Norse Norway samples among the 10 most similar crania. Each cranium which is suggested to be of foreign descent is discussed separately in the results sections and the criteria used in each particular case should be evident from that discussion.

Table 12 The samples included in the Cranid database

No.	Sample	N	No.	Sample	N
1	Norse Norway M	55	**38**	Tolai New Britain F	54
2	Zalavar Hungary M	53	**39**	Mokapu Hawaii F	49
3	Berg Austria M	56	**40**	Easter I. F	37
4	Teita E. Afr. M	33	**41**	Moriori Chat Is. F	51
5	Dogon W. Afr. M	47	**42**	Arikara Dakota F	27
6	Zulu S. Afr. M	55	**43**	San Cruz I. Calif. F	51
7	S. Australia M	52	**44**	Peru Youyos F	55
8	Tasmania M	45	**45**	N. Japan Hokkaido F	32
9	Tolai New Britain M	56	**46**	S. Japan Kyushu F	41
10	Mokapu Hawaii M	51	**47**	Hainan China F	38
11	Easter I. M	49	**48**	Atayal Taiwan F	18
12	Moriori Chat Is. M	57	**49**	Guam Latte Period F	27
13	Arikara Dakota M	42	**50**	Egypt 26-30 Dyn F	53
14	San Cruz I. Calif. M	51	**51**	Bushman Afr. F	49
15	Peru Youyos M	55	**52**	Andaman Is. F	35
16	N. Japan Hokkaido M	55	**53**	Ainu Hokkaido F	38
17	S. Japan Kyushu M	50	**54**	Buriat Siberia F	54
18	Hainan China M	45	**55**	Eskimo Greenland F	55
19	Atayal Taiwan M	29	**56**	Beduin W. Asia MF	30
20	Philippines M	50	**57**	India M	25
21	Guam Latte Period M	30	**58**	India F	23
22	Egypt 26-30 Dyn M	58	**59**	Poundbury UK Rom. M	28
23	Bushman Afr. M	41	**60**	Poundbury UK Rom. F	21
24	Andaman Is. M	35	**61**	Lachish W. Asia M	30
25	Ainu Hokkaido M	48	**62**	Lachish W. Asia F	20
26	Buriat Siberia M	55	**63**	London Med. M	52
27	Eskimo Greenland M	53	**64**	London Med. F	49
28	Anyang China M	42	**65**	Patagonian M	33
29	Maori New Zealand M	20	**66**	Patagonian F	35
30	Norse Norway F	55	**67**	Italian F	35
31	Zalavar Hungary F	45	**68**	Italian M	63
32	Berg Austria F	53	**69**	Punjab F	36
33	Teita E. Afr. F	50	**70**	Punjab M	50
34	Dogon W. Afr. F	52	**71**	Denmark Neol. F	17
35	Zulu S. Afr. F	46	**72**	Denmark Neol. M	50
36	S. Australia F	49	**73**	Sydney F	22
37	Tasmania F	42	**74**	Sydney M	20

Table reproduced after Wright, 2009.

Table 13. Cranial measurements used in the Cranid analysis

Measurement	Craniometric points	Howell's code
Maximum cranial length	g-op	GOL
Nasio-occipital length	n-op	NOL
Cranial base length	ba-n	BNL
Basion-bregma height	ba-b	BBH
Maximum cranial breadth	eu-eu	XCB
Maximum frontal breadth		XFB
Biauricular breadth	au-au	AUB
Biasterionic breadth	as-as	ASB
Basion-prosthion length	ba-pr	BPL
Upper facial height	n-pr	NPH
Nasal height	n-ns	NLH
Orbital height		OBH
Orbital breadth	d-ec	OBB
Bijugal breadth	Ju-ju	JUB
Nasal breadth	al-al	NLB
Maxillo-alveolar breadth	ecm-ecm	MAB
Bimaxillary breadth	zm:a-zm:a	ZMB
Zygomaxillary subtense		SSS
Upper facial breadth	fmt-fmt	FMB
Nasion-frontal subtense		NAS
Biorbital breadth	ec-ec	EKB
Interorbital breadth	d-d	DKB
Cheek height		WMH
Frontal chord	n-b	FRC
Nasion-bregma subtense		FRS
Parietal chord	b-l	PAC
Bregma-lambda subtense		PAS
Occipital chord	l-o	OCC
Lambda-opisthion subtense		OCS

Table reproduced after Wright, 2009.

6.1.2 Sex determination

Sex, as determined from the examination of a human skeleton, refers to the biological sex of the individual, reflecting the phenotypic expression of the chromosomal differences between the two sexes. This should, under no circumstances, be confused with the term gender which is a cultural construct and a reflection of a society's perception of feminine and masculine attributes (Cox et al., 2008:328). Although it is generally accepted that sex refers to male and female as determined by biology and gender to male and female (one may in some cases operate with more than two genders (Geller, 2005)) as determined by culture, this is not reflected in the literature where gender can be estimated from bones and by molecular means (e.g. Martin, 2002, Shahrul Hisham et al., 2009, Zeybek et al., 2008) and it is therefore appropriate to point this out again. The study of gender, if possible, in past societies requires a whole other set of evidence (see Claassen, 1992, Schiebinger, 1986) and was not part of this study.

The methods for determination of sex of an individual will depend on whether the individual has reached adulthood or not. Sex determination for adult and sub-adult individuals will be discussed separately in the following.

6.1.2.1 Adult individuals

Due to the sexually dimorphic features of the pelvis, mostly related to the child bearing capacity of women, sex can be determined with fairly high accuracy in the adult skeleton. But, even though most adults are clearly male or female, it is generally agreed that sex cannot be accurately determined in more than 80-90% of skeletons (St. Hoyme and Iscan, 1989). This value refers to complete skeletons, or skeletons where at least the pelvis and skull is preserved. Duric et al. (2005) tested several sexually dimorphic traits of the pelvis and skull for accuracy as well as for observer agreement. In this test, the pelvis was sexed with 100% accuracy and the skull with 71% accuracy when done by an experienced anthropologist and when sexed by a less experienced anthropologist, the accuracy was 91% and 54% respectively. This shows that the pelvis is clearly the most sexually dimorphic skeletal element, but the study also shows that the accuracy depends on the examiner.

Even though the sexing accuracy is high when using the pelvis alone or in combination with the skull, these elements are not always present when dealing with archaeological material and even when the pelvic bones and skull are preserved, the appearance of the bones may have been altered by taphonomic processes which will further compromise the determination of the sex of an individual. Because of these inaccuracies when determining sex, it is appropriate to classify a skeletal sample into five categories: male, probably male, ambiguous sex, probably female and female.

A large amount of work has been published with regard to determining sex from the skeleton and nearly every skeletal element in the human body is covered. In the following, a brief discussion of different methods and their accuracy will be presented. The discussion will concentrate on methods developed for Caucasian individuals as that will be most applicable to this project. There are two main types of sexing methods: morphological and osteometric. Morphological methods rely on the visual examination and classification of morphological features on the skeleton while the osteometric methods rely on measurements of the skeleton which will classify the skeleton as male or female on the basis of discriminant functions. Morphological methods are mostly applicable to the pelvis and skull, (e.g. Bruzek, 2002, Graw et al., 1999, Iscan and Derrick, 1984, Loth and Henneberg, 1996, Phenice, 1969, Schiwy-Bochat, 2001, Sutherland and Suchey, 1991, Walker, 2005, Walker, 2008) although Rogers (1999) published a method for visual sex determination from the distal humerus. Osteometric methods are generally applicable to every part of the human skeleton: pelvic girdle (e.g. Albanese, 2003, Fernández Comacho et al., 1993, Flander, 1978, Luo, 1995, MacLaughlin and Bruce, 1986, Schulter-Ellis et al., 1985), skull (e.g. Giles, 1964, Konigsberg and Hens, 1998, Loth and Henneberg, 1996, Lynnerup et al., 2006, Saavedra de Paiva and Segre, 2003), long bones (e.g. Berrizbeitia, 1989, Holland, 1991, Holman and Bennet, 1991, Purkait, 2001, Purkait, 2005, Safont et al., 2000, Seidemann et al., 1998, Slaus et al., 2003, Steel, 1972, Steyn and Iscan, 1997, Trancho et al., 1997), hands and feet (e.g. Falsetti, 1995, Introna et al., 1997, Lazenby, 1994, Robling and Ubelaker, 1997, Smith, 1996, Smith, 1997, Stojanowski, 1999, Sulzmann et al., 2008) and other bones (e.g. Bainbridge and Tarazaga, 1956, Introna et al., 1998, Kemkes-Grottenthaler, 2005, Miller et al., 1998, Reesink et al., 1999, Wescott, 2000, Yu et al., 2008). The accuracy of sex determination varies depending on the method, skeletal element, and the observer; it is therefore advisable to examine various parts of the skeleton and to apply different methods for each individual.

For this project, the emphasis was put on morphological traits for the determination of sex. The pelvic girdle and the skull were visually examined with regard to the sexually dimorphic traits listed in table 14 and table 15. These traits have been chosen on the basis of the information presented in Buikstra and Ubelaker (1994), Cox et al. (2008), Rogers and Saunders (1994) and Phenice (1969). In addition to this, metric methods were used when the skull and pelvis were not present or poorly preserved. Metric methods were applied to the long bones of the upper and lower limbs. The humeri, radii and ulnae were sexed metrically by the methods developed by Holman and Bennet (1991) and Stewart (1979) and the femora and tibiae were sexed by the methods developed by Steyn and Iscan (1997) and Stewart (1979).

Table 14. Sexually dimorphic features of the pelvic girdle

Morphological trait	**Male**	**Female**
Pelvic inlet	Heart shaped	Circular, elliptical
Blade of ilium	High, tends to be vertical	Low, laterally divergent
Sacral curvature	More curved	Less curved
Sacral alae (relative to body)	Narrow	Broad
Preauricular sulcus	Infrequent	Frequent
Greater sciatic notch	Smaller, narrower, acute angle	Larger, wider, approaching 90°
Acetabulum	Large, faces laterally	Small, faces anterolaterally
Obturator foramen	Large and ovoid	Small and triangular
Medial aspect of Ischiopubic ramus	Wide, slightly elevated	Narrow, strongly everted
Subpubic angle	V-shaped, narrow, sharp	U-shaped, wide, rounded
Ventral arc	Absent/rare	Usually present
Subpubic concavity	Absent/rare	Present

Table 15. Sexually dimorphic features of the skull

Morphological trait	**Male**	**Female**
Supraorbital ridges	Medium to large	Small to medium
Glabella	Prominent and rounded	Not prominent
Forehead	Inclined, less rounded	Vertical, full
Orbital outline	Squared	Circular
Supraorbital margin	Rounded, blunt margins	Sharper, thinner margins
Suprameatal crest	Extends as a crest past the auditory meatus	Crest does not extend past the auditory meatus
Mastoid processes	Larger volume, more pronounced	Lesser volume, less pronounced
Nuchal area	Marked muscle lines and protuberances	No marked muscle lines and protuberances
Mental eminence	Marked projection of area above surrounding bone	Little or no projection of areas above surrounding bone
Gonial angle	Flared laterally	Not flared laterally
Mandible chin shape	Square (U-shaped)	Pointed (V-shaped)
Frontal eminences	Absent or not pronounced	Pronounced
Parietal eminences	Absent or not pronounced	Pronounced
Temporal ridges	Marked	Slight

6.1.2.2 Sub-adult individuals

Determination of sex of the sub-adult skeleton is very difficult as most of the sexually dimorphic skeletal traits do not develop until early adulthood. There are, however, methods available for sex determination of the sub-adult skeleton (e.g. Loth and Henneberg, 2001, Molleson and Cruse, 1998, Schutkowski, 1993, Vlak et al., 2008); since they are generally not very accurate, the sex will not be determined for the sub-adult individuals in this study.

6.1.3 Estimation of age at death

The method for estimating the age at death for an individual depends on the individual’s age at death. While the estimation of age at death for sub-adults is based on the individual’s level of development, the estimations are mostly based on degenerative changes for adult individuals. The estimation of age at death for adult and sub-adult individuals will be discussed separately below.

6.1.3.1 Adult individuals

Accurate estimation of age at death for adult individuals is a difficult task and in most cases impossible. The reason for this is that most of the methods available are based on the assessment of degenerative changes in the skeleton and such changes tend to affect different individuals at different ages. Thus, when estimating the age at death of adult individuals, one will have to operate with broad age groups. With regard to degenerative changes, there are mainly five areas of the human skeleton which have been subjected to most research: the pubic symphysis (e.g. Berg, 2008, Brooks and Suchey, 1990, Kimmerle et al., 2008, Konigsberg et al., 2008, Meindl et al., 1985, Todd, 1921a, Todd, 1921b), the auricular surface (e.g. Buckberry and Chamberlain, 2002, Falys et al., 2006, Lovejoy et al., 1985), the rib ends (e.g. Kunos et al., 1999, Yoder et al., 2001), the dentition (e.g. Lamendin et al., 1992, Liversidge et al., 2006, Prince et al., 2008, Prince and Konigsberg, 2008, Walker et al., 1991), and the fusion of the cranial sutures (e.g. Dorandeu et al., 2008, Galera et al., 1998, Mann et al., 1987, Meindl and Lovejoy, 1985, Parsons and Box, 1905).

Four areas of the human skeleton were examined when estimating age at death for the individuals in this project: the pubic symphyses, the auricular surfaces, the cranial sutures and the dentition. The pubic symphyses were assessed according to the phases described in Brooks and Suchey (1990) and aided by the Suchey-Brooks male and female age determination casts produced by France Casting. For the auricular surfaces, the method developed by Buckberry and Chamberlain (2002) was applied. The reason for choosing this method, and not the original method by Lovejoy et al. (1985), is that the author finds it easier to use consistently, and the method is also recommended by Cox et al. (2008:379) as it facilitates more objective scoring. The examination of cranial sutures for age at death estimation is by many considered to be unreliable (see Cox et al., 2008), but is also often used both osteoarchaeologically and forensically (Dorandeu et al., 2008). In particular, there is one method which is mostly used (Meindl and

Lovejoy, 1985) and this method has been applied in this study. This method is also recommended in general texts books (Buikstra and Ubelaker, 1994, White and Folkens, 2000) and has been used in recent osteoarchaeological studies (e.g. Kjellström, 2005). The last area to be assessed for estimation of age at death was the dentition where molar attrition was scored according to the chart presented by Brothwell (1981:72).

6.1.3.2 Sub-adult individuals

Age at death for sub-adult individuals can be estimated with much higher accuracy than for adult individuals. The development of the dentition and skeleton has been extensively studied and is well understood; this information can be used to estimate the age at death for sub-adult individuals to within a few years. Ageing a skeleton from its dental development is normally done by comparing the teeth of the individual in question to standardised dental development charts. Several studies have published such charts (Linden and Duterloo, 1976, Schour and Massler, 1941, Ubelaker, 1978), but only the Schour and Massler (1941) chart was applied in this study. The reason for choosing this chart was that it was shown by Liversidge (1994) to be more accurate than the other methods. The skeleton of the sub-adult individuals was aged by an examination of bone sizes and level of epiphyseal fusion. This development is well established and discussed in detail elsewhere, and will not be given any further consideration here. For further detail regarding the development of the human skeleton, the reader is referred to the excellent and comprehensive text by Scheuer and Black (2000).

6.1.3.3 Age groups

The accuracy of the estimated age varies from individual to individual, but each individual was, as far as possible, assigned to one of the following age groups:

- Infant: 0 - 1 year
- Child I: 1 – 4 years
- Child II: 4 – 8 years
- Juvenile: 8 – 12 years
- Adolescent: 12 – 18 years
- Young adult: 18 – 30 years
- Adult: 30 – 50 years
- Mature adult: 50+ years
- Unestimated: 20+ years

6.1.3.4 Average age at death

Calculating the average age at death of past populations, based on the examination of skeletalised individuals, is deemed to be inaccurate. The main reason for this lies in the inaccuracy in estimating the age at death for adult individuals. Skeletalised individuals can only be assigned to relatively broad age groups and this will affect the calculations of average life span. There are, however, ways to get an idea of the average age at death for these individuals, and the method used here was to take the mean of an age group as the age of every individual in that age group. Thus, every individual in the 0-1 year age group was assigned an age of 0.5 years, the individuals in the 1-4 years group were assigned an age of 2 years and so on. This gives a rough estimate of the average age at death for the individuals in the sample. This estimate is, however, only representative for the skeletal sample under investigation, and for it to be applicable to the general population from which the sample came, one will have to carefully consider the representativeness of the material.

6.1.4 Stature estimation

Estimating living stature from skeletal remains is done by applying skeletal measurements to an appropriate regression formula. Regression formulae have been developed for long bones (e.g. Bach, 1965, Dupertuis and Hadden, 1951, Sjøvold, 1990, Trotter and Gleser, 1952, Trotter and Gleser, 1958), hand and foot bones (e.g. Holland, 1995, Musgrave and Harneja, 1978), partial or fragmented bones (e.g. Bidmos, 2008, Giroux and Wescott, 2008, Steele and McKern, 1969) and for complete skeletons (the anatomical method) (Fully, 1960, Fully and Pineau, 1956, Raxter et al., 2006). The anatomical method for estimating living stature is clearly the most accurate, but, as it requires a completely preserved skeleton, it is often difficult to apply this method to archaeological skeletal remains. Of the other methods, the formulae developed by Trotter and Gleser (1952, 1958) and Trotter (1970) are the most commonly used. However, the author would like to advocate the use of a more recently developed set of formulae (Sjøvold, 1990). The reasons for applying these formulae are that they are developed on larger samples of skeletal measurements than any other method and the formulae are independent of sex. That the formulae can be used without knowing the sex of an individual, is a clear advantage when working with archaeological remains where this information is not always known.

6.1.5 Measuring equipment

All the measurements involved in the above analyses were taken with the following equipment:

- Osteometric board: Paleo-Tech laboratory osteometric board.
- Spreading calliper: Paleo-Tach spreading calliper.
- Sliding calliper: Mitutoyo absolute 100mm digimatic sliding calliper.

6.2 Social differences

Studying social differences between skeletonised individuals is not straight forward as a single skeleton does not say anything about the social position the person had within its society. However, this study has attempted to determine whether or not the early Christian graveyards were socially stratified and it was therefore necessary to apply a method for determining social differences. In this study, social differences were mainly determined through an examination of stature, degenerative changes to the skeleton and enamel hypoplasias. In addition to this, the skeletons were examined for several other traits to develop a health index for each individual.

The study of these traits and the health index as indicators of social status is based on some assumptions about the mediaeval society:

1. There were distinct differences between the lower and the upper social classes.
2. The lower classes were subjected to greater levels of occupational stress and harder physical labour than the upper classes.
3. The lower classes had less access to food and nutritional quality than the upper classes.
4. The lower classes were generally less healthy than the upper classes.

A discussion of the different traits and how they relate to social differences is presented in the following.

6.2.1 Stature and social position

Although the majority of an individual's stature is genetically determined, a portion of a person's height is determined by environmental and nutritional factors. "...terminal height is a product of nutritional adequacy and, to a lesser extent, disease history. Individuals with adequate nutrition tend to reach their genetic growth potential; those with poor nutrition do not" (Larsen, 1999:14). One could therefore expect a difference in stature between the upper and lower classes.

6.2.2 Degenerative joint disease and spinal degeneration

Degenerative joints disease (DJD) is a non-inflammatory, chronic, progressive condition characterised by the loss of joint cartilage and subsequent lesions resulting from direct interosseous contact within synovial joints (Aufderheide and Rodriguez-Martin, 1998:93) (figure 10). The disease is generally defined by breakdown of bone at the articular surface areas of joints. Following the exposure of subchondral bone, the bone contact points become pitted, with marginal lipping and erosion, and eventually eburnation (Steckel and Rose, 2002:41-42). This disease is the most common form of joint pathology and is usually detectable during the fourth decade of life and is, thereafter, age progressive (Aufderheide and Rodriguez-Martin, 1998:93). Degenerative changes in the vertebral column are usually detectable somewhat earlier, during the third decade of life (Aufderheide and Rodriguez-Martin, 1998:96). DJD is normally subclassified as primary in which no cause is evident, and secondary in which the joint has been altered by some other disease or event (Aufderheide and Rodriguez-Martin, 1998:93). Age and physical activity are the most common factors implicated in the aetiology of the disease (Bridges, 1992). As an indicator of social status, the secondary form of DJD is of main interest as occupational stress can play a role in the development of the disease. However, DJD affects most people, regardless of social level, if they live long enough; it is therefore important to consider an individual's age when interpreting the presence of DJD. The occupational stresses of the lower classes could have expedited the onset of the disease and one is thus likely to find evidence of DJD in younger individuals in this social group.

Figure 10. Left femur head displaying the signs of advanced joint degeneration.
Notice the lipping around the edge of the femur head, the pitting of the articular surface with the polished areas of eburnation (St. Mary's church, Bergen, 75004).
Photo by Stian Hamre.

6.2.3 Enamel hypoplasia

Enamel hypoplasia is the term used to describe a defect in the structure of tooth enamel resulting from a body-wide, metabolic insult sufficient to disrupt ameloblastic physiology (Aufderheide and Rodriguez-Martin, 1998:405). What causes the disruption in ameloblastic physiology is both an easy question to answer and an impossible one. On a general level it is known that enamel hypoplasias can be caused by nutritional imbalances, drug toxicities and almost any disease which severely stresses metabolism (Steckel and Rose, 2002:24). For a list of factors which can possible cause enamel defects, see Cutress and Suckling (1982). On a specific level, it is generally not possible to attribute a specific enamel defect to a specific disease or event and it is therefore preferable to look at enamel hypoplasias as indicators of nonspecific stress.

The importance of these defects rests on the fact that they provide an indelible indicator of stress during tooth crown development. The crowns of deciduous teeth start developing prenatally and the development lasts until about a year after birth, while the crowns of the permanent dentition start developing during the first year of life and are complete at the age of 8 years (the third molar excluded) (Schour and Massler, 1940a, Schour and Massler, 1940b) (table 16). It is reasonable to believe that the lower classes of the population were more susceptible to such severe metabolic insults and thus, the examination of enamel hypoplasias could provide evidence of social stratification.

Table 16. Period of crown development for the permanent dentition

Maxillary dentition	**Period of crown formation**	**Mandibular dentition**	**Period of crown formation**
I^1	0.25-5.0 years	I_1	0.25-5.0 years
I^2	0.8-5.0 years	I_2	0.25-5.0 years
C^1	0.3-7.0 years	C_1	0.3-7.0 years
P^1	1.5-6.0 years	P_1	1.5-6.0 years
P^2	2.0-7.0 years	P_2	2.0-7.0 years
M^1	0.0-3.0 years	M_1	0.0-3.0 years
M^2	2.5-8.0 years	M_2	2.5-8.0 years
M^3	7.0-16 years	M_3	7.0-16.0 years

Information adapted from Schour and Massler (1940a) and Schour and Massler (1940b). I=incisor, C=canine, P=premolar, M=molar.

6.2.4 The health index

In addition to the above discussed conditions, a health index was calculated for each individual (considering some criteria are fulfilled). The health index attempts to give a picture of an individual's health during life by examining a set of skeletal indicators of health. Such an index was first developed by Steckel and Rose (2002) and was more recently applied in a Scandinavian setting by Kjellström (2005). The same health indicators were applied in this study as were used in the afore mentioned studies: stature, dental health, degenerative joint disease, anaemia, auditory exostosis, periosteal reactions and trauma. A health index based on these criteria will, by no means, give a complete picture of an individual's health during life. Firstly, most diseases or complaints a person experiences during life do not leave any traces in the skeleton. Secondly, the preservation of the skeletal remains will determine to what extent the potential skeletal conditions are available for examination. However, such an index may give an idea of the health status of these individuals and it provides a tool for making easy comparisons between different populations with regard to health on a population level. For more information about the background for the health index, see Steckel and Rose (2002).

Ideally, a skeleton should be complete enough for all health criteria to be examined for and a health index to be calculated. However, if this was to be followed strictly, a significant number of individuals would have been excluded due to poor preservation; therefore, it was decided that a health index should be calculated as long as at least four of the seven criteria could be examined. An individual's health index was calculated in the following manner:

sum of scores for the different criteria / number of criteria examined

This gives a score between 1 and 0 where a score of 1 indicates an individual where no signs of ill health were observed. The lower the score the more signs of health problems were evident from the skeletal examination.

The different health criteria and how they were scored will be discussed in the following.

6.2.4.1 Stature

Stature was scored according to the average stature in the studied population, in this case the average for the four graveyards in this study. Individuals falling below the second standard deviation of the average were scored zero and individuals above two standard deviations were scored 1.0. Anyone in between was scored on a scale from the second standard deviation below the average to two standard deviations above.

6.2.4.2 Dental health

Dental health was calculated from two components, completeness (weight of 75%) and abscesses (weight of 25%). Completeness is defined by one minus the ratio of the sum of antemortem tooth loss and carious cavities to the sum of teeth present and antemortem tooth loss. Abscesses were scored as follows: No abscesses score 1, one abscess scores 0.5 and two or more abscesses score 0.

The calculation of dental health was done as follows:

Completeness = 1 – ((Antemortem loss + Cavities) / (Teeth + Antemortem loss))

Dental health score = ((Completeness * 3) + Abscess) / 4

Thus, a person with no dental disease scored 1 and the lower the score the worse the dental health of the individual.

6.2.4.3 Degenerative joint disease

The score for degenerative joint disease was determined by the lowest of the scores for the following joints.

- Shoulder, elbow, hip and knee (right and left side separate)
    - 1.00 = Joints show no signs of degenerative disease
    - 0.75 = Initial osteophyte formation or deterioration of the joint surface

- 0.50 = Major osteophyte formation and/or destruction of the joint surface, such as eburnation
- 0.25 = Immobilisation of the joint due only to degenerative disease
- 0.00 = Systemic degenerative disease (rheumatoid arthritis, alkaptonuria)

- Radioulnar joint, bones of the hands and feet, and the temporomandibular joint (right and left side separate)
  - 1.00 = No degenerative disease
  - 0.50 = degenerative disease
  - 0.00 = degenerative disease with eburnation
- Cervical, thoracic and lumbar vertebrae (scored separately)
  - 1.00 = No lesions on at least two observable vertebrae
  - 0.66 = Initial osteophyte formation along rim of vertebral body(-ies)
  - 0.33 = Extensive osteophyte formation along rim of the vertebrae
  - 0.00 = Two or more vertebral bodies fused together

6.2.4.4 Anaemia (cribra orbitalia and porotic hyperostosis)

Red blood cells have only one function and that is to transport oxygen, essential to all living cells, from the lungs to all cellular tissues throughout the body (Aufderheide and Rodriguez-Martin, 1998:345). Oxygen is transported by its attachment to the iron molecule of haemoglobin. Anaemia is the general term used to describe a diminished content of haemoglobin in the blood. Anaemia can come about by any three mechanisms: blood loss, decreased production rate and increased destruction rate. The clinical symptoms of prolonged anaemia can include skin pallor, fatigue, weakness, dyspnea, vertigo and tachycardia (Aufderheide and Rodriguez-Martin, 1998:346). Thus, anaemia can severely affect the well being of an individual. In the skeletal record, there are two changes which are normally considered to be evidence of anaemia and these are cribra orbitalia and porotic hyperostosis. Porotic hyperostosis is characterised by cranial lesions involving the outer table of the frontal and parietal bones.

> "In the fully developed lesion the involved areas of the skull are thickened by the expanded diploic layer and the outer table overlying the lesions has been resorbed completely. This permits direct visualization of the trabeculae of the expanded cancellous bone, and coarsening of these trabeculae is usually apparent. In earlier cases or those of lesser degree the outer table is often incompletely resorbed, the most minimal examples presenting only as multiple, discrete pinhead-sized perforations." (Aufderheide and Rodriguez-Martin, 1998:348-349).

Cribra orbitalia is similar, but with smaller lesions located in the orbital ceiling (figure 11).

The score for anaemia is determined by the lowest score for either porotic hyperostosis or cribra orbitalia:

- Porotic hyperostosis and cribra orbitalia
    - 1.00 = No lesion on at least one observable parietal bone or orbital ceiling
    - 0.50 = Presence of a lesion
    - 0.00 = Gross lesions with excessive expansion and large area of exposed diploe

Figure 11. Left orbital ceiling displaying cribra orbitalia.
Notice the pitting in the ceiling of this eye socket (Hamar cathedral CG57).
Photo by Stian Hamre.

6.2.4.5 Auditory exostosis

An auditory exostosis is a benign lesion composed of dense bone located at the auditory meatus or within the external auditory canal (Aufderheide and Rodriguez-Martin, 1998:254). These lesions do impair hearing on the affected ear (Steckel and Rose, 2002:88) and are scored as follows:

- 1.00 = Auditory meatus exhibits no exostosis
- 0.50 = Exostosis present in one ear
- 0.00 = Exostoses present in both ears

6.2.4.6 Periosteal reactions

Infections of bone can be quite serious and debilitating as they result in pain and swelling, and interfere with normal activities. An infection is also a burden on the individual's defence mechanism, which can result in reduced resistance to other disease processes (Steckel and Rose, 2002:89). Periosteal reactions, as can be recognised on the skeletal material, are generally the result of an infection but may have other causes like trauma. For more information about bone infection, see Roberts and Manchester (1999:126-131). The most common site for infectious lesions is the tibia (Steckel and Rose, 2002:89) and this is scored separately from the rest of the skeleton which is scored as one. The score for periosteal reactions is the lowest of the two scores.

- Tibia
    - 1.00 = No infectious lesions of the tibia(e) with at least one tibia available for observation
    - 0.66 = Slight, small discrete patch(es) of periosteal reaction involving less than one quarter of the tibia(e) surface on one or both tibiae
    - 0,33 = Moderate periosteal reaction involving less than one half of the tibia(e) surface on one or both tibiae
    - 0.00 = Severe periosteal reaction involving more than one half of the tibia(e) surface on one or both tibiae
- Rest of the skeleton
    - 1.00 = No periosteal reaction on any other bone than the tibiae
    - 0.50 = Periosteal reaction on any other bone(s) than the tibiae not caused by trauma

    - 0.00 = Evidence of systemic infection involving any of the bones (including the tibiae) of the skeleton. This would include (but not limited to) diseases like tuberculosis, leprosy and syphilis.

6.2.4.7 Trauma

Trauma is scored in the following manner:

- Arms and legs
    - 1.00 = Not fractured
    - 0.66 = Healed fracture with acceptable alignment
    - 0.33 = Healed and poorly aligned
    - 0.00 = Healed with fusion of the joint
- The rest of the skeleton
    - 1.00 = No fracture
    - 0.00 = Healed fracture
- Weapon wounds
    - 1.00 = No weapon wounds
    - 0.00 = Weapon wounds

6.3 Family plots

Through the examination of a selection of cranial non-metric traits and one post cranial trait, an attempt has been made to investigate the possible presence of family plots on these graveyards. Although it has been shown that the expression of many of these traits are partially environmentally influenced, it is generally agreed that there is a significant genetic component in their development. The expression of certain traits will, therefore, run in some families while be absent in other. Thus, clusters on the graveyard of a specific trait could signify a biological relationship between these individuals and could present evidence of family burial areas. The expression of the traits listed in table 17 was, as far as possible, recorded for all of the examined skeletons.

Table 17. Non-metric trait recorded for the skeletons in this study

Non-metric traits	
Metopic suture	Supraorbital structures
Parietal foramen	Coronal ossicle
Bregmatic bone	Sagittal ossicle
Lambdoid ossicle	Asterionic bone
Inca bone	Mandibular torus
Mantal foramen number	Septal aperture

6.4 Archaeology

Archaeology plays a big part in this project as all the studied material is, in fact, archaeological in nature. The excavations producing this material were, however, carried out decades ago (1960s-1990s) and thus, the author had no influence on the methodological decisions made for these excavations. The records (diaries, recording forms, plan drawings, reports) for these excavations were rather used to gather the information required.

One of the most crucial pieces of information needed to carry out this project was the knowledge of the exact location of each burial on the graveyard and later the location of the actual skeletal remains corresponding to each grave. This information was collected through the examination of the plan drawings from the sites. Although, the exact location of every grave could not be determined, this information was available for the great majority of the graves. The few graves for which the coordinates could not be found were excluded from this study. The specific information for the different sites is given in the presentation of the material above.

It was important to determine the absolute and relative chronology of the burials included in the research. This information has, for the majority of the material, been gathered from the different publications regarding the sites. For a smaller part of the material, however, the author has determined the chronology of the burials through an interpretation of the archaeological documentation.

6.4.1 Non-osseous artefacts

Although, the main find category from a cemetery excavation is the physical remains of the individuals buried there, there is also a significant amount of other material worth considering. This is material which could provide information relevant for this study. Especially an analysis of the grave itself could be particularly illuminating. It can be assumed that social differences are reflected in the different types of burials: earthen burials, coffin burials, different types of coffins. A detailed study of this material, including the creation of a burial typology for each site, is likely to have revealed patterns which could have been related to social differences. However, there is a major difference between the study of the skeletal material and grave: the skeletal material represents the actual people who live within the social hierarchy while the graves represent the buriers' (family, friends, society) view of the buried individuals. Because of the difference in approach the study of these two find groups represent, it would be very interesting to see how the different results correspond.

The inclusion of this material was intended for this study, but as it turned out, the time scope for this project did not leave enough room to do an examination of this material justice and it was thus excluded all together.

There are generally very few other artefacts found in Christian graves but there is one find group which has received a lot of attention: the burial rods. These burial rods are also called hazel rods, sticks, wands etc. as many of these rods are made of hazel but they are often also made from other types of wood, so hazel is not appropriate in a general description of these finds. These rods have been assigned a number of different meanings and uses and have been extensively discussed in the literature (see Jonsson (2009:111-122) for a thorough discussion and references). These rods have also been found buried with both sexes, adults and children, and in all areas of the graveyards; therefore, it is difficult to see how any emphasis can be put on these rods as markers of social status or differences between the sexes.

6.5 Statistical analyses

The main purpose of using statistical analyses in this project was to investigate the differences between different distributions. The Fisher's two-tailed exact test was used to determine whether or not the difference between the following was statistically significant: difference in sex distribution between different areas of the graveyards; difference between the sex distribution and a hypothetical distribution where the sexes were equally represented; differences in prevalence for the different pathological conditions between different areas of the graveyards and between the sexes. Any result at P=0.05 or less has been considered significant. The calculations were made using the Statistica 7 statistical package.

7. Results

The results of the examination of the skeletal remains will be discussed in the following. The results for the different graveyards will be presented separately and the questions of sexual segregation and social stratification are discussed for each site as far as possible. A comparison between the different sites with regard to differences and similarities is found in the next chapter.

7.1 Some explanations for the results chapter

Although the methodology has been discussed in detail above, there are a few explaining points which need to be made. This is with regard to the number of individuals included in the calculations dealing with the prevalence of the different pathological conditions. Since the proper examination of the different conditions requires certain skeletal elements to be preserved, it is not appropriate to include the full sample in these calculations. To determine whether or not an individual suffered from DJD requires the examination of that individual's joints. Thus, it would be wrong to include individuals for whom the joints were not preserved in the discussion of DJD. It was, therefore, decided that any individual with less than half their joints preserved should be excluded. With regard to degenerative changes to the spine, only individuals with preserved vertebrae from at least two vertebral sections were included. Dental conditions were examined for individuals with two thirds of their jaws present. Some individuals with too little material preserved still showed signs of pathological changes. If these individuals were excluded, it would have lowered the prevalence for the different conditions. Including these individuals could possibly inflate figures somewhat, but it was decided that they should be included since these individuals actually suffered from these conditions. Thus, the number of individuals included in the calculations in the following chapter will vary between the different conditions.

7.2 The St. Mary's church graveyard, Bergen

The skeletal sample excavated from the graveyard at the St. Mary's church in Bergen consists of 119 individuals. Nearly two thirds of the material is well dated which makes these skeletons suited for studying temporal changes. For the purpose of this study, this is particularly useful when trying to determine whether this graveyard was sexually divided at some point in time. On the other hand, all the skeletons were excavated from the southern section of the graveyard, so a direct comparison between the different sides of the church with regard to sexual segregation is not possible. Also, the excavated area only covers the outer half of the graveyard and it is therefore difficult to directly compare the distribution of data at different distances from the church, which is of importance for this study with regard to the question of whether or not the graveyard was socially stratified. Due to the limitations of this material, some of the questions will not be discussed here, but will rather be treated in the discussion chapter in comparison with the three other graveyards in this study. All the data, however, will be presented in the following.

7.2.1 Biological affiliation

Six of the skeletons from the St. Mary's church graveyard were well enough preserved for the complete set of Cranid measurements to be taken. Two of the measured crania (75003 and 75039) were not well catered for by the Cranid database and have for this reason been excluded. The results of the Cranid analyses are presented in table 18. Skeleton 75038 displays a cranial morphology which differs from the Norwegian sample to such an extent that she might be considered to be foreign to this group, and this is discussed in more detail below.

Skeleton 75038: This individual shows the highest probability of membership in the Poundbury UK Rom F (0.46) and Bushman Afr M (0.46) groups in the Cranid database. Also the NNDA analysis puts this cranium closest to those groups (Bushman Afr M:617, Poundbury UK Rom F:602), but the cranium also shows a good resemblance to the Bushman Afr F (516) and the Berg Austria F (358) groups. The cranium in the database which most resembles skeleton 75038 is from the Bushman Afr M group. On the list of the 56 closest matches to this cranium, there are four crania from the Norwegian samples and the most resembling is number 24 on the list. On the other hand, among the 10 crania which show the greatest similarity to skeleton 75038, five are from the Bushman Afr samples. On the basis of this, this individual differs from the individuals in the Norwegian samples to such an extent that it seems reasonable to suggest that this was a person of foreign descent. To suggest an origin for this individual is somewhat difficult as the results are split between two groups which are geographically wide apart. It is, however, interesting to note that among the 56 crania most similar to 75038, 16 are from the Bushman Afr samples and nine of these are among the top 16. In addition to this, two of the other crania among the top 10 are also from African samples, the Egyptian. One would not necessarily think of a significant African presence in mediaeval Bergen, but this is possibly not as farfetched as it may sound, as is shown by a recently published article about a woman from Roman age Britain (Leach et al., 2010). Leach et al. (2010) studied the grave and skeleton of a woman exhumed in York, and through the examination of the grave goods, morphological and metric features of the cranium in addition to an isotopic analysis, concluded convincingly that she was an immigrant to York and was likely to be of North African origins. However, any conclusions as to the origins of this lady from the St. Mary's church graveyard shall not be drawn at this point. A further analysis of this question would be interesting and especially isotope and DNA analyses will have the potential of shedding more light on the geographical and biological origins of this individual.

Table 18. Results of the Cranid analysis of the crania from the St. Mary's church graveyard

Skeleton ID	LDA		NNDA	
	Group	**Probability**	**Group**	**Weighted score**
75016	Lachish W Asia F	0.71	Lachish W Asia F	474
			Norse Norway M	460
			Egypt 26-30 Dyn F	358
	Norse Norway F	0.09	Egypt 26-30 Dyn M	327
75030	Norse Norway F	0.63	Zalavar Hungary F	562
	Beduin W Asia MF	0.15	Egypt 26-30 Dyn F	418
	Zalavar Hungary F	0.13	Norse Norway M	345
75038	Poundbury UK Rom F	0.46	Bushman Afr M	617
	Bushman Afr M	0.46	Poundbury UK Rom F	602
			Bushman Afr F	516
			Berg Austria F	358
	Norse Norway F	0.00	Norse Norway F	230
76330	Italian F	0.27	Zalavar Hungary F	562
	Norse Norway F	0.20	Denmark F	372
	Zalavar Hungary F	0.20	Lond. Medvl. F	323
			Norse Norway F	288

7.2.2 Sex distribution

Of the 119 individuals included in this sample, 38 were determined to be male or probably male while 46 individuals were placed in the female categories. Sex could not be determined for 30 of the skeletons, of which 16 were children. Table 19 shows the distribution of the sexes according to time periods and all groups show that both sexes are fairly equally represented. Thus, there is nothing to suggest that sexes were ever separated on the graveyard for the St. Mary's church in Bergen.

Table 19. Sex distribution for the St. Mary's church sample

Time period	N	Male	Male?	Ambiguous	Female?	Female
Pre 1170	7	4 (57%)	0	0	0	3 (43%)
1170-1198	39 *32*	5 (13%) *5 (16%)*	4 (10%) *4 (12%)*	13 (7 children) (33%) *6 (19%)*	5 (13%) *5 (16%)*	12 (31%) *12 (37%)*
1198-1248	20 *14*	5 (25%) *5 (36%)*	2 (10%) *2 (14%)*	6 (6 children) (30%) *0*	5 (25%) *5 (36%)*	2 (10%) *2 (14%)*
1248-1332	7	2 (29%)	2 (29%)	0	2 (29%)	1 (13%)
Unknown	46 *43*	12 (26%) *12 (28%)*	7 (15%) *7 (16%)*	11 (3 children) (24%) *8 (19%)*	7 (15%) *7 (16%)*	9 (20%) *9 (21%)*
Combined	119 *103*	28 (23%) *28 (27%)*	15 (13%) *15 (15%)*	30 (16 children) (25%) *14 (14%)*	19 (16%) *19 (18%)*	27 (23%) *27 (26%)*

The figures in italics are calculated without the sub-adult individuals.

7.2.3 Age distribution

There are 119 individuals for which the age at death has been estimated. Among these were 17 (14%) below the age of 18 and 102 (86%) above this age. Eight of the adult individuals could not be assigned to an age group and were only determined to be of adult age at the time of death and were, therefore, excluded from the calculations presented in tables 20 and 21.

When looking at the age composition in this sample, one thing in particular becomes apparent and that is the very low number of children present and that the two youngest age groups are absent (figure 12). The placement of children on the graveyard and a possible explanation for the absence of the youngest children in this sample is discussed below (page 192). With this exception, there is nothing obviously remarkable about the distribution of the different age groups on the graveyard for the St. Mary's church. The age distribution is discussed further below in comparison with the other graveyards.

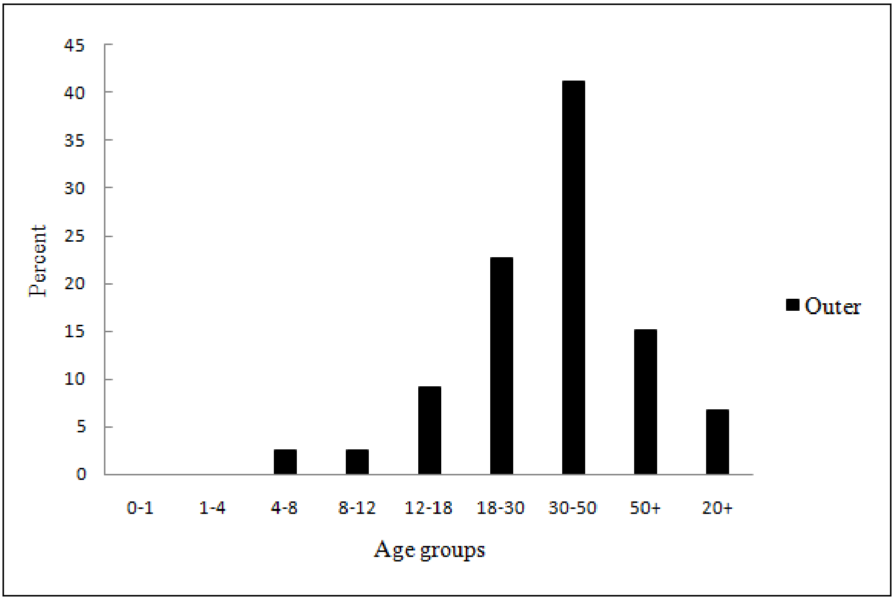


Figure 12. Age distribution for the St. Mary's church graveyard.

Table 20. Age distribution for the St. Mary's church sample

Age distribution of individuals aged 0-18			
Age group	**N**	**% of children**	**% of total**
0-1 years	0	0.0	0.0
1-4 years	0	0.0	0.0
4-8 years	3	17.7	2.7
8-12 years	3	17.7	2.7
12-18 years	11	64.6	9.9
Total	**17**	**100**	
Age distribution of individuals aged 18+			
Age group	**N**	**% of adults**	
18-30 years	27	28.7	24.3
30-50 years	49	52.1	44.2
50+ years	18	19.2	16.2
Total	**94**	**100**	**100**

Eight of the 102 adult individuals could not be assigned to an age group and were only determined to be of adult age at the time of death. These individuals have been excluded from these calculations.

7.2.3.1 Average age at death

As seen in table 21, the average age for the individuals in this sample is estimated to be 35.2 years. Looking at the adult individuals separately, the average age at death is 39.2.

Table 21. Average age at death calculated from the St. Mary's church sample

Age group	**Average age**	**N**	**Average age * N**	**Average age**	**Average age adults**
0-1 years	0.5	0	0		
1-4 years	2	0	0		
4-8 years	6	3	18		
8-12 years	10	3	30		
12-18 years	15	11	165		
18-30 years	24	27	648		
30-50 years	40	49	1960		
50+ years	60	18	1080		
Sum		**111**	**3901**	**3901/111=35.1**	**3688/94=39.2**

7.2.4 Social stratification

The data used to suggest social status will be presented in the following, but as only the outer half of the graveyard has been excavated no conclusion will be drawn as to whether or not this graveyard was socially stratified. This will rather be discussed below in comparison with the other skeletal samples.

7.2.4.1 Stature distribution

The average femur length for females is 415.8mm which corresponds to a living stature of 159.32±4.52cm (all stature calculations are made with Sjøvold's (1990) formula for Caucasians independent of sex) while the average male femur is 42.7mm longer at 458.5mm, and this corresponds to a living stature of 170.55±4.52cm. The femur maximum length data is presented in table 22.

Figure 13 gives a representation of the sexual dimorphism in femur lengths and it is evident that the majority of the female femora are between 400mm-

440mm and the majority of the male femora have a maximum length of between 440mm-490mm. In living stature terms, this means that most women were between 155.16±4.52cm and 165.68±4.52cm tall while most males were between 165.68±4.52cm and 178.83±4.52cm tall.

Table 22. Femur maximum lengths (millimetres) for the St. Mary's church sample

	N	**Mean**	**Min.**	**Max.**	**Std. dev.**
Male	27	458.5	426	508	20.9
Female	15	415.8	390	457	20.1

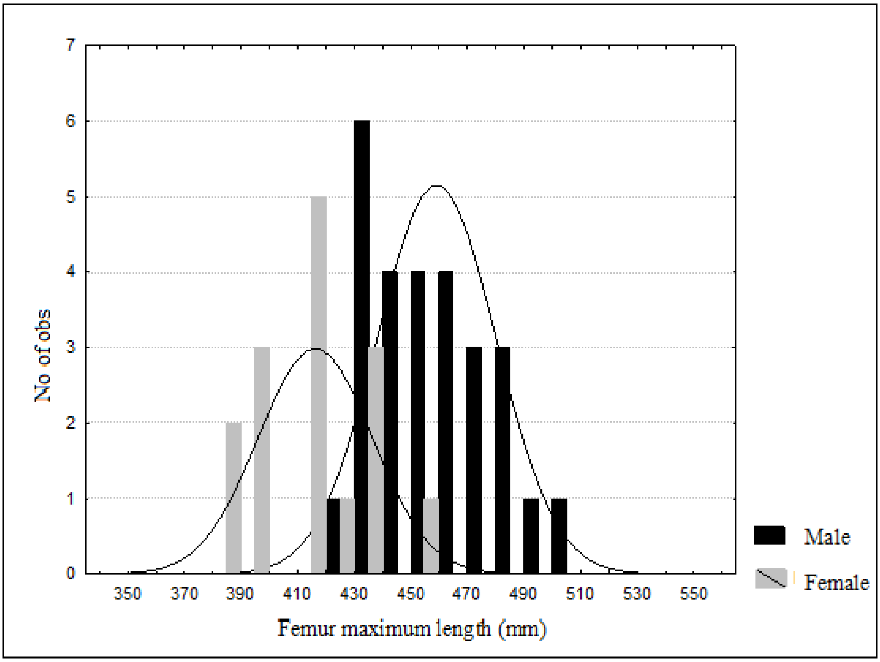


Figure 13. Representation of male and female femur maximum lengths.

7.2.4.2 Degenerative joint disease (DJD)

Thirty two individuals showed signs of degenerative joint disease which equates to 42.7% of the adult population. Considering only the younger part of the population (the individuals below 50 years at the time of death), the prevalence is somewhat lower at 32.3%. The DJD data is presented in table 23.

Table 23. Prevalence of DJD

	N	%
Adults with DJD	32	42.7
Adults below 50 years with DJD	20	32.3

Only individuals with at least 50% of their joints preserved are included in these calculations.
All adults: N75, Adults below 50: N62

Investigating whether there is a difference in prevalence between the sexes, it becomes clear that the prevalence for DJD is slightly lower for females than for males (table 24). Among all the adult male individuals, 50% show signs of DJD while 37.9% of the females show evidence of this condition. Looking at the individuals below 50 years, the prevalence is 40% for males and 26.1% for females.

When testing to see if this difference between the sexes is statistically significant, it is shown that the prevalence of DJD is not significantly different between the sexes with P=0.65 for all individuals and P=0.58 for adults below 50.

Table 24. Prevalence of DJD according to sex and age

	N	**Male (N36)* (N30)**	**Ambiguous (N10) (N9)**	**Female (N29) (N23)**
Adults with DJD	32	18 (50.0%)	3 (30.0%)	11 (37.9%)
Adults below 50 years with DJD	20	12 (40.0%)	2 (22.2%)	6 (26.1%)

Only individuals with at least 50% of their joints preserved are included in these calculations.
*The top (N) is the total number of that sex in the sample and the bottom (N) is the number of that sex below 50 years. Thus, the total number of individuals is 75 and the number of individuals below 50 years is 62.

7.2.4.3 Spinal degeneration (SD)

Thirty-eight individuals showed signs of spinal degeneration and this equates to 55.9% of the adult population. When looking at individuals below 50 years at death, the prevalence is 47.3%. The spinal degeneration data is presented in table 25.

Table 25. Prevalence of SD

	N	%
Adults with spinal degeneration	38	55.9
Adults below 50 years with spinal degeneration	26	47.3

Only adult individuals with at least two vertebral sections preserved are included in these calculations (adults N 68) (below 50 N 55).

The prevalence for spinal degeneration is equal between the sexes (58%) when looking at all adult individuals (table 26). When only including individuals below 50 years, the prevalence is 50% for males and 68% for females. There is no significant difference in prevalence between the sexes at P1.0 for all individuals and P=0.62 for individuals below 50.

Table 26. Prevalence of SD according to sex and age

	N	**Male (N29)* (N22)**	**Ambiguous (N5) (N0)**	**Female (N34) (N22)**
Adults with spinal degeneration	38	17 (58.6%)	1 (20.0%)	20 (58.8%)
Adults below 50 years with spinal degeneration	26	11 (50.0%)	0 (0.0%)	15 (68.2%)

Only adult individuals with at least two vertebral sections preserved are included in these calculations (adults N68) (below 50 N55).
*The top (N) is the total number of that sex in the sample and the bottom (N) is the number of that sex below 50 years. Thus, the total number of individuals is 68 and the number of individuals below 50 years is 44.

7.2.4.4 Cribra orbitalia and porotic hyperostosis

Sixteen individuals showed signs of cribra orbitalia which equals 23.5% of this population. The cribra orbitalia data is presented in table 27.

Only two individuals showed signs of porotic hyperostosis and will not be discussed any further due its low occurrence.

Table 27. Prevalence of cribra orbitalia

	N	%
Individuals with cribra orbitalia	16	23.5

Only individuals with at least one orbital ceiling preserved are included in these calculations (N 68).

7.2.4.5 Dental conditions

Thirteen individuals showed signs of dental abscesses and 21 individuals had suffered tooth loss during their lifetime. This equates to 27.1% and 41.2% of the adult sample, respectively. The data for dental abscesses and ante-mortem tooth loss are presented in tables 28 and 29 respectively.

Only three individuals showed signs of dental caries and will not be discussed any further due its low occurrence.

Table 28. Prevalence of dental abscesses

	N	%
Individuals with dental abscesses	13	27.1

Only adult individuals with at least 2/3 of their jaws preserved are included in these calculations (N 48).

Table 29. Prevalence of ante-mortem tooth loss

	N	%
Individuals with ante-mortem tooth loss	21	41.2

Only adult individuals with at least 2/3 of their jaws preserved are included in these calculations (N 51).

Looking at which teeth had been lost ante-mortem (table 30) it is seen that 20 of the individuals with ante-mortem tooth loss had lost one or more of their molars or premolars, while the front teeth (canines and incisors) were involved in only 8 of the cases. There is no difference between the sexes with regard to tooth loss. Of the 21 individuals having suffered tooth loss during their lifetime, 10 were male and 10 were female and the sex could not be determined for 1 of the individuals. With regard to age, just over half of these people (11) were more than 50 years at the time of death, while the remaining 10 individuals suffered tooth loss earlier in life (3 below the age of 30).

Table 30. Presentation of which teeth had been lost ante-mortem

ID	**Left**								**Right**							
	M^3	M^2	M^1	P^2	P^1	C^1	I^2	I^1	I^1	I^2	C^1	P^1	P^2	M^1	M^2	M^3
	M_3	M_2	M_1	P_2	P_1	C_1	I_2	I_1	I_1	I_2	C_1	P_1	P_2	M_1	M_2	M_3
69618																X
F50+		X	X											X		
69660		X														
F30-50																
69675						X					X					
F30-50																
70300																
M18-30			X					X	X				X	X		
75003	X															
M50+		X	X											X	X	
75004												X			X	X
M30-50	X	X	X											X	X	
75013																
A12-18															X	
75031																
M18-30									X							
75036				X	X					X		X	X			
F50+	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
75040																
M30-50					X							X				
75061																
F30-50			X													

The ID column gives the skeleton no. in addition to information about the sex and the age of the individual.

The grey rows represent the maxillary dentition while the mandibular dentition is represented by the white rows. M=molar, P=premolar, C=canine, I=incisor. The numbers in superscript and subscript represent the tooth number in the maxillary and mandibular dentition respectively.

Table 30 continued

ID	Left								Right							
	M^3	M^2	M^1	P^2	P^1	C^1	I^2	I^1	I^1	I^2	C^1	P^1	P^2	M^1	M^2	M^3
	M_3	M_2	M_1	P_2	P_1	C_1	I_2	I_1	I_1	I_2	C_1	P_1	P_2	M_1	M_2	M_3
75066			X										X	X	X	X
M50+																
75067	X									X						
F50+																X
75229												X		X		
F30-50																
76320																
M50+	X									X						
76326																
F50+	X	X	X									X	X	X	X	X
76334																
M30-50	X	X	X											X	X	X
76339								X	X	X						
F50+			X	X									X	X		
76346	X															
F50+	X	X	X											X		
76347			X													
M50+													X	X	X	
76348						X	X						X			
M50+	X	X	X											X		

The ID column gives the skeleton no. in addition to information about the sex and the age of the individual.

The grey rows represent the maxillary dentition while the mandibular dentition is represented by the white rows. M=molar, P=premolar, C=canine, I=incisor. The numbers in superscript and subscript represent the tooth number in the maxillary and mandibular dentition respectively.

7.2.4.6 Enamel hypoplasia

Five individuals showed enamel hypoplasias on one or more teeth. This constitutes 9.3% of this population.

Table 31. Prevalence of enamel hypoplasia

	N	%
Enamel hypoplasia	5	9.3

Only adult individuals with at least 2/3 of their jaws preserved are included in these calculations (N 54).

As seen in table 31, the hypoplastic enamel was found on the canines for four of the individuals, with the first premolar also involved in one of these individuals. The last individual had this enamel defect on the central incisors. These enamel defects are produced during tooth crown development and thus, hold information about the age these individuals were subjected to stresses severe enough to stunt enamel development. The four individuals with hypoplastic lines on the canines would have had a severe period in their life when they were between 3 and 7 years (table 16). The individual with the two affected central incisors would have had a problematic period sometime between the age of 3 months and 5 years.

Table 32. Presentation of the teeth with hypoplastic enamel

ID	**Left**								**Right**							
	M^3	M^2	M^1	P^2	P^1	C^1	I^2	I^1	I^1	I^2	C^1	P^1	P^2	M^1	M^2	M^3
	M_3	M_2	M_1	P_2	P_1	C_1	I_2	I_1	I_1	I_2	C_1	P_1	P_2	M_1	M_2	M_3
69698								X	X							
A18-30																
70301					X	X					X					
M18-30																
75038						X										
F30-50																
75049											X					
A12-18																
76334						X					X					
M30-50																

The ID column gives the skeleton no. in addition to information about the sex and the age of the individual.

The grey rows represent the maxillary dentition while the mandibular dentition is represented by the white rows. M=molar, P=premolar, C=canine, I=incisor. The numbers in superscript and subscript represent the tooth number in the maxillary and mandibular dentition respectively.

7.2.4.7 Health index

A health index was calculated for 52 of the individuals in this sample. The scores ranged from 0.44 to 1 with an average of 0.84 (table 33). This will be discussed further in comparison with the other samples.

Table 33. Data for the health index

	N	Mean	Min.	Max.	Std. Dev.
Outer	52	0.84	0.44	1	0.12

7.2.5 Family plots

Neither of the non-metric traits included in this study have a distribution on the graveyard which could suggest the presence family areas.

7.3 The Public Library site graveyard, Trondheim

The skeletal sample excavated from the graveyard at the Public Library site in Trondheim, consists of 215 individuals. All the skeletons have been dated and assigned to one of two burial phases; and, although only the northern part of the graveyard has been excavated, the excavation stretched from the church to the outer limit of the burial area. This makes this material well suited for examining the questions dealt with in this study.

7.3.1 Biological affiliation

Twenty-three of the skeletons from the Public Library site graveyard were well enough preserved for the complete set of Cranid measurements to be taken. One of the measured crania (351) was not well catered for by the Cranid database and has for this reason been excluded. The results of the Cranid analyses are presented in table 34. Skeletons 119, 196, 207 and 294 show a cranial morphology which differ from the Norwegian sample to such an extent that they might be considered to be foreign to this group and these are discussed in more detail below.

Skeleton 119: This individual shows the highest probability (0.30) of membership in the Egypt 26-30 Dyn F sample in the Cranid database, with a reasonable probability of a match with the female Italian (0.17) and the female Hungarian (0.12) samples. The NNDA gives a very different result which shows the closet match to the S. Japan Kyushu F (540), and also a significant resemblance with the N. Japan Hokkaido F (494), the Atayal Taiwan F, and the Beduin W Asia MF samples. The actual nearest neighbour is a cranium from the Egypt 26-30 Dyn M sample. On the list of the 56 closest matches to this cranium, there are five crania from the Norwegian samples and the most resembling is number 24 on the list. Among the 10 crania which show the greatest similarity to skeleton 119, five are from Asian samples. With these results, it is possible to suggest that this individual was an immigrant to Trondheim.

Skeleton 196: This individual shows a good probability (0.42) of membership in the San Cruz I Calif F sample in the Cranid database and also a significant probability (0.28) of belonging to the San Cruz I Calif M sample. The NNDA supports the LDA in that the closest resemblance is to the San Cruz I Calif M (620) sample, but also with a strong resemblance to the San Cruz I Calif F (434) and the Arikara Dakota F samples (351). On the list of the 56 closest matches to this cranium, there are only two crania from the Norwegian samples but the most resembling is number seven on the list. Among the 10 crania which show the greatest similarity to skeleton 196, five are from the San Cruz I Calif samples. Based on these results, it seems likely that this individual was an immigrant to Trondheim.

Skeleton 207: This individual shows a high probability (0.90) of membership in the Poundbury UK Rom F sample in the Cranid database. The NNDA gives a somewhat different suggestion as to the origin of this individual. The closest resemblance is to the Zalavar Hungary F (562) sample, but there is also a significant resemblance to the San Cruz I Calif F (310) sample and the Berg Austria F (298) sample. The actual nearest neighbour is a cranium from the Austrian sample. On the list of the 56 closest matches to this cranium, there are four crania from the Norwegian samples and the most resembling is number 12 on the list. Among the 10 crania which show the greatest similarity to skeleton 207, there are representatives from eight different samples. Thus, it is suggested that this individual was an immigrant to Trondheim and that she was of European descent.

Skeleton 294: This individual shows a strong probability (0.89) of membership in the San Cruz I Calif F sample in the Cranid database. The NNDA supports the LDA in that the closest resemblance is to the San Cruz I Calif F (1364) sample, but also with a strong resemblance to the Peru Youyos F (518) and the San Cruz I Calif M (434). On the list of the 56 closest matches to this cranium, there are two crania from the Norwegian samples and the most resembling is number 16 on the list. Among the 10 crania which show the greatest similarity to skeleton 294, six are from the San Cruz I Calif samples. Based on these results it seems likely that this individual was an immigrant to Trondheim.

It is found likely that these individuals were of foreign descent, or at least morphologically different from the Norwegian population, but where may they have come from? Skeleton 207 shows most similarities with European populations and this is probably where this individual's ancestry lies. The other three individuals, however, show traits which suggest an origin much further afield. They all show a strong Asian influence. Cranid put skeletons 196 and 294 right in the middle of the San Cruz I samples and if these individuals had been found in America, their Native American origin would probably not have been doubted. However, these two were buried on a cemetery in 13th century Trondheim which makes such a conclusion not so easy to accept. One explanation for this is that they have been misclassified. The Cranid program compares a cranium to each of the crania in the database, but if a cranium comes from a population which is not represented in the database it will still be assigned to a group, but will not be classified correctly. If this is what has happened with these skeletons, one can start to wonder what population this might be. Two groups which would have a morphology that could set them apart from the Norwegian Cranid sample and are geographically closer are the Inuits and Saamis. An Inuit sample from Greenland is, however, in the Cranid database and there is absolutely no similarity between this sample and the two individuals in question.

Another possibility is, of course, that there actually is a Native American influence on the morphology. A recent publication makes this slightly less unlikely than it previously would have been. Ebeneserdottir et al. (2010) presents evidence suggesting that members of the Native American population travelled back to Iceland on one or more of the voyages between the countries, maybe as early as the 11th century. This is based on the discovery of the mtDNA haplogroup C1 among modern day Icelanders. The C1 haplogroup "can be divided into four subclades: C1a, which is found only in East Asian populations, and C1b, C1c, and C1d, which are restricted to Native American populations" (Ebeneserdottir et al., 2010). The C1 lineages found in Iceland do, however, not compare to any of the subclades and are therefore named C1e. This does not make it possible to determine with certainty where these lineages originated and this will not be possible until new examples of the C1e subclade are found elsewhere. Furthermore, it is not known exactly when this lineage was introduced into the Icelandic population except for that it was sometime between 870 A.D. and 1700 A.D. However, Ebeneserdottir et al. (2010) argues that "the most likely hypothesis is that the Icelandic voyages to the Eastern coastline of the Americas resulted in the migration of at least one Native American woman carrying the C1e lineage to Iceland around the year 1000".

As to the origin of these two individuals from the cemetery in Trondheim, it is not possible to conclude one way or the other. An isotope or DNA analysis, or a facial reconstruction of these individuals is likely to produce more solid evidence, but based on the current evidence this will remain a mystery. What one can say with reasonable certainty is that they were of different ancestry than the majority of the contemporary population in Trondheim and it seems likely that they had shared ancestry. There is also other evidence that these two individuals were connected in other ways. They are both women and they were buried within a metre of each other on the graveyard and they were of very similar stature (femur lengths of 419mm and 416mm which is around the average of 420mm for the females in this sample). This does suggest that these two were connected in some way. It would be too much of a coincidence that two women of very similar morphology, but very different from the general population, were buried right next to each other on the graveyard. Any further speculation into their relationship would not be appropriate at this point as it would have very little basis in reality, but future molecular analyses of these remains could possibly shed some more light on these questions.

Table 34. Results of the Cranid analysis of the crania from the Public Library site church graveyard

Skeleton ID	**LDA**		**NNDA**	
	Group	**Probability**	**Group**	**Weighted score**
78	Denmark M	0.76	Denmark M	633
	Italian M	0.14	Zalavar Hungary M	418
			Italian M	301
	Norse Norway M	0.00	Norse Norway M	230
119	Egypt 26-30 Dyn F	0.30	S. Japan Kyushu F	540
	Italian F	0.17	N. Japan Hokkaido F	494
	Zalavar Hungary M	0.12	Atayal Taiwan F	351
			Beduin W Asia MF	316
	Norse Norway F	0.03	Norse Norway F	173
150	Norse Norway F	0.37	Norse Norway F	690
	Italian F	0.20	Beduin W Asia MF	422
	Beduin W Asia MF	0.12	Norse Norway M	403
			Egypt 26-30 Dyn F	382
			Denmark F	372

Table 34 continued

Skeleton ID	LDA		NNDA	
	Group	Probability	Group	Weighted score
152	Atayal Taiwan F	0.35	Atayal Taiwan F	703
	Egypt 26-30 Dyn F	0.20	Atayal Taiwan M	436
	Norse Norway F	0.15	Berg Austria F	418
			Egypt 26-30 Dyn F	358
			San Cruz I Calif F	310
			Norse Norway F	230
162	Lachish W Asia F	0.56	Atayal Taiwan F	527
	Norse Norway F	0.17	Egypt 26-30 Dyn F	477
	Egypt 26-30 Dyn F	0.15	Norse Norway F	460
			Lachish W Asia F	316
			S. Japan Kyushu F	309
173	Norse_Norway_F	0.47	Zalavar_Hungary_F	492
	Beduin_W_Asia_MF	0.21	Norse_Norway_F	403
			Denmark_F	372
			Berg_Austria_F	358
			Beduin_W_Asia_MF	316
175	Norse Norway F	0.43	Norse Norway F	460
	Norse Norway M	0.16	Guam Latte Period F	351
	Punjab M	0.11	Beduin W Asia MF	316
	Egypt 26-30 Dyn M	0.10		
196	San Cruz I Calif F	0.42	San Cruz I Calif M	620
	San Cruz I Calif M	0.28	San Cruz I Calif F	434
			Arikara Dakota F	351
	Norse Norway F	0.01	Norse Norway M	58
199	Egypt 26-30 Dyn M	0.35	Norse Norway F	518
	Zalavar Hungary M	0.15	Egypt 26-30 Dyn M	327
	Norse Norway M	0.13		
207	Poundbury UK Rom F	0.90	Zalavar Hungary F	562
			San Cruz I Calif F	310
	Norse Norway M	0.00	Norse Norway F	115
225	Norse Norway M	0.71	Moriori Chat Is F	372
			Norse Norway M	173
238	Norse Norway M	0.31	Norse Norway M	575
	Poundbury UK Rom M	0.21	Denmark F	372
	Egypt 26-30 Dyn M	0.12	Egypt 26-30 Dyn M	327
			Beduin W Asia MF	316

Table 34 continued

Skeleton ID	LDA		NNDA	
	Group	Probability	Group	Weighted score
249	Norse Norway F	0.45	Norse Norway F	633
	Denmark F	0.20	Denmark F	372
	Lachish W Asia F	0.16	Egypt 26-30 Dyn F	358
			Lachish W Asia F	316
254	Zalavar Hungary F	0.20	Norse Norway F	460
	Beduin W Asia MF	0.17	Denmark F	372
	Norse Norway F	0.15	Zalavar Hungary F	351
257	Poundbury UK Rom M	0.73	Zalavar Hungary F	422
	Zalavar Hungary M	0.11	Poundbury UK Rom M	339
			Poundbury UK Rom F	301
	Norse Norway M	0.02	Norse Norway M	288
259	Norse Norway F	0.67	Norse Norway F	518
	Italian F	0.12	Zalavar Hungary F	492
			Beduin W Asia MF	422
280	Berg Austria F	0.29	San Cruz I Calif F	496
	Norse Norway F	0.16	Norse Norway F	403
	Italian F	0.13	Peru Youyos F	345
	San Cruz I Calif F	0.11	San Cruz I Calif M	310
294	San Cruz I Calif F	0.89	San Cruz I Calif F	1364
			Peru Youyos F	518
			San Cruz I Calif M	434
	Norse Norway F	0.00	Norse Norway F	115
303	Denmark M	0.66	Denmark M	759
	Lond. Medvl. M	0.24	Lond. Medvl. F	452
			Denmark F	372
			Poundbury UK Rom F	301
	Norse Norway M	0.01	Norse Norway M	230
340	Egypt 26-30 Dyn F	0.32	Norse Norway F	403
	Zalavar Hungary F	0.19	Egypt 26-30 Dyn F	358
	Norse Norway F	0.12	Zalavar Hungary F	351
352	Peru Youyos M	0.59	Peru Youyos F	633
	Peru Youyos F	0.17	Peru Youyos M	575
			San Cruz I Calif M	372
			San Cruz I Calif F	310
	Norse Norway M	0.07	Norse Norway M	288
386	Norse Norway F	0.47	Norse Norway M	403
	Peru Youyos F	0.19	Zalavar Hungary F	351
	Peru Youyos M	0.12		

7.3.2 Sex distribution

The sex distribution will be discussed separately for phase A and B.

7.3.2.1 Phase A

Sex was determined for 12 of the individuals from phase A. Of these, one was determined to be male, one to probably be male, six to be female and four to probably be female. Sex could no not be determined for the remaining ten individuals from phase A, two of which were children. The distribution of the sexes is shown in table 35.

7.3.2.2 Phase B

For the skeletons from phase B, 45 were determined to be male, 11 to probably be male, 42 to be female and 17 to probably be female. Sex could not be determined for the remaining 76 skeletons from phase B, of which 57 were children. The sex distribution is presented in table 35.

Table 35. Sex distribution for the Public Library site

	N	Male	Male?	Ambiguous	Female?	Female
Phase A	22 *20*	1 (5%) *1 (5%)*	1 (5%) *1 (5%)*	10 (2 children) (45%) *8 (40%)*	4 (18%) *4 (20%)*	6 (27%) *6 (30%)*
Phase B	191 *134*	45 (23%) *45 (34%)*	11 (6%) *11 (8%)*	76 (57 children) (40%) *19 (14%)*	17 (9%) *17 (13%)*	42 (22%) *42 (31%)*
Phase B inner	105 68	25 (24%) 25 (37%)	7 (7%) 7 (10%)	54 (37 children) (51%) 17 (25%)	5 (5%) 5 (7%)	14 (13%) 14 (21%)
Phase B outer	86 66	20 (23%) 20 (30%)	4 (5%) 4 (6%)	22 (20 children) (25%) 2 (3%)	12 (14%) 12 (18%)	28 (33%) 28 (43%)

The figures in italics were calculated without the sub-adult individuals.

7.3.2.3 Discussion of the sex distribution

Looking at the sex distribution from phase-A, there is a clear discrepancy between the number of males to females and it is tempting to suggest that this is the result of a practice separating men and women on the graveyard. This can, of course, be the case, but there are reasons for being sceptical about such a suggestion based on the present evidence. The number of skeletons from this phase is quite small (20 adults and 2 children) and the sex has only been determined for about half of these. This number is so small that the sex of the unsexed individuals could greatly affect the ratio of women to men. The present data gives a ratio of 5:1 (including both female categories and both male categories); however, if the eight unsexed adults are equally distributed between the sexes, the ratio drops to 2.33:1. If there are more males than females among the unsexed individuals, the ratio drops to well below 2:1. However, there is no reason why the sex distribution among the unsexed skeletons should be markedly different from the rest of the individuals. Testing the hypothesis that the sexes should be equally represented shows that the difference between the sexes is not statistically significant (P=0.19). It is also not known where the male population was buried if the north side was mainly reserved for females. Thus, the evidence for sexual division of the graveyard during the earliest phase at the Public Library site cemetery is possible, but as long as it is not known where the male population was buried, this evidence remains inconclusive.

The evidence for phase B is, at first glance, much easier to interpret: the graveyard does not seem to have been sexually divided during this phase. As seen in table 35, the ratio of women to men is nearly 1:1 for phase B. However, when taking the analysis of the phase B data one step further and separate the outer (northern) and inner (southern) halves of the graveyard, a very different picture emerges. From table 35 it is seen that there are more women than men buried on the northern half of the graveyard and more men than women on the southern half. Testing the two distributions from the two graveyard halves to see if they are statistically significant gives a positive result at P=0.01.

The evidence from this graveyard points towards a possible sexual segregation in phase A and a likely segregation in phase B. In phase B, the north south division seems to have been followed, but not in relation to the church but rather on the graveyard. Since the area south of the church is not likely to have been used for burials (Christophersen and Nordeide, 1994:102-103), a north-south division with the church in the middle could not be enforced. Instead, the graveyard on the northern side of the church appears to have been divided into a northern and a southern section. The segregation of the sexes is, however, by no means complete as there are both men and women buried on both halves of the graveyard, but there is a significant difference in the composition of the sexes between the northern and the southern section. Thus, it is reasonable to assume that the preferred area for female burials was to the north and the preferred area for men was to the south.

7.3.3 Age distribution

The age distribution for the phase A and B will be discussed separately.

7.3.3.1 Phase A

Only seven of the adults in phase A could be aged accurately enough to be assigned to an age group, the remaining 13 individuals were only estimated to be of adult age at the time of death. The age distribution is presented in table 36.

Table 36. Age distribution for the Public Library site sample, phase A

Age group	**N**
0-1 years	0
1-4 years	1
4-8 years	1
18-30 years	4
30-50 years	2
50+ years	1
20+ years	13
Total	**22**

7.3.3.2 Phase B

There are 191 individuals for which the age at death has been estimated. Among these were 64 (33.5%) below the age of 18 years and 127 (66.5%) above this age. Thirty of the adult individuals could not be assigned to an age group and were only determined to be of adult age at the time of death and were, therefore, excluded from the calculations presented in tables 37 and 39.

Table 37. Age distribution for the Public Library site sample, phase B

Age distribution of individuals aged 0-18			
Age group	**N**	**% of children**	**% of total**
0-1 years	11	17.1	6.8
1-4 years	14	21.9	8.7
4-8 years	9	14.1	5.6
8-12 years	14	21.9	8.7
12-18 years	16	25.0	9.9
Total	**64**	**100**	
Age distribution of individuals aged 18+			
Age group	**N**	**% of adults**	
18-30 years	39	40.2	24.2
30-50 years	47	48.5	29.3
50+ years	11	11.3	6.8
Total	**97***	**100**	**100**

Thirty of the 127 adult individuals could not be assigned to an age group and were only determined to be of adult age at the time of death. These individuals have been excluded from these calculations.

When analysing the distribution of the different age groups according to where they were buried on the graveyard (table 38 and figure 14), a few things become apparent. Firstly, it seems likely that the age of the youngest children affected their placement on the graveyard. All but one of the children in the 0-1 year age group were buried on the inner half of the graveyard, within approximately 6.5 metres from the church and half of these were buried within a metre and a half from the church. The children in the other age groups are found all over the graveyard and their burial does not seem to follow any obvious pattern related to their age. The distribution of the adult individuals shows that the two youngest age groups (18-30 and 30-50) are fairly evenly distributed across the graveyard, while the majority (82%) of the individuals over 50 is found on the outer half of the graveyard. As the discrepancies seem to regard only the youngest and oldest age groups, it is natural to wonder if taphonomy and preservation can have played a part in creating this distribution. As discussed above (chapter 5), the youngest and oldest age groups are most prone to be misrepresented due to taphonomic processes. Generally, the Public Library site sample is well preserved, but there are reasons to suggest that the preservation was somewhat better on the outer half of the graveyard. Firstly, if one looks at the individuals that could not be assigned to an age group (this is generally due to the skeleton being poorly preserved), these are clearly overrepresented on the inner half of the graveyard compared to the outer (table 38 and figure 14). The same is the case when looking at the crania well enough preserved for the Cranid measurements to be taken. All but two of these were found on the outer half of the graveyard. This could support that taphonomic processes played a part in the overrepresentation of 50+ individuals on the outer half of the graveyard. However, as the vast majority of the youngest children are found on the inner half, it is not likely that the older individuals were so badly preserved that they vanished. It is still possible that preservation could have had an impact on the age distribution of the oldest individuals. The poorer preservation condition on the inner half of the graveyard would have left the 50+ individuals more poorly preserved and this would have affected the age estimation of these individuals. Thus, it is suggested that the oldest individuals were not necessarily mainly buried on the outer half of the graveyard, but are rather hiding in the unestimated 20+ category due to their preservational quality having hindered proper age estimation. A further discussion of these age patterns can be found below when discussed in comparison with the other graveyards.

Table 38. Age distribution according to burial area for the Public Library site (phase B)

Age group	Outer (N 86)	Inner (N 105)
0-1 years	1 (1.2%)	10 (9.5%)
1-4 years	5 (5.8%)	9 (8.6%)
4-8 years	4 (4.7%)	5 (4.8%)
8-12 years	5 (5.8%)	9 (8.6%)
12-18 years	10 (11.6%)	6 (5.7%)
18-30 years	20 (23.3%)	19 (18.1%)
30-50 years	26 (30.1%)	21 (20.0%
50+ years	9 (10.5%)	2 (1.9%)
20+ years	6 (7.0%)	24 (22.8%)

The percentage values represent the proportion of the particular age group on that specific area of the graveyard.

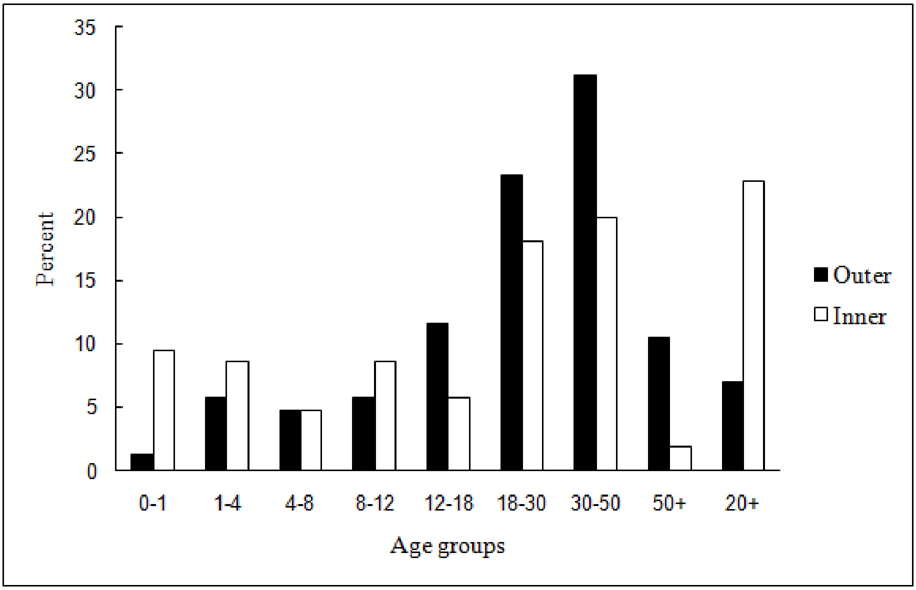


Figure 14. Representation of the distribution of the different age groups on the graveyard (phase B).
The bars represent the percentage proportion of the different age groups on the specific areas of the graveyard.

7.3.3.3 Average age at death

The average age at death for this population has been calculated to be 24.5 years. Looking at the adult individuals separately, gives an average age at death of

35.8 years (table 39). Average age at death is discussed further below in comparison with the other graveyards.

Table 39. Average age at death calculated from the Public Library site sample, phase B

Age group	Average age	N	Average age * N	Average age	Average age adults
0-1 years	0.5	11	5.5		
1-4 years	2	14	28		
4-8 years	6	9	54		
8-12 years	10	14	140		
12-18 years	15	16	240		
18-30 years	24	39	936		
30-50 years	40	47	1880		
50+ years	60	11	660		
Sum		**161**	**3943.5**	**3943.5/161=24.5**	**3476/97=35.8**

7.3.4 Social stratification

To determine the presence or absence of social stratification on the Public Library site graveyard, the cemetery has been divided into an inner (nearest the church) and an outer (furthest from the church) section. This dividing line has been arbitrarily drawn half way between the church wall and the graveyard fence as present in phase B. Thus, the line was drawn approximately 10 metres from the church. This arbitrary division of the graveyard represents the hypothetical social division as described in the Eidsivating and Borgarting legislation, and the different skeletal conditions will, in the following, be discussed with regard to the inner and outer half of the graveyard. Social stratification will not be discussed for phase A as there are quite few, and mostly poorly preserved, individuals in this phase and thus, no reliable results could come from such an analysis.

7.3.4.1 Stature distribution

Forty seven individuals had at least one femur well enough preserved for the maximum length of the bone to be measured. Additionally, the maximum length of 17 femora was measured in the field as it was clear that these bones would be too damaged when removed from the grave. The in situ measurements are published in Anderson and Göthberg (1986:19-31). To check the accuracy of the in situ measurements, they were compared to the measurements of the preserved femora. The average length of the complete femora, measured by the author, is 437.4mm while the average length of the femora measured in situ is 441.3. This difference of 3.9mm (0.89%) is so small that the in situ measurements were considered to give an accurate representation of the femur lengths. The in situ measurements were therefore included and the following calculations were based on the femur maximum length measurements from 27 males and 37 females.

The average femur length for females is 419.6mm which corresponds to a living stature of 160.32±4.52cm (all stature calculations are made with Sjøvold's (1990) formula for Caucasians independent of sex) while the average male femur is 44.6mm longer at 464.2mm, and this corresponds to a living stature of 172.05±4.52cm. The femur maximum length data is presented in table 40. Figure 15 gives a representation of the sexual dimorphism in femur lengths and it is evident that the majority of the female femur lengths are between 410mm-440mm and the majority of the male femurs have a maximum length of between 450mm-470mm. In living stature terms, this means that most women were between 157.79±4.52cm and 165.68±4.52cm tall while most males were between 168.31±4.52cm and 173.57±4.52cm tall.

Table 40. Femur maximum length (millimetres) data for the Public Library site sample

	N	**Mean**	**Min.**	**Max.**	**Std. dev.**
Male	27	464.2	416	513	23.5
Female	37	419.6	386	458	15.4

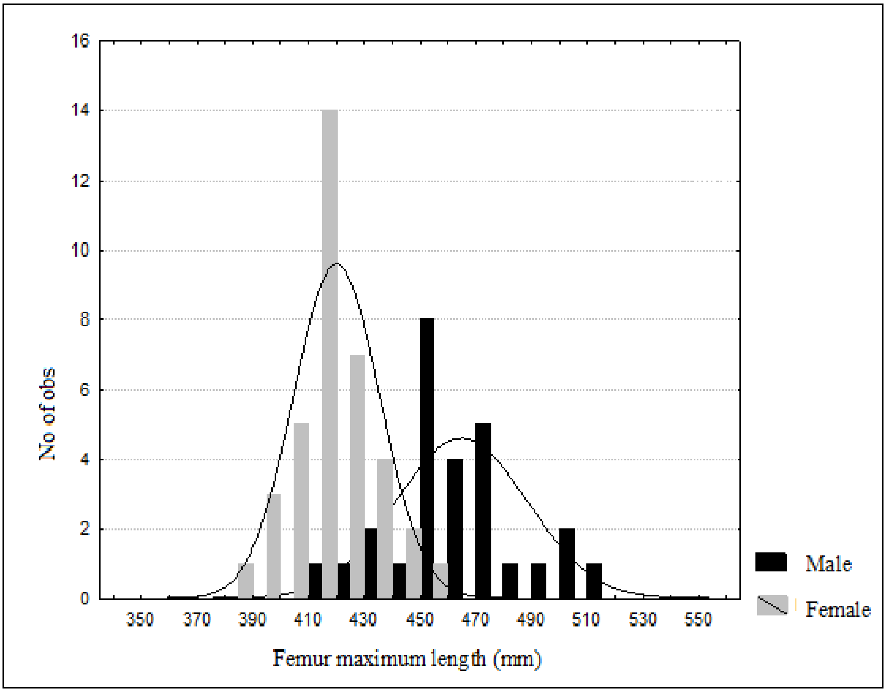


Figure 15. Representation of male and female femur maximum lengths.

Analysing the distribution of the femur lengths across the graveyard, it becomes clear that the average lengths, for both males and females, are longer on the outer half of the graveyard than on the inner. The average femur lengths for the two halves of the graveyard are presented in table 41.

Table 41. Average femur lengths (millimetres) according to sex and burial area

	Male		**Female**	
	Inner (N 12)	**Outer (N 15)**	**Inner (N 6)**	**Outer (N 31)**
Average femur maximum length (mm)	459.5	468.0	410.3	421.4

7.3.4.2 Degenerative joint disease (DJD)

All together 18 individuals showed evidence of DJD, which equates to 23.4% of the population. Thus, it seems reasonable to suggest that at least one in five suffered from DJD during their life. Among the individuals below 50 years at the age of death, the prevalence is 15.6%.

When looking at the distribution of DJD, it becomes clear that this condition is not evenly distributed across the graveyard (table 42). Of the 18 cases, only 5 were found on the inner half of the graveyard while 13 were exhumed from the outer. Thus, 19.2% of individuals buried on the inner half suffered from DJD while 25.5% of the individuals on the outer half suffered from the same condition. If one only considers the younger part of the population (adults below 50 years), the prevalence is also higher on the outer half of the graveyard. Ten of the adults below 50 years showed signs of DJD and only one of these came from the inner part of the graveyard while the remaining 9 came from the outer. Thus, only 4.8% of younger individuals on the inner half of the graveyard suffered from DJD while as much as 20.5% of the individuals buried on the outer half showed signs of DJD.

Table 42. Prevalence of DJD (phase B)

	N	**Inner**	**N**	**Outer**
Adults with DJD	5	19.2%	13	25.5%
Adults below 50 years with DJD	1	4.8%	9	20.5%

Only individuals with at least half of their joints preserved are included in these calculations.
N77 for all adults (inner 26 and outer 51).
N64 for adults below 50 (inner 21 and outer 44).

The difference in prevalence between the inner and outer halves of the graveyard is far from statistically significant when including all individuals (P=0.78). However, when only including the individuals below 50, the difference between the graveyard halves does not reach significance, but at P=0.26 there is a marked difference and it is greatly increased from when all individuals were included.

With regard to sexual differences, the occurrence is markedly higher for men than for women when considering all age groups, 32.4% and 16.3% respectively (table 43). When only looking at the individuals below 50, the prevalence is nearly equal at 20.0% and 16.3%. This difference between the sexes is not statistically significant (P=0.29 for all individuals and P=1.0 for individuals below 50).

The DJD data will be further discussed below in comparison with the other graveyards.

Table 43. Prevalence of DJD according to sex and age (phase B)

	N	**Male (N34)* (N25)**	**Ambiguous (N0) (N0)**	**Female (N43) (N40)**
Adults with DJD	18	11 (32.4%)	0 (0.0%)	7 (16.3%)
Adults below 50 years with DJD	12	5 (20.0%)	0 (0.0%)	7 (17.5%)

Only adult individuals with at least half of their joints preserved are included in these calculations.
*The top (N) is the total number of that sex in the sample and the bottom (N) is the number of that sex below 50 years. Thus, the total number of individuals is 77 and the number of individuals below 50 years is 65.

7.3.4.3 Spinal degeneration (SD)

As with DJD, the prevalence for spinal degeneration is higher on the outer half of the graveyard compared to the inner (table 44). For all adults, 34.8% of the individuals on the inner half showed signs of spinal degeneration while 40.8% of the individuals buried on the outer half showed similar signs. When only including the individuals below 50 the figures are 25% for the inner half and 31% for the outer. The difference in prevalence between the two halves of the graveyard is far from statistically significant at P=0.81 for all individuals and P=0.78 for individuals below 50.

Table 44. Prevalence of SD (phase B)

	N	Inner	N	Outer
Adults with spinal degeneration	8	34.8%	20	40.8%
Adults below 50 years with spinal degeneration	5	25.0%	13	31.0%

Only adult individuals with at least two vertebral sections preserved are included in these calculations.
N72 for all adults (inner 23 and outer 49).
N62 for adults below 50 (inner 20 and outer 42).

Looking at the sexes separately, one can see that the occurrence is somewhat higher for males when including all age groups (table 45). The prevalence is nearly equal when only considering the individuals below 50. The difference between the sexes is not significant at P=0.50 for all individuals and P=1.0 for individuals below 50.

Table 45. Prevalence of SD according to sex and age (phase B)

	N	**Male (N29)* (N22)**	**Ambiguous (N2) (N2)**	**Female (N43) (N41)**
Adults with spinal degeneration	28	13 (44.8%)	1 (50%)	14 (32.6%)
Adults below 50 years with spinal degeneration	20	7 (31.8%)	1 (50%)	12 (29.3%)

Only adult individuals with at least two vertebral sections preserved are included in these calculations.
*The top (N) is the total number of that sex in the sample and the bottom (N) is the number of that sex below 50 years. Thus, the total number of individuals is 77 and the number of individuals below 50 years is 65.

7.3.4.4 Cribra orbitalia and porotic hyperostosis

Of the 107 individuals with at least one orbit preserved for observation, 30 showed signs of cribra orbitalia. Eight of these were found on the inner half of the graveyard and 22 on the outer. This means that 21.6% of the individuals buried on the inner half of the graveyard had this condition while 31.4% of the individuals on the outer half showed similar signs (table 46). Only four individuals showed signs of porotic hyperostosis and these were all found on the outer half of the graveyard. At P=0.51, the difference in prevalence for cribra orbitalia between the inner and outer halves of the graveyard is not significant.

Table 46. Prevalence for cribra orbitalia (phase B)

	N	Inner	N	Outer
Individuals with cribra orbitalia	8	21.6%	22	31.4%

Only individuals with at least one orbital ceiling preserved are included in these calculations.
N107 (Inner N37, Outer N70).

7.3.4.5 Dental conditions

The rate of occurrence for dental abscesses and ante-mortem tooth loss was calculated from the skeletons with at least 2/3 of the jaws present for observation. As seen in table 47, 18.8% of the individuals on the inner half suffered from dental abscesses while 26% of the individuals on the outer half suffered from the same condition. The difference between the halves is not significant (P=0.61). The difference between the inner and outer half is more marked when it comes to individuals having experienced ante-mortem tooth loss (table 48). Of the individuals buried on the inner half, 17.7% had suffered ante-mortem tooth loss while the prevalence on the outer half is 38%. This difference between the inner and outer halves of the graveyard is marked at P=0.16. As only one individual had dental caries, this will not be considered with regard to social differences.

Table 47. Prevalence for dental abscesses

	N	Inner	N	Outer
Individuals with dental abscesses	6	18.8%	13	26%

Only adult individuals with at least 2/3s of the jaws present are included in these calculations.
N82 (inner N32, outer N50).

Table 48. Prevalence for ante-mortem tooth loss

	N	Inner	N	Outer	N	All
Individuals with ante-mortem tooth loss	6	17.7%	19	38%	25	30%

Only adult individuals with at least 2/3s of the jaws present are included in these calculations.
N84 (inner N34, outer N50).

Looking at which teeth had been lost ante-mortem (table 49) it is seen that 24 of the individuals with ante-mortem tooth loss had lost one or more of their molars or premolars, while the front teeth (canines and incisors) were involved in only 9 of the cases. There is a clear difference between the sexes with regard to tooth loss. Of the 25 individuals having suffered tooth loss during their lifetime, 9 were male and 15 were female and the sex could not be determined for 1 of the individuals. With regard to age, only 6 of these people were more than 50 years at the time of death, while the remaining 19 individuals suffered tooth loss earlier in life (4 below the age of 30).

Table 49. Presentation of which teeth had been lost ante-mortem

ID	Left								Right							
	M^3	M^2	M^1	P^2	P^1	C^1	I^2	I^1	I^1	I^2	C^1	P^1	P^2	M^1	M^2	M^3
	M_3	M_2	M_1	P_2	P_1	C_1	I_2	I_1	I_1	I_2	C_1	P_1	P_2	M_1	M_2	M_3
115																
F50+	X	X	X											X		X
119																X
F30-50	X	X									X	X			X	
150																
F30-50													X			
152																
F18-30				X												
169																
F12-18				X									X			
177																
F30-50			X	X										X	X	X

The ID column gives the skeleton no. in addition to information about the sex and the age of the individual.
The grey rows represent the maxillary dentition while the mandibular dentition is represented by the white rows. M=molar, P=premolar, C=canine, I=incisor. The numbers in superscript and subscript represent the tooth number in the maxillary and mandibular dentition respectively.

Table 49 continued

ID	Left								Right							
	M^3	M^2	M^1	P^2	P^1	C^1	I^2	I^1	I^1	I^2	C^1	P^1	P^2	M^1	M^2	M^3
	M_3	M_2	M_1	P_2	P_1	C_1	I_2	I_1	I_1	I_2	C_1	P_1	P_2	M_1	M_2	M_3
195																
F30-50			X													
207		X	X	X	X							X	X	X	X	
F30-50						X	X	X								
218														X		
M30-50			X													
223			X													
F30-50																
239					X	X	X	X	X	X	X	X	X	X	X	X
M30-50	X	X	X											X		
266														X		
F30-50		X														
268																
F30-50			X												X	
273																
A30-50			X											X	X	
292																
M18-30				X												
294																
F30-50			X									X				
308							X									
M18-30																
321		X	X					X					X	X	X	
M50+	X	X	X									X		X		X
326																
F20+														X	X	X
328																
M30-50			X											X		
329	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
M50+			X											X		

The ID column gives the skeleton no. in addition to information about the sex and the age of the individual.

The grey rows represent the maxillary dentition while the mandibular dentition is represented by the white rows. M=molar, P=premolar, C=canine, I=incisor. The numbers in superscript and subscript represent the tooth number in the maxillary and mandibular dentition respectively.

Table 49 continued

ID	Left								Right							
	M^3	M^2	M^1	P^2	P^1	C^1	I^2	I^1	I^1	I^2	C^1	P^1	P^2	M^1	M^2	M^3
	M_3	M_2	M_1	P_2	P_1	C_1	I_2	I_1	I_1	I_2	C_1	P_1	P_2	M_1	M_2	M_3
332																
F30-50	X	X	X									X		X	X	X
334				X				X	X		X	X	X	X	X	X
M50+	X															X
385							X	X								
M50+	X	X	X	X	X	X					X	X	X	X	X	X
386								X								
F50+					X							X		X		X

The ID column gives the skeleton no. in addition to information about the sex and the age of the individual.
The grey rows represent the maxillary dentition while the mandibular dentition is represented by the white rows. M=molar, P=premolar, C=canine, I=incisor. The numbers in superscript and subscript represent the tooth number in the maxillary and mandibular dentition respectively.

7.3.4.6 Enamel hypoplasia

Only three individuals showed signs of hypoplastic enamel (two on the outer half and one on the inner) and have been excluded from the social stratification discussion due to its low prevalence (table 50).

Table 50. Prevalence for enamel hypoplasia

	N	%
Enamel hypoplasia	3	2.7

This trait could be examined on 112 individuals.

As seen in table 51, the hypoplastic enamel was found on the canines for two of the individuals while the last individual had this enamel defect on the mandibular first premolars. This means that these individuals suffered the period of severe physiological stress sometime between the age of 3 and 7 years (table 16).

Table 51. Presentation of which teeth had hypoplastic enamel

ID	Left								Right							
	M^3	M^2	M^1	P^2	P^1	C^1	I^2	I^1	I^1	I^2	C^1	P^1	P^2	M^1	M^2	M^3
	M_3	M_2	M_1	P_2	P_1	C_1	I_2	I_1	I_1	I_2	C_1	P_1	P_2	M_1	M_2	M_3
238						X					X					
M18-30						X					X					
258						X					X					
M12-18																
343																
A12-18					X							X				

The ID column gives the skeleton no. in addition to information about the sex and the age of the individual.
The grey rows represent the maxillary dentition while the mandibular dentition is represented by the white rows. M=molar, P=premolar, C=canine, I=incisor. The numbers in superscript and subscript represent the tooth number in the maxillary and mandibular dentition respectively.

7.3.4.7 Health index

A health index was calculated for 75 of the individuals buried at the Public Library site graveyard. The results of these calculations are presented in table 52 and show that the mean index for the individuals buried on the inner half is somewhat higher than for the individuals buried on the outer half, 0.87 and 0.82 respectively. The health index for the population as a whole is 0.84, with a minimum of 0.58 and a maximum of 1.

Table 52. Results for the health index calculations (phase B)

	N	**Mean**	**Min.**	**Max.**	**Std. Dev.**
Inner	24	0.87	0.62	1	0.096
Outer	51	0.82	0.58	1	0.097
Combined	75	0.84	0.58	1	0.098

7.3.4.8 Discussion of social stratification

The different criteria which were meant to be indicators of social status do not all point in the same direction. Looking at the pathological conditions, their occurrence is always greater on the outer half of the graveyard. This is what one would expect if the graveyard was socially stratified as described in the early

Christian laws. However, the femur lengths show that the tallest people are also found on the outer half of the cemetery, which is not what one would expect in a socially stratified graveyard. This discrepancy can be explained by the differences in development of an individual's stature and the pathologies studied here. While the conditions causing the observed pathological changes are nearly exclusively environmentally determined, an individual's living stature is mainly determined by that individual's genetic makeup. It is a well known fact that the environment, especially nutrition, also affects the terminal stature of an individual, but only within the limits determined by the genetic composition of the person. Thus, there is no reason why people of the lower classes should not be just as tall, or taller than the rest of the population as long as they had the right genetic makeup. For a thorough discussion of factors affecting stature, see Larsen (1999:13-19). The pathological conditions looked at in this study have an aetiology which is more directly connected to the class differences with regard to nutrition, health and occupational stress, and are not genetically determined to any great extent. It is thus, reasonable to suggest that these criteria are more reliable when determining the presence of socially stratified graveyards.

All the pathological conditions presented above appear more often on the outer half of the graveyard than on the inner half. With regard to social differences it is especially interesting that the difference in prevalence of DJD between the two groups shows a marked increase when excluding the oldest age group. On the background of this one could suggest that the DJD on the outer half of the graveyard had secondary causes like occupational stress, while the DJD on the inner half was more age related. This could again represent the difference between the social classes with the lower strata of society being subjected to physically harder labour than the upper classes. The same pattern is evident when looking at the distribution of spinal degeneration. The difference is not as marked as for DJD, but the prevalence is higher on the outer half than on the inner which would support social stratification on the graveyard. That the difference between the outer and inner half does not increase as much for spinal degeneration as for DJD when excluding the above 50 age group can be explained by the nature of spinal degeneration and the problem of inaccurate adult age estimation; the onset of spinal degeneration is generally earlier and a cut off point at 40 years would be more appropriate, but this is not supported by the age groups.

The prevalence of cribra orbitalia is also higher on the outer half of the graveyard. This could reflect a poorer nutritional quality among the individuals on the outer half of the graveyard compared to the rest of the population which again could relate to different social classes on the graveyard.

Dental abscesses and ante-mortem tooth loss also accur more often on the outer half of the graveyard. The author is not aware of any information relating to the level of dental hygiene and care in mediaeval Norway, but judging from these data it seems like the upper classes took better care of their teeth than the rest of the population. This inference is, however, only valid if one accepts that the graveyard was socially divided as supported by the evidence above.

As discussed, there is a significant difference in the sex composition between the two halves of the graveyard and this could affect the distribution of the different pathological conditions if there is real difference in prevalence for these conditions between the sexes. If the prevalence for DJD and SD was higher among women than men, one could suspect that the distribution of these conditions was a product of sexual rather than social differences. As it is, the prevalence is actually somewhat higher among the male individuals (see tables 43 and 45) and this makes it unlikely that sexual differences caused the distribution of DJD and SD. If anything, the higher prevalence among males should strengthen the theory that the distribution of the pathological conditions was caused by social differences.

The majority of the individuals above 50 years at death are found on the outer half of the graveyard. Initially this is not what one expects in a socially stratified graveyard as many modern studies show that the rich and well educated live longer and have better health than the poor and less well educated. It is easy to presume that such connection also existed in the past, but several studies (Davin, 1993, Preston and Haines, 1991, Steckel, 1988) have shown that this was not the case. Preston and Haines (1991) found that the correlation between socioeconomic status and survival was weak as late as at the turn of the twentieth century. It is thus likely that the correlation also was weak in the middle ages. The reason for this correlation being weak in the past is probably due to the lack of a reliable theory of disease causation: the upper classes did not know how to spend their wealth to improve health (Steckel et al., 2006:219).

7.3.5 Family plots

Looking at the distribution of the different non-metric traits, there is especially one trait that turned out to be of particular interest. Ten individuals had a septal aperture and as shown in figure 16 the distribution does not appear to be random. The northernmost group contains seven individuals which are buried within an area of less than 3 by 3 metres. A bit closer to the church there is another group of three individuals with a septal aperture, buried in relatively close proximity to each other. From this distribution it is possible that these individuals are genetically connected and one could suggest that these groups of septal apertures represent family areas on the graveyard. If one considers the sex distribution among these, the family plot scenario becomes somewhat less likely. All of these individuals with septal apertures were female and this is difficult to conform with traditional family and marriage structures. In a society where women were married into the man's family one could possibly expect the men in a family plot to be biologically related, but in such a context it makes little sense to have a group of six related women buried together (figure 16). It is difficult to be conclusive as to the significance of the cluster of the septal apertures. Such a distribution of a non-metric trait on the graveyard suggests that the placement of these individuals was not random, but the cultural significance of this shall be left unanswered.

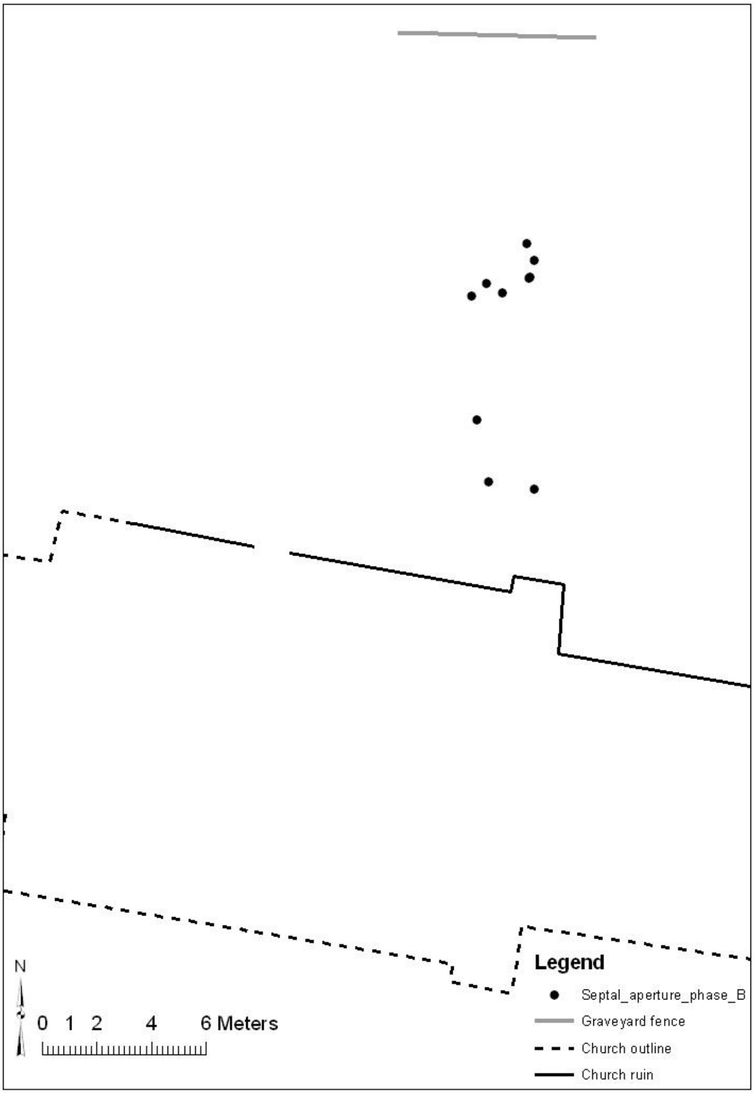


Figure 16. Distribution of septal apertures.

7.4 The Hamar cathedral

The skeletal sample from the graveyard at the Hamar cathedral consists of 277 individuals. Skeletons were excavated from all sides around the cathedral, but only very few were found on the northern side. The lack of burials north of the cathedral is best explained by the topography of the graveyard. “The church was built on a sloping cliff, and on the north side of the building there was hardly any topsoil over the bedrock. The few graves to the north had been placed in pockets and crevices in the rock.” (Sellevold, 2001:197).

7.4.1 Biological affiliation

Thirteen of the skeletons from the Hamar cathedral graveyard were well enough preserved for the complete set of Cranid measurements to be taken. Three of the measured crania (CG20, HG109 and HG121) were not well catered for by the Cranid database and have for this reason been excluded. The results of the Cranid analyses are presented in table 53. Skeletons BG67, EG86 and EG90 show a cranial morphology which differs from the Norwegian sample to such an extent that they might be considered to be foreign to this group and these are discussed in more detail below.

Skeleton BG67: This individual shows a high probability of belonging to the Italian M sample (0.52), but with significant probability of inclusion in two other groups: the Lond. Medvl. M (0.16) and Berg Austria M (0.13) samples. The NNDA analysis gives a very similar result with a score of 402 for the Italian M sample and a score of 339 for the Berg Austria M sample. The actual nearest neighbour is, however, a cranium from the Peru Youyos M sample. On the list of the 56 closest matches to this cranium, there are three crania from the Norwegian samples and the most resembling is number 16 on the list. Among the 10 crania which show the greatest similarity to skeleton BG67, five are from the Italian and

Austrian samples. On the basis of this, it is suggested that this individual might have been of foreign descent and possibly from southern Europe.

Skeleton EG86: This individual shows a fairly equal probability of inclusion in four different groups: N. Japan Hokkaido M (0.14), N. Japan Hokkaido F (0.11), Peru Youyos M (0.11) and Arikara Dakota M (0.10). The NNDA analysis also suggests four samples to which this cranium could belong: Atayal Taiwan M (327), N. Japan Hokkaido F (297), Zalavar Hungary F (281) and S. Japan Kyushu F (231). The actual nearest neighbour is a cranium from the Italian M sample. On the list of the 56 closest matches to this cranium, there are three crania from the Norwegian samples and the most resembling is number 23 on the list. Among the 10 crania which show the greatest similarity to skeleton EG86, there are representatives from eight different samples. This is taken to suggest that this individual was of foreign descent.

Skeleton EG90: This individual shows a high probability of inclusion in the Teita E. Afr M sample (0.65) and a smaller probability of belonging to the Atayal Taiwan M sample (0.13). The NNDA analysis gives a similar result with the Atayal Taiwan M sample being the most likely with a score of 654, but with high scores for three other groups as well: Teita E. Afr M (383), Hainan China M (351) and Philippines M (316). The actual nearest neighbour is from the Atayal Taiwan M sample. On the list of the 56 closest matches to this cranium, there are two crania from the Norwegian samples and the most resembling is number 30 on the list. Among the 10 crania which show the greatest similarity to skeleton EG90, six are from the samples from Taiwan and China. This suggests that this individual was of foreign descent.

Table 53. Results of the Cranid analysis of the crania from the Hamar cathedral graveyard

Skeleton ID	LDA		NNDA	
	Group	Probability	Group	Weighted score
BG 55	Egypt 26-30 Dyn M Norse Norway M	0.56 0.10	Egypt 26-30 Dyn M Norse Norway M	600 345
BG 56	Norse Norway M Italian M Lond. Medvl. M	0.52 0.17 0.14	Norse Norway M Italian M Zalavar Hungary M	633 502 418
BG 67	Italia M Lond. Medvl. M Berg Austria M Norse Norway M	0.52 0.16 0.13 0.04	Italian M Berg Austria M Norse Norway M	402 339 173
CG 20	Norse Norway M Italian M Beduin W Asia AF	0.39 0.30 0.23	Beduin W Asia MF Maori New Zealand M Norse Norway M	527 474 288
CG 52	Denmark M Norse Norway M Poundbury UK Rom M	0.37 0.30 0.22	Zalavar Hungary M Norse Norway M	477 403
CG 67	Egypt 26-30 Dyn M Norse Norway F Norse Norway M Lachish W Asia F Zalavar Hungary M	0.18 0.15 0.13 0.11 0.11	Egypt 26-30 Dyn M Norse Norway M Norse Norway F Denmark F Zalavar Hungary F Beduin W Asia MF	545 403 403 372 351 316
EG 54	Egypt 26-30 Dyn M Peru Youyos M Beduin W Asia MF Norse Norway M	0.35 0.29 0.10 0.07	Peru Youyos M San Cruz I Calif M Norse Norway M	633 434 173
EG 86	N. Japan Hokkaido M N. Japan Hokkaido F Peru Youyos M Arikara Dakota M Norse Norway M	0.14 0.11 0.11 0.10 0.06	Atayal Taiwan M Norse Norway F	327 173
EG 90	Teita E. Afr M Atayal Taiwan M Norse Norway M	0.65 0.13 0.01	Atayal Taiwan M Teita E. Afr M Hainan China M Philippines M Norse Norway M	654 383 351 316 58

Table 53 continued

Skeleton ID	LDA		NNDA	
	Group	Probability	Group	Weighted score
HG 103	Norse Norway M	0.80	Egypt 26-30 Dyn M Norse Norway M	436 345
HG 109	Berg Austria M Norse Norway M Lond. Medvl. M	0.41 0.29 0.24	Peru Youyos M San Cruz I Calif M Norse Norway M	403 372 230
HG 120	Norse Norway M	0.69	Norse Norway M	460
HG 121	Lond. Medvl. M Norse Norway M Berg Austria M	0.41 0.33 0.24	Lond. Medvl. M Berg Austria M Norse Norway M	487 452 173

7.4.2 Sex distribution

Skeletons were excavated on all sides of the Hamar cathedral, but only very few were found on the northern side. All these skeletons were dated to be younger than 1350 and were, for that reason, excluded from the analysis; the sample consists of 3 children, 3 males, 2 females and 2 skeletons for which the sex could not be determined.

Looking at the distribution of the sexes on the west side of the cathedral (table 54), it becomes clear that the sexes are not equally represented. Of the 19 adult individuals in this sample, 11 were put in the male categories while only 2 were classified as female. Six of the skeletons could not be sexed. There is a marked difference between the sexes when tested against the assumption that the sexes should be equally represented (P=0.10). The south side shows a similar pattern with a clear majority of male skeletons (table 56). Of the 43 adult skeletons dated to the period before 1350, 29 were male and 6 female, while 8 skeletons could not be sexed. The difference between the sexes is statistically significant (P=0.01). When including the adult individuals from area C, which could not be assigned to a time period, the pattern is fairly similar. Then, the distribution is 114 individuals in the male categories, 28 in the female categories, while 16 could not be sexed. The difference between the sexes is still statistically significant (P=0.00). The distribution of the sexes on the east side of the cathedral is, however, quite different (table 55). There are 24 adult individuals in the male categories, 19 in the female categories and 6 skeletons could not be sexed. Thus, the sexes have a relatively equal representation on this side of the building (P=0.67).

Analysing the sex distribution on the different sides against each other, one can see that there is a statistically significant difference in sex distribution between the south side and the east side (P=0.02). There is also a clear difference between the west and the east side (P=0.10) but there is no significant difference between the west side and the south side (P=1.00).

This data shows that the distribution of the sexes around the Hamar cathedral is not random and it seems likely that an individual's sex was a deciding factor when determining the place of burial. The earliest version of the Eidsivating law states that men should be buried south of the church and that women should buried to the north, but as the northern part of this graveyard was not suitable for burials, this could not be properly enforced. However, it looks like the preferred place for burying women was to the east of the cathedral. It is also clear that males were buried on all areas of the graveyard, so a real separation of the sexes does not seem to have been practiced.

Another striking feature of the sex composition on this graveyard is the overall low number of females (table 57). Among the skeletons determined to be from before 1350, 49% were male and only 21% were female, while the sex could not be determined for 30% of these individuals. This uneven representation of the sexes suggests that certain criteria were used to determine who was allowed burial on the graveyard. There is no reason to believe that this sex composition is reflective of the composition in mediaeval Hamar and thus, it is more likely that the people buried on this graveyard were not fully representative of the general population.

A last point about the sex distribution on this graveyard which should be discussed is the pattern shown by Risan (1998:57-60) with a difference in the sex composition between the inner and outer half of excavation area C. Risan (1998) found that if excavation area C was divided into an inner and outer section, there was a significant difference in the sex composition between the two sections. The dividing line was drawn at the level of a row of stones found at the eastern part of area C and Risan (1998:57) suggests that these stones are the remnants of the earliest wall for the graveyard. Koch (1992:55, 145), on the other hand, sees these stones as naturally occurring and not as part of an old fence. This difference in sex composition is presented as an example of sexual segregation by Jonsson (2009:35). As there are nearly only men buried on the inside of the stone "wall", Risan (1998) suggests that the graveyard was mainly used for men in the earliest phase with a greater inclusion of women at the later stages. However, it can be argued that this difference between the two halves of area C should not be seen as an example of sexual segregation. The main reason for this is that the whole of area C is located on the inner half of the graveyard and if this was evidence of sexual separation one would expect to find a majority of women on the outer half and this is not the case. It would also imply that there should be mostly women buried further out on the graveyard, the known sex composition on this graveyard with a great majority of male burials cannot support this as a likely scenario. It is also difficult to support the temporal change as suggested by Risan (1998). Looking at the sex composition among the individuals buried before 1350, there are significantly more males buried south of the cathedral. Comparing this to the material from area C which represents the whole temporal extent of the graveyard, there is little difference in the sex composition. In fact, the difference in the representation of the sexes increases slightly, quite the opposite of what one would expect with a greater inclusion of women in the later stages. If there was such a change, it would have taken place a lot earlier than 1350. Further evidence of temporal changes could possibly be gained by a detailed examination of the interskeletal relations, but at this point in time, the evidence is not really there.

Table 54. Sex distribution for the west side of the Hamar cathedral

West side						
Time period	**N**	**Male**	**Male?**	**Ambiguous**	**Female?**	**Female**
Pre 1250	4 *3*	2 (50%) *2 (67%)*	0 *0*	1 (1 child) (25%) *0*	0 *0*	1 (25%) *1 (33%)*
Pre 1350	18 *16*	6 (33%) *6 (37%)*	3 (17%) *3 (19%)*	8 (2 children) (44%) *6 (38%)*	0 *0*	1 (6%) *1 (6%)*
Combined	22 *19*	8 (36%) *8 (42%)*	3 (14%) *3 (16%)*	9 (3 children) (41%) *6 (32%)*	0 *0*	2 (9%) *2 (10%)*

The figures in italics were calculated without the sub-adult individuals.

Table 55. Sex distribution for the east side of the Hamar cathedral

East side						
Time period	**N**	**Male**	**Male?**	**Ambiguous**	**Female?**	**Female**
Pre 1250	1	1	0	0	0	0
Pre 1350	56 *48*	21 (38%) *21 (44%)*	2 (4%) *2 (4%)*	14 (8 children) (24%) *6 (13%)*	2 (4%) *2 (4%)*	17 (30%) *17 (35%)*
Combined	57 *49*	22 (39%) *22 (45%)*	2 (4%) *2 (4%)*	14 (8 children) (24%) *6 (12%)*	2 (4%) *2 (4%)*	17 (30%) *17 (35%)*

The figures in italics were calculated without the sub-adult individuals.

Table 56. Sex distribution for the south side of the Hamar cathedral

South side						
Time period	**N**	**Male**	**Male?**	**Ambiguous**	**Female?**	**Female**
Pre 1250	5 *3*	1 (20%) *1 (33%)*	0 *0*	3 (2 children) (60%) *1 (34%)*	0 *0*	1 (20%) *1 (33%)*
Pre 1350	46 *40*	28 (61%) *28 (70%)*	0 *0*	13 (6 children) (28%) *7 (18%)*	0 *0*	5 (11%) *5 (12%)*
Unknown (area C)	147 *115*	81 (55%) *81 (70%)*	4 (3%) *4 (4%)*	40 (32 children) (27%) *8 (7%)*	2 (1%) *2 (2%)*	20 (14%) *20 (17%)*
Combined	198 *158*	110 (56%) *110 (70%)*	4 (2%) *4 (3%)*	56 (40 children) (28%) *16 (10%)*	2 (1%) *2 (1%)*	26 (13%) *26 (16%)*

The figures in italics were calculated without the sub-adult individuals.

Table 57. Sex distribution for all excavated areas

All excavated areas						
Time period	**N**	**Male**	**Male?**	**Ambiguous**	**Female?**	**Female**
Pre 1250	10 *7*	4 (40%) *4 (57%)*	0 *0*	4 (3 children) (40%) *1 (14%)*	0 *0*	2 (20%) *2 (29%)*
Pre 1350	120 *104*	55 (46%) *55 (53%)*	5 (4%) *5 (5%)*	35 (16 children) (29%) *19 (18%)*	2 (2%) *2 (2%)*	23 (19%) *23 (22%)*
Combined	130 *111*	59 (45%) *59 (53%)*	5 (4%) *5 (4%)*	39 (19 children) (30%) *20 (18%)*	2 (2%) *2 (2%)*	25 (19%) *25 (23%)*

The figures in italics were calculated without the sub-adult individuals.

7.4.3 Age distribution

For the burials dated to before 1350, there are 131 individuals for which the age has been estimated. Among these were 23 (17.6%) below the age of 18 and 108 (82.4%) were above this age. Twenty one of the adult individuals could not be assigned to an age group and were only determined to be of adult age at the time of death and were, therefore, excluded from the calculations presented in tables 58 and 61. For the undated skeletons in area C, 37 were estimated to be below the age of 18 (25.2%) and 110 (74.8%) to be above this age at the time of death. Nine of the adults from area C could not be assigned to an age group and were only determined to be of adult age at the time of death and these skeletons have been excluded from the calculations presented in tables 59 and 62.

The most noteworthy about the age distribution for the Hamar cathedral sample is the very small proportion of children. Among the sub-adult individuals, as much as 39% are in the 12-18 age group and the rest of the sub-adults are evenly distributed between the four other age groups. The youngest children (0-1 years) are only represented by three individuals which constitutes less than 3% of the total population. This is an infant mortality rate which is somewhat lower than one would expect in a mediaeval community. This lack of children may indicate that this graveyard was not for everybody and that children were generally buried elsewhere, probably at the graveyard for the only other church in contemporary Hamar, the Church of the Holy Cross (*Korskirken*). This church was situated in the secular part of mediaeval Hamar (Sæther, 2005:20) and is likely to have catered for the general public. Sellevold (2001:203-221) argues that the Hamar cathedral graveyard was used by the general public as well as catering for the ecclesiastical community and the upper social classes. The fact that children are clearly underrepresented in this material may suggest that the process of deciding who was allowed burial was more selective than this.

When looking at the distribution of the different age groups on the different sides of the cathedral (table 60 and figure 17), it is noted that all of the 0-1 children are buried on the east side of the cathedral (they were found within a couple of metres from the cathedral wall). The other sub-adults are not concentrated in one area.

A further discussion of the age distribution is found below when discussed in comparison with the other graveyards.

Table 58. Age distribution for the Hamar cathedral sample (individuals buried before 1350)

Age distribution of individuals aged 0-18			
Age group	**N**	**% of children**	**% of total**
0-1 years	3	13.0	2.7
1-4 years	3	13.0	2.7
4-8 years	5	21.8	4.6
8-12 years	3	13.0	2.7
12-18 years	9	39.2	8.2
Total	**23**	**100**	
Age distribution of individuals aged 18+			
Age group	**N**	**% of adults**	
18-30 years	26	29.9	23.6
30-50 years	41	47.1	37.3
50+ years	20	23.0	18.2
Total	**87**	**100**	**100**

Twenty-one of the 108 adult individuals could not be assigned to an age group and were only determined to be of adult age at the time of death. These individuals have been excluded from these calculations.

Table 59. Age distribution for the Hamar cathedral sample (undated individuals, area C)

Age distribution of individuals aged 0-18			
Age group	**N**	**% of children**	**% of total***
0-1 years	5	13.5	3.6
1-4 years	3	8.1	2.2
4-8 years	6	16.2	4.4
8-12 years	8	21.6	5.8
12-18 years	15	40.6	10.9
Total	**37**	**100**	
Age distribution of individuals aged 18+			
Age group	**N**	**% of adults**	
18-30 years	32	31.7	23.1
30-50 years	54	53.4	39.1
50+ years	15	14.9	10.9
Total	**101**	**100**	**100**

* Nine of the 110 adult individuals could not be assigned to an age group and were only determined to be of adult age at the time of death. These individuals have been excluded from these calculations.

Table 60. Age distribution according to burial area

Age group	**West (N22)**	**South (N50)**	**East (N57)**
0-1 years	0	0	3 (5.3%)
1-4 years	2 (9.1%)	0	1 (1.8%)
4-8 years	0	3 (6.0%)	1 (1.8%)
8-12 years	0	2 (4.0%)	1 (1.8%)
12-18 years	2 (9.1%)	3 (6.0%)	4 (7.0%
18-30 years	4 (18.2%)	14 (28.0%)	8 (14.0%)
30-50 years	4 (18.2%)	20 (40.0%)	17 (29.7%)
50+ years	3 (13.6%)	5 (10.0%)	12 (21.0%)
20+ years	7 (31.8%)	3 (6.0%)	10 (17.6%)

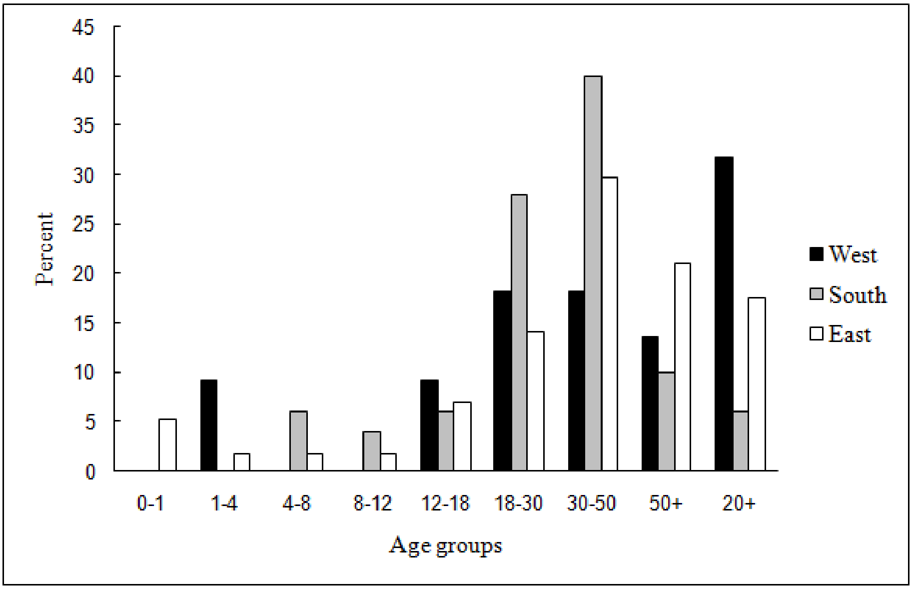


Figure 17. Representation of the different age groups according to burial area.
The bars represent the percentage proportion of the different age groups on the specific area of the graveyard.

7.4.3.1 Average age at death

The average age at death has been estimated to be 33.3 years when calculated from the individuals buried before 1350 (table 61). Looking at adults and sub-adults separately, one gets an average age at death of 39.8 years and 8.8 years respectively. The undated material from area C gives a fairly similar result with an average age at death of 30.3 years, and an average age at death of 9.5 years for sub-adults and 37.9 years for adults (table 62). Average age at death is discussed further below in comparison with the other graveyards (193).

Table 61. Average age at death calculated from the Hamar cathedral sample (individuals buried before 1350)

Age group	**Average age**	**N**	**Average age * N**	**Average age**	**Average age adults**
0-1 years	0.5	3	1.5		
1-4 years	2	3	6		
4-8 years	6	5	30		
8-12 years	10	3	30		
12-18 years	15	9	135		
18-30 years	24	26	624		
30-50 years	40	41	1640		
50+ years	60	20	1200		
Sum		**110**	**3666.5**	**3666.5/110=33.3**	**3464/87=39.8**

Table 62. Average age at death calculated from the Hamar cathedral sample (undated individuals, area C)

Age group	**Average age**	**N**	**Average age * N**	**Average age**	**Average age adults**
0-1 years	0.5	5	2.5		
1-4 years	2	3	6		
4-8 years	6	6	36		
8-12 years	10	8	80		
12-18 years	15	15	225		
18-30 years	24	32	768		
30-50 years	40	54	2160		
50+ years	60	15	900		
Sum		**138**	**4177.5**	**4177.5/138=30.3**	**3828/101=37.9**

7.4.4 Social stratification

The data used to suggest social status will be presented in the following, but as the outer half of the graveyard has not been excavated it is not possible to analyse the data according to distance from the cathedral. It is, therefore, difficult to discuss social stratification at this site, but the data have been analysed according to the different sides of the cathedral to see if any differences existed. All the data from this site have been discussed further below in comparison with the other graveyards.

7.4.4.1 Stature distribution

One hundred and twenty individuals had at least one femur well enough preserved for the maximum length measurement to be taken. For females, the average femur length is 423.6mm which corresponds to a living stature of 161.37±4.52cm. The male femur length is 45.8mm longer at 469.4mm which corresponds to a living stature of 173.41±4.52cm. The femur maximum length data is presented in table 63. The histogram in figure 18 gives a representation of the sexual dimorphism in femur lengths and it is evident that the majority of the female femora are between 410mm-440mm and most male femora have a length between 450mm-480mm. In living stature terms this means that most women were between 157.79±4.52cm and 165.68±4.52cm tall while most males were between 168.31±4.52 and 176.20±4.52cm tall.

Table 63. Femur maximum length (millimetres) data

	N	**Mean**	**Min.**	**Max.**	**Std. dev.**
Male	78	469.4	402	535	23.1
Female	42	423.6	388	468	16.8

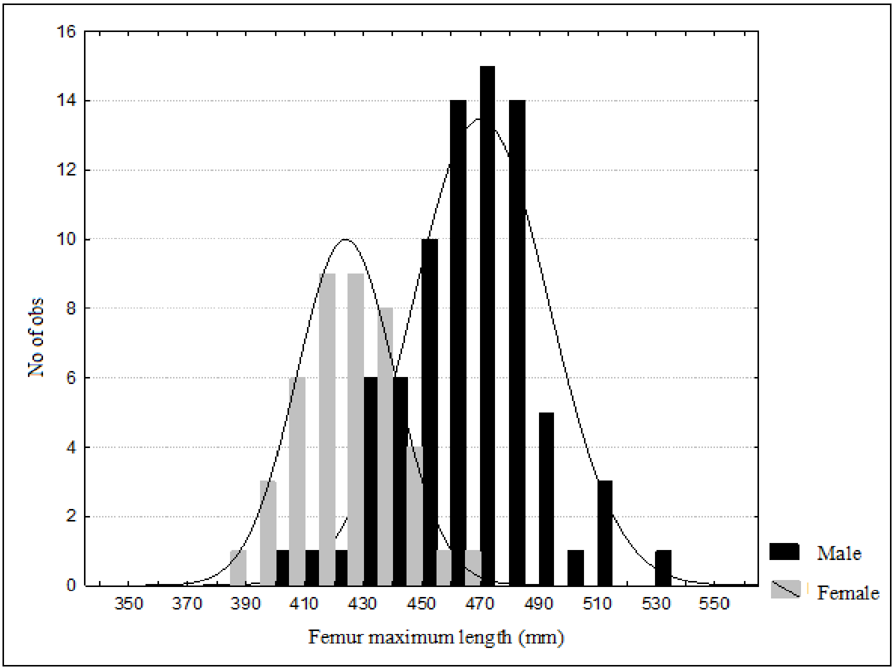


Figure 18. Representation of male and female femur maximum lengths.

7.4.4.2 Degenerative joint disease (DJD)

Of the individuals buried before 1350, 24 showed signs of DJD (table 67). This constitutes 41% of the adult population. Of the individuals below 50 years of age, 33% showed signs of DJD. The DJD data for area C is nearly identical to the dated material (table 68). Looking at the distribution across the graveyard, it is difficult to argue for a real difference in prevalence between the different sides of the church (tables 64, 65, 66). The difference in occurrence for DJD between the south and the east side is far from significant at P=0.80 when including all age groups and P=0.75 for individuals below 50. However, there seems to be a slight difference in prevalence between the sexes; while 33% of the male individuals had degenerative changes in the joints, as much as 55% of the females showed similar changes (P=0.34). When only considering the individuals below 50 years of age, the difference is more pronounced with 25% of males affected and 60% of females (P=0.19). Thus, there is a marked disparity between the sexes, a difference which just about becomes statistically significant for the younger individuals. DJD will be further discussed below in comparison with the other graveyards.

Table 64. Prevalence for DJD according to sex and age (west side of the cathedral)

	All (N4)* (N2)		**Male (N3) (N2)**		**Female (N1) (N0)**	
	N	%	N	%	N	%
Adults with DJD	3	75.0	2	66.7	1	100
Adults below 50 years with DJD	1	50.0	1	50.7	0	0

Only individuals with at least half of their joints preserved were included in these calculations.
*The top (N) is the total number of that sex in the sample and the bottom (N) is the number of that sex below 50 years. Thus, the total number of individuals is 4 and the number of individuals below 50 years is 2.

Table 65. Prevalence for DJD according to sex and age (south side of the cathedral)

	All (N26)* (N22)		**Male (N20) (N18)**		**Female (N6) (N4)**	
	N	%	N	%	N	%
Adults with DJD	11	42.3	7	35.0	4	66.6
Adults below 50 years with DJD	6	27.3	4	22.2	2	50.0

Only individuals with at least half of their joints preserved were included in these calculations.
*The top (N) is the total number of that sex in the sample and the bottom (N) is the number of that sex below 50 years. Thus, the total number of individuals is 26 and the number of individuals below 50 years is 22.

Table 66. Prevalence for DJD according to sex and age (east side of the cathedral)

	All (N28) (N18)		**Male (N13) (N12)**		**Female (N15) (N6)**	
	N	%	N	%	N	%
Adults with DJD	10	35.7	3	23.1	7	46.7
Adults below 50 years with DJD	7	38.9	3	25.0	4	66.7

Only individuals with at least half of their joints preserved were included in these calculations.
*The top (N) is the total number of that sex in the sample and the bottom (N) is the number of that sex below 50 years. Thus, the total number of individuals is 28 and the number of individuals below 50 years is 18.

Table 67. Prevalence for DJD according to sex and age (individuals buried before 1350)

	All (N58) (N42)		**Male (N36) (N32)**		**Female (N22) (N10)**	
	N	%	N	%	N	%
Adults with DJD	24	41.4	12	33.3	12	54.6
Adults below 50 years with DJD	14	33.3	8	25.0	6	60.0

Only individuals with at least half of their joints preserved were included in these calculations.
*The top (N) is the total number of that sex in the sample and the bottom (N) is the number of that sex below 50 years. Thus, the total number of individuals is 58 and the number of individuals below 50 years is 42.

Table 68. Prevalence for DJD according to sex and age (undated individuals, area C)

	All (N56)* (N47)		**Male (N48) (N43)**		**Female (N8) (N4)**	
	N	%	N	%	N	%
Adults with DJD	23	41.1	15	31.3	6	75.0
Adults below 50 years with DJD	16	34.0	14	32.6	2	50.0

Only individuals with at least half of their joints preserved were included in these calculations.
*The top (N) is the total number of that sex in the sample and the bottom (N) is the number of that sex below 50 years. Thus, the total number of individuals is 56 and the number of individuals below 50 years is 47.

7.4.4.3 Spinal degeneration (SD)

Of the individuals buried before 1350, 35 showed signs of spinal degeneration (table 69). This constitutes 59% of the adult population. Of the individuals below 50 years of age, 48% showed degenerative changes in the spine. The data for area C is very similar (table 70). Looking at the distribution across the graveyard, it seems like the prevalence of spinal degeneration is a fair bit higher on the east side compared to the southern part of the graveyard (tables 72 and 73) (the N for the west side was too small to be considered (table 71)). The difference between the southern and eastern side of the cathedral is not statistically significant (P=0.28). There is a clear difference between the sexes (P=0.13) as the prevalence for females is about twice as high as for males (table 69). This will be discussed further below in comparison with the other graveyards.

Table 69. Prevalence for SD according to sex and age (individuals buried before 1350)

	All (N59)* (N46)		**Male (N40) (N37)**		**Female (N19) (N9)**	
	N	%	N	%	N	%
Adults with spinal degeneration	35	59.3	18	45.0	17	89.5
Adults below 50 years with spinal degeneration	22	47.8	15	40.5	7	77.8

Only individuals with at least two vertebral sections preserved were included in these calculations.
*The top (N) is the total number of that sex in the sample and the bottom (N) is the number of that sex below 50 years. Thus, the total number of individuals is 59 and the number of individuals below 50 years is 46.

Table 70. Prevalence for SD according to sex and age (undated individuals, area C)

	All (N62)* (N49)		**Male (N48) (N43)**		**Female (N14) (N6)**	
	N	%	N	%	N	%
Adults with spinal degeneration	41	66.1	29	60.4	12	85.7
Adults below 50 years with spinal degeneration	28	57.1	24	55.8	4	66.7

Only individuals with at least two vertebral sections preserved were included in these calculations.
*The top (N) is the total number of that sex in the sample and the bottom (N) is the number of that sex below 50 years. Thus, the total number of individuals is 62 and the number of individuals below 50 years is 49.

Table 71. Prevalence for SD according to sex and age (west side of the cathedral)

	All (N2)* (N1)		**Male (N2) (N1)**		**Female (N0) (N0)**	
	N	%	N	%	N	%
Adults with spinal degeneration	1	50.0	1	50.0	0	0
Adults below 50 years with spinal degeneration	0	0	0	0	0	0

Only individuals with at least two vertebral sections preserved were included in these calculations.
*The top (N) is the total number of that sex in the sample and the bottom (N) is the number of that sex below 50 years. Thus, the total number of individuals is 2 and the number of individuals below 50 years is 1.

Table 72. Prevalence for SD according to sex and age (south side of the cathedral)

	All (N28)* (N24)		**Male (N23) (N21)**		**Female (N5) (N3)**	
	N	%	N	%	N	%
Adults with spinal degeneration	12	42.9	8	34.8	4	80.0
Adults below 50 years with spinal degeneration	8	33.3	6	28.6	2	6.7

Only individuals with at least two vertebral sections preserved were included in these calculations.
*The top (N) is the total number of that sex in the sample and the bottom (N) is the number of that sex below 50 years. Thus, the total number of individuals is 28 and the number of individuals below 50 years is 24.

Table 73. Prevalence for SD according to sex and age (east side of the cathedral)

	All (N29)* (N21)		**Male (N15) (N15)**		**Female (N14) (N6)**	
	N	%	N	%	N	%
Adults with spinal degeneration	22	75.9	9	60.0	13	92.9
Adults below 50 years with spinal degeneration	14	66.7	9	60.0	5	83.3

Only individuals with at least two vertebral sections preserved were included in these calculations.
*The top (N) is the total number of that sex in the sample and the bottom (N) is the number of that sex below 50 years. Thus, the total number of individuals is 29 and the number of individuals below 50 years is 21.

7.4.4.4 Cribra orbitalia and porotic hyperostosis

Twelve individuals from the dated sample showed signs of cribra orbitalia which constitutes 24% of the population (table 74). For the undated material in area C the occurrence rate is 28% (table 75). There is no real difference in prevalence between the south side and the east side of the cathedral with 24% and 25% showing signs of cribra orbitalia (tables 76, 77 and 78). Cribra orbitalia will be discussed further below in comparison with the other graveyards.

Table 74. Prevalence for cribra orbitalia (individuals buried before 1350)

	N	%
Individuals with cribra orbitalia	12	24.0

Only individuals with at least one orbital ceiling preserved were included in these calculations: N50.

Table 75. Prevalence for cribra orbitalia (undated individuals, area C)

	N	%
Individuals with cribra orbitalia	17	27.9

Only individuals with at least one orbital ceiling preserved were included in these calculations: N61.

Table 76. Prevalence for cribra orbitalia (west side of the cathedral)

	N	%
Individuals with cribra orbitalia	0	0.0

Only individuals with at least one orbital ceiling preserved were included in these calculations: N1.

Table 77. Prevalence for cribra orbitalia (south side of the cathedral)

	N	%
Individuals with cribra orbitalia	5	23.8

Only individuals with at least one orbital ceiling preserved were included in these calculations: N21.

Table 78. Prevalence for cribra orbitalia (east side of the cathedral)

	N	%
Individuals with cribra orbitalia	7	25.0

Only individuals with at least one orbital ceiling preserved were included in these calculations: N28.

7.4.4.5 Dental conditions

For the dated material, 15 individuals showed signs of dental abscesses and 13 had suffered tooth loss during their lifetime. This equates to 26.8% and 22.8%

respectively, of the adult sample (tables 79 and 80). The data for area C is somewhat lower at 14.9% for dental abscesses and 14.7% for ante-mortem tooth loss (tables 81 and 82).

Table 79. Prevalence for dental abscesses (individuals buried before 1350)

	N	**%**
Individuals with dental abscesses	15	26.8

Only individuals with at least 2/3s of their jaws preserved were included in these calculations: N56.

Table 80. Prevalence for ante-mortem tooth loss (individuals buried before 1350)

	N	**%**
Individuals with ante-mortem tooth loss	13	22.8

Only individuals with at least 2/3s of their jaws preserved were included in these calculations: N57.

Table 81. Prevalence for dental abscesses (undated individuals, area C)

	N	**%**
Individuals with dental abscesses	10	14.9

Only individuals with at least 2/3s of their jaws preserved were included in these calculations: N67.

Table 82. Prevalence for ante-mortem tooth loss (undated individuals, area C)

	N	**%**
Individuals with ante-mortem tooth loss	10	14.7

Only individuals with at least 2/3s of their jaws preserved were included in these calculations: N68.

Looking at the difference in prevalence between the different sides of the cathedral, there is no apparent difference with regard to dental abscesses (tables 83 and 85). There is, however, a big difference with regard to ante-mortem tooth loss. While 14.8% of the individuals from the south side of the cathedral had suffered tooth loss during their lifetime, the prevalence for the east side is more than twice as high at 31% (tables 84 and 86), but the difference is not statistically significant at P=0.36. The number of individuals with preserved jaws from the west side was too small (N1) for any comparisons to be made.

Table 83. Prevalence for dental abscesses (south side of the cathedral)

	N	%
Individuals with dental abscesses	7	26.9

Only individuals with at least 2/3s of their jaws preserved were included in these calculations: N26.

Table 84. Prevalence for ante-mortem tooth loss (south side of the cathedral)

	N	%
Individuals with ante-mortem tooth loss	4	14.8

Only individuals with at least 2/3s of their jaws preserved were included in these calculations: N27.

Table 85. Prevalence for dental abscesses (east side of the cathedral)

	N	%
Individuals with dental abscesses	8	27.6

Only individuals with at least 2/3s of their jaws preserved were included in these calculations: N29.

Table 86. Prevalence for ante-mortem tooth loss (east side of the cathedral)

	N	%
Individuals with ante-mortem tooth loss	9	31.0

Only individuals with at least 2/3s of their jaws preserved were included in these calculations: N29.

Looking at which teeth had been lost ante-mortem (table 87) it is seen that 10 of the individuals with ante-mortem tooth loss had lost one or more of their molars or premolars, while the front teeth (canines and incisors) were involved in 7 of the cases. The sexes are evenly represented with 7 males and 6 females having suffered tooth loss during their lifetime. Eight of these people were over 50 years at the time of death, while only three were below this age.

Table 87. Presentation of which teeth were lost ante-mortem (individuals buried before 1350)

ID	Left								Right							
	M^3	M^2	M^1	P^2	P^1	C^1	I^2	I^1	I^1	I^2	C^1	P^1	P^2	M^1	M^2	M^3
	M_3	M_2	M_1	P_2	P_1	C_1	I_2	I_1	I_1	I_2	C_1	P_1	P_2	M_1	M_2	M_3
BG3							X	X								
F50+								X								
BG15							X	X								
F50+						X	X	X	X	X					X	
BG24				X									X		X	X
M30-50																
BG28												X				
F50+	X		X					X	X	X	X		X	X	X	X
BG31			X													
M30-50																
BG42			X				X	X	X	X			X	X		
M50+																X
BG58				X	X	X	X	X	X	X						
F50+														X		
BG60																
M30-50	X															
EG1																
F50+			X													
EG32			X									X				
M30-50	X															
EG52							X				X					
F50+																
EG73			X											X		
M30-50	X	X														
MG1																
M50+					X	X	X	X	X	X	X	X	X	X	X	

The ID column gives the skeleton no. in addition to information about the sex and the age of the individual.
The grey rows represent the maxillary dentition while the mandibular dentition is represented by the white rows. M=molar, P=premolar, C=canine, I=incisor. The numbers in superscript and subscript represent the tooth number in the maxillary and mandibular dentition respectively.

Looking at which teeth had been lost ante-mortem (table 88), among the individuals in area C, it is seen that 9 of the individuals with ante-mortem tooth loss had lost one or more of their molars or premolars, while the front teeth (canines and incisors) were involved in 4 of the cases. The sexes are evenly represented with 6 males and 4 females having suffered tooth loss during their lifetime. Six of these people were over 50 years at the time of death, while 4 were below this age.

Table 88. Presentation of which teeth were lost ante-mortem (undated individuals, area C)

ID	**Left**								**Right**							
	M^3	M^2	M^1	P^2	P^1	C^1	I^2	I^1	I^1	I^2	C^1	P^1	P^2	M^1	M^2	M^3
	M_3	M_2	M_1	P_2	P_1	C_1	I_2	I_1	I_1	I_2	C_1	P_1	P_2	M_1	M_2	M_3
CG4																
M30-50			X													
CG20	X	X													X	X
M50+			X										X	X		
CG105																
M50+			X			X	X		X							X
CG115		X	X			X	X	X								
M50+	X	X	X	X										X	X	X
CG147	X	X	X			X						X	X	X	X	X
F50+		X		X										X		
CG149	X	X			X							X	X	X		
F50+					X										X	X
CG52															X	
M30-50																
CG61	X	X	X										X	X	X	
F50+																
CG62							X	X								
F30-50																
CG64														X		
M30-50														X	X	

The ID column gives the skeleton no. in addition to information about the sex and the age of the individual.
The grey rows represent the maxillary dentition while the mandibular dentition is represented by the white rows. M=molar, P=premolar, C=canine, I=incisor. The numbers in superscript and subscript represent the tooth number in the maxillary and mandibular dentition respectively.

7.4.4.6 Enamel hypolasia

Only six individuals showed hypoplastic enamel on one or more teeth. Two of these were among the dated material and 4 were found in area C (table 89).

Table 89. Prevalence for enamel hypoplasia

	N	%
Enamel hypoplasia	6	10.7

This trait could be examined on 56 individuals

Six individuals had hypoplastic enamel, 2 among the dated material and 4 of the individuals from area C. Three of these had the hypoplastic lines on the incisors, canines and premolars (table 90) and would have had severe problems one or more times between the age of 3 months and 7 years (table 16). Two other individuals had only their incisors involved and would have been subjected to the stresses between the age of 3 months and 5 years. The last individual had hypoplastic enamel on all teeth from the lateral maxillary incisor to the third maxillary molar. This individual must have had at least two episodes of severe metabolic stress between the age of 10 months and 16 years.

Table 90. Presentation of the teeth with hypoplastic enamel

ID	**Left**								**Right**							
	M^3	M^2	M^1	P^2	P^1	C^1	I^2	I^1	I^1	I^2	C^1	P^1	P^2	M^1	M^2	M^3
	M_3	M_2	M_1	P_2	P_1	C_1	I_2	I_1	I_1	I_2	C_1	P_1	P_2	M_1	M_2	M_3
BG40						X	X	X	X	X	X					
A12-18																
HG93								X	X							
A4-8																
CG58					X	X		X	X	X	X					
M18-30																
CG59					X	X	X	X								
A12-18							X	X	X	X						
CG89	X	X	X	X	X	X	X							X	X	
M18-30																
CG110								X	X	X						
M30-50																

The ID column gives the skeleton no. in addition to information about the sex and the age of the individual.
The grey rows represent the maxillary dentition while the mandibular dentition is represented by the white rows. M=molar, P=premolar, C=canine, I=incisor. The numbers in superscript and subscript represent the tooth number in the maxillary and mandibular dentition respectively.

7.4.4.7 Health index

A health index was calculated for 103 of the individuals buried on this graveyard. The results of the calculations are presented in table 91 and show an average score of 0.85 for all individuals. The score for the dated material is slightly lower than for the skeletons in area C with a score of 0.83 and 0.87 respectively. Comparing the south side to the east side, it is seen that the skeletons to the south score slightly higher. The health index scores are discussed further below in comparison with the other graveyards.

Table 91. Health index data according to burial area

	N	Mean	Min.	Max.	Std. Dev.
South	15	0.85	0.65	1.00	0.11
East	24	0.82	0.52	1.00	0.11
All dated	40	0.83	0.52	1.00	0.11
Area C	63	0.87	0.65	1.00	0.09
All	103	0.85	0.52	1.00	0.10

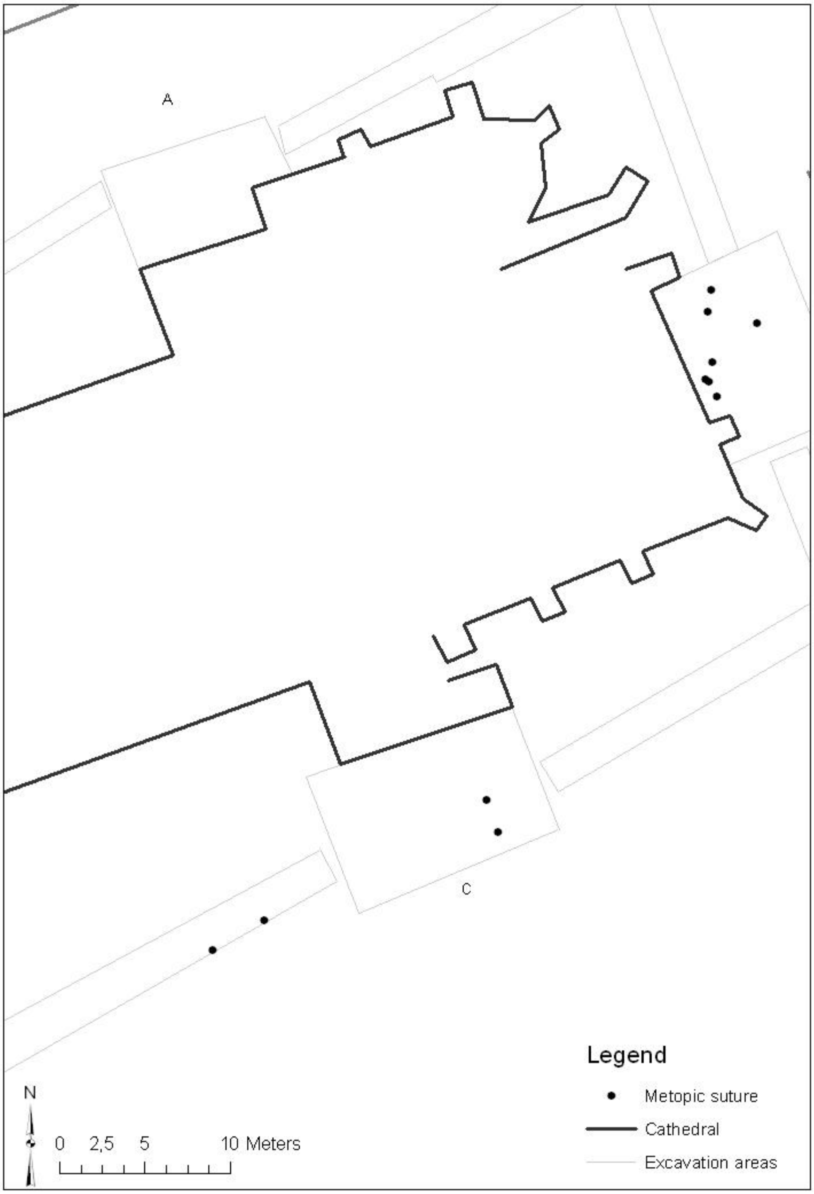
7.4.4.8 Discussion of social differences

It has not been possible to examine the appearance of these conditions with regard to the distance from the cathedral as all the skeletons came from the inner half of the graveyard. However, an attempt has been made to see if there are any differences between the southern and the eastern side of the cathedral. No meaningful comparisons could be made with the western side as the number of individuals was too small. For DJD, there is very little difference between the two sides (P=0.80) when including all age groups with a slightly higher incidence on the south side. When omitting the older individuals, the difference is a bit more pronounced (P=0.75), but the prevalence is higher on the east side. These differences are, however, far from statistically significant and the small differences between the south and the east side could just as well be due to chance. With regard to the distribution of SD, the difference in prevalence between the two sides is more pronounced with a higher occurrence on the east side. The difference is, however, not statistically significant when including all age groups or when omitting the older individuals at P=0.28 and P=0.21 respectively. This difference may, however, not necessarily be due to social differences as it seems to be strongly influenced by sexual differences in prevalence for SD. As discussed above, the main burial area for women was on the east side of the cathedral, and there is also a clear difference (P=0.13) in prevalence between the sexes for SD. Looking at the males only, the occurrence for SD is still higher on the east side but much less pronounced at P=0.39 for all age groups. The difference increases only slightly to P=0.36 when omitting the oldest individuals. There is no difference in incidence for SD between the sides for the women. Judging from this, it is difficult to argue for any social difference between the people buried on the south side and the east side of the Hamar cathedral. The data for cribra orbitalia and the dental conditions give similar results with no real difference in occurrence between the two sides.

7.4.5 Family plots

The distribution of individuals with a metopic suture does not appear to be completely random and may represent related people being buried in close proximity to each other. As seen in figure 19, 11 individuals had this trait, of which 4 were buried south of the cathedral while the remaining 7 were buried on the east side. Four of the ones on the east side are located within 2 metres of each other, only a couple of metres from the cathedral wall. Could this little cluster of metopic sutures represent a family plot on this graveyard? The age and sex composition of this group does not go against this suggestion. This group of four individuals consists of one elderly female (50+) and three younger males in their twenties. If these individuals were related one could possibly suggest that this group consists of a mother and her three sons. This is, of course, pure speculation, but certainly a possibility.

Figure 19. Distribution of metopic sutures around the Hamar cathedral.



7.5 The St. Peter's church, Tønsberg

The sample from the St. Peter's church graveyard consists of 223 skeletons, all of which were excavated from the northern side of the church. Eleven of these cannot be directly related to the church building as they pre-date the stone church and have, therefore, not been included in the general analysis of the St. Peter's church material. The skeletons pre-dating the church will rather be mentioned separately when found appropriate.

The excavated area stretches from close to the church wall to the outer extent of the graveyard. To analyse differences in the material with regard to the distance from the church, the graveyard has been divided into two halves. The dividing line has been arbitrarily drawn half way between the church and the outer limit of the burial area. In the following, the material will be discussed in relation to the inner and outer halves of the graveyard when this is found relevant.

7.5.1 Biological affiliation

Five of the skeletons from the St. Peter's church graveyard were well enough preserved for the complete set of Cranid measurements to be taken. One of the measured crania (HS247) is not well catered for by the Cranid database and has for this reason been excluded. The results of the Cranid analyses are presented in table 92. Skeleton HS191 showed a cranial morphology which differs from the Norwegian sample to such an extent that it might be considered to be foreign to this group and this is discussed in more detail below.

Skeleton HS191: This individual shows a high probability of belonging to the Beduin W Asia MF sample (0.45) with a lesser probability for the Egypt 26-30 Dyn M group. The NNDA analysis puts this skeleton with the Zalavar Hungary M and Egypt 26-30 Dyn M groups. The actual nearest neighbour comes from the S Australia M sample. On the list of the 56 closest matches to this cranium, there are four crania from the Norwegian samples and the most resembling is number 34 on the list. Among the 10 crania which show the greatest similarity to skeleton HS191, three are from the Egyptian samples. This could suggest that this individual was of foreign descent.

Table 92. Results for the Cranid analysis

Skeleton ID	LDA		NNDA	
	Group	**Probability**	**Group**	**Weighted score**
HS 191	Beduin W Asia MF Egypt 26-30 Dyn M Norse Norway M	0.45 0.13 0.03	Zalavar Hungary M Egypt 26-30 Dyn M Norse Norway M	418 382 173
HS 231	Norse Norway M	0.86	Norse Norway M Zalavar Hungary M	805 418
HS 247	Poundbury UK Rom M Norse Norway F Italian F Lachish W Asia F	0.37 0.13 0.11 0.11	Egypt 26-30 Dyn F Norse Norway F Egypt 26-30 Dyn M Poundbury UK Rom F	418 403 327 301
HS 251	Zalavar Hungary F N. Japan Hokkaido M Norse Norway M	0.40 0.32 0.07	Atayal Taiwan M Norse Norway M	327 230
HS 253	Norse Norway M	0.71	Maori New Zealand M Norse Norway M Moriori Chat Is M	474 345 333

7.5.2 Sex distribution

For both the inner and the outer half of the graveyard, the women outnumber the men (table 93). Combined, 32% are in the male categories and 57% in the female categories while 11% of the adult individuals could not be sexed. This difference between the sexes is statistically significant (P=0.04). Even though there are significantly more females buried here, the separation of the sexes, as it is, is by no means complete. However, as it is likely that this part of the graveyard was used for as long as the church was in use, this composition of the sexes can possibly be explained by changing practices during the Middle Ages. As there are significantly more females than males buried here, it is likely that this area of the graveyard was the preferred area for female burial, for at least a period. If the paragraphs concerning sexual division in the Eidsivating law were followed here, even though this is not mentioned in the Borgarting law (which pertained to this region), one could suggest that the graveyard was sexually divided only in the earlier burial phase. This would explain the composition of the sexes seen here. A scenario where this north side was the burial area for women in an early phase, and burial area for both sexes in the later period would give a composition with a majority of women but with a good number of men. This interpretation with segregation being practiced in an early phase and later abandoned is also suggested by Jonsson (2009:76). Another possibility could be that the sexual division was not strictly enforced and, although the north side was mainly reserved for women, certain groups of men would also be buried in this area. No matter the reason, the composition of the sexes is not likely to be random, so it appears that the sexes were not treated equally at the St. Peter's church graveyard, at least for a period.

Looking at the individuals excavated from within the church, the picture is quite different from what is seen on the graveyard north of the church. The difference here does not reach statistical significance (P=0.19), but there are clearly more males buried inside the church. This strengthens the impression that the sexes were not treated equally on the graveyard for the St. Peter's church.

7.5.2.1 Pre-church individuals

Judging from the evidence outlined above, it seems likely that this graveyard was sexually segregated at an early stage, with mainly women buried north of the church. Looking at the sex composition of the individuals pre-dating the stone church can lend some support to this conclusion. Of these individuals were 5 women, 5 children and only 1 male. The male individual is the one furthest to the south, right outside the wall of the stone church (the distribution of these skeletons can be seen in figure 20). This sample is quite small and it is difficult to draw solid conclusions from so few individuals, but it can be suggested that this sex composition is the result of a sexually segregated graveyard pre-dating the stone church. If this was the case, the area where these people were buried can represent the northern part of the graveyard belonging to an earlier church.

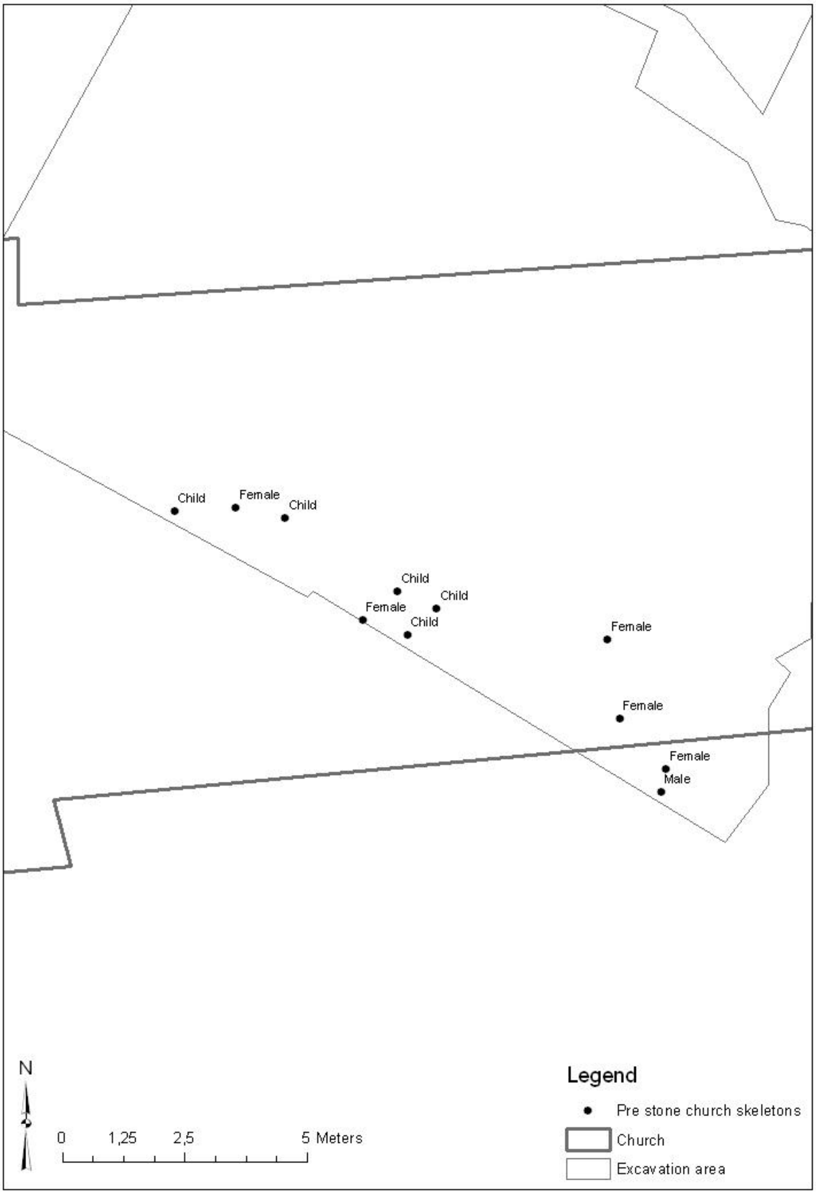


Figure 20. Distribution of the individuals pre-dating the St. Peter's stone church.

Table 93. Sex distribution for the St. Peter's church

	N	Male	Male?	Ambiguous	Female?	Female
Outer	78 *64*	17 (22%) *17 (27%)*	0 *0*	25 (14 children) (32%) *11 (17%)*	1 (1%) *1 (1%)*	35 (45%) *35 (55%)*
Inner	113 *74*	24 (21%) *24 (33%)*	4 (4%) *4 (5%)*	43 (39 children) (38%) *4 (5%)*	0 *0*	42 (37%) *42 (57%)*
Inside church	19 *13*	10 (53%) *10 (77%)*	0 *0*	7 (6 children) (37%) *1 (8%)*	0 *0*	2 (10%) *2 (15%)*
Pre church	11 *6*	1 (10%) *1 (17%)*	0 *0*	5 (5 children) (45%) *0*	0 *0*	5 (45%) *5 (83%)*
Combined*	210 *151*	51 (24%) *51 (34%)*	4 (2%) *4 (3%)*	75 (36%) *16 (11%)*	1 (1%) *1 (1%)*	79 (37%) *79 (52%)*
Combined**	191 138	41 (21%) 41 (30%)	4 (2%) 4 (2%)	68 (36%) 15 (11%)	1 (1%) 1 (1%)	77 (40%) 77 (56%)

The figures in italics were calculated without the sub-adult individuals.
*The pre-church individuals are not included.
**Only the inner and outer included.

7.5.3 Age distribution

There are 211 individuals for which the age at death has been estimated. Among these were 60 (28.4%) below the age of 18 years and 151 (71.6%) above this age. Fifty seven of the adult individuals could not be assigned to an age group and were only determined to be of adult age at the time of death and were, therefore, excluded from the calculations presented in tables 94 and 96. Among the pre-church individuals there were 6 adults and 5 sub-adults. The age distribution for these individuals is presented in table 95.

Table 94. Age distribution for the St. Peter's church sample

Age distribution of individuals aged 0-18			
Age group	**N**	**% of children**	**% of total**
0-1 years	35	58.3	22.7
1-4 years	7	11.7	4.6
4-8 years	5	8.3	3.3
8-12 years	3	5	2
12-18 years	10	16.7	6.5
Total	**60**	**100**	
Age distribution of individuals aged 18+			
Age group	**N**	**% of adults**	
18-30 years	25	26.6	16.2
30-50 years	59	62.8	38.2
50+ years	10	10.6	6.5
Total	**94****	**100**	**100**

- Fifty seven of the 151 adult individuals could not be assigned to an age group and were only determined to be of adult age at the time of death. These individuals have been excluded from these calculations.
- Pre-church individuals are not included in these calculations.

Table 95. Age distribution for the individuals pre-dating the church

Age group	**N**
0-1 years	1
1-4 years	4
4-8 years	0
8-12 years	0
12-18 years	0
18-30 years	3
30-50 years	2
50+ years	0
20+ years	1

Table 96. Average age at death calculated from the St. Peter's church sample

Age group	**Average age**	**N**	**Average age * N**	**Average age**	**Average age adults**
0-1 years	0.5	35	17.5		
1-4 years	2	7	14		
4-8 years	6	5	30		
8-12 years	10	3	30		
12-18 years	15	10	150		
18-30 years	24	25	600		
30-50 years	40	59	2360		
50+ years	60	10	600		
Sum		**154**	**3801.5**	**3801.5/154=24.7**	**3560/94=37.9**

- Pre-church individuals are not included in these calculations.
- Fifty seven of the 151 adult individuals could not be assigned to an age group and were only determined to be of adult age at the time of death. These individuals have been excluded from these calculations.

When looking at the distribution of the different age groups according to where they were buried on the graveyard (table 97 and figure 21), a few things become apparent. Firstly, the large majority of the youngest children (0-1 years) was found on the inner half of the graveyard. However, in this case one should not rule out a taphonomic influence on this distribution. Generally speaking, the preservation for the St. Peter's church sample is poor and it can be suggested that the preservational quality differs between the two halves of the graveyard. Based on the distribution of adult individuals which could not be assigned to an age group more specific than 20+, it can be suggested that the preservational conditions differed across the graveyard (32% of the adult individuals from the inner half of the graveyard could only be estimated to be of adult age and 48% of the adults from the outer half were put in this category). The inability to assign an individual to an age category more specific than adult is generally related to that individual being poorly preserved and thus it can be suggested that the preservation was poorer on the outer half of the graveyard. In a poorly preserved sample like this one, a difference in the preservation conditions within the graveyard could influence the representation of some age groups. As discussed above (chapter 5), the age groups most affected by differential representation due to taphonomic processes are the youngest and the oldest individuals. There is, therefore, a chance that some of the youngest individuals buried on this graveyard have vanished due to poor preservation and, if the preservation conditions were poorer on the outer half, this could have affected this area more. Thus, it is possible that the difference between the two graveyard halves with regard to the representation of the 0-1 age groups has been accentuated due to taphonomic factors. In spite of this, the difference in representation of this age group is so large that it still seems likely that there was a preference for burying the youngest children closer to the church building.

Taphonomy is also likely to have played a role in the representation of the oldest (50+) individuals in this sample. As this is an age group which is more affected by poor preservation, it is likely that they are overrepresented among the skeletons for which age cannot be properly estimated. Therefore, it is quite possible that many of the oldest individuals are to be found in the 20+ category where age could not be estimated due to poor preservation.

Table 97. Distribution of the different age groups across the graveyard

Age group	**Outer (N 78)**	**Inner (N 113)**	**Inside church (N 19)**
0-1 years	6 (7.7%)	28 (24.8%)	1 (5.3%)
1-4 years	1 (1.3%)	4 (3.5%)	2 (10.5%)
4-8 years	0	4 (3.5%)	1 (5.3%)
8-12 years	0	1 (0.9%)	2 (10.5%)
12-18 years	8 (10.3%)	2 (1.8%)	0
18-30 years	10 (12.8%)	14 (12.4%)	1 (5.3%)
30-50 years	20 (25.6%)	30 (26.6%)	9 (47.3%)
50+ years	3 (3.9%)	6 (5.3%)	1 (5.3%)
20+ years	30 (38.4%)	24 (21.2%)	2 (10.5%

The percentage figures represent the proportion of that age group on that particular part of the graveyard.

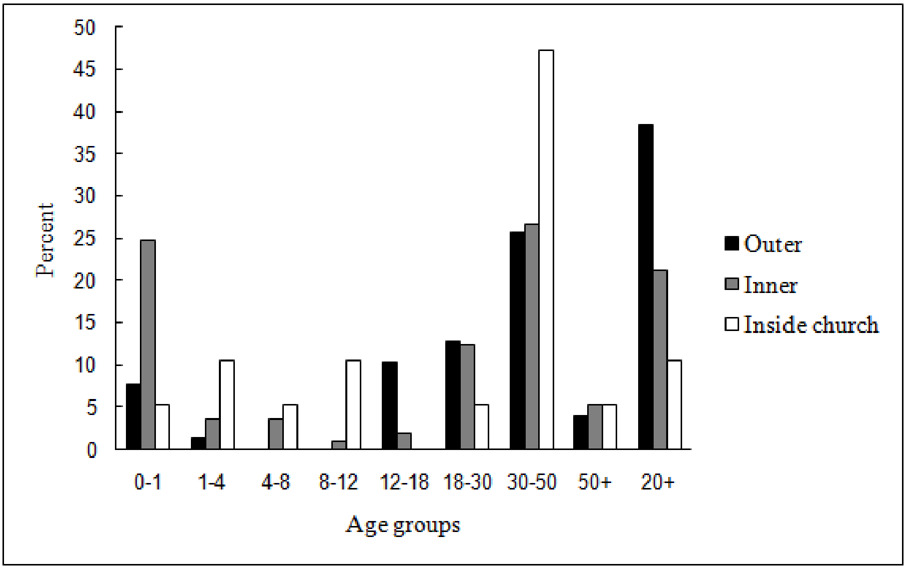


Figure 21. Representation of the different age groups according to burial area.
The bars represent the percentage proportion of individuals within each age group according to burial area.

7.5.4 Social stratification

To determine whether or not the graveyard for the St. Peter's church was socially stratified, the burial area has been divided into an inner and an outer section. The dividing line has been arbitrarily drawn half way between the church wall and the outer extent of the graveyard. This division of the graveyard represents the hypothetical social division as described in the Eidsivating and Borgarting legislation, and the different skeletal conditions will, in the following, be discussed with regard to the inner and outer half of the graveyard.

7.5.4.1 Stature distribution

Forty five individuals had at least one femur well enough preserved for the maximum length of the bone to be measured: 21 males and 24 females. The average femur length for females is 424.6mm which corresponds to a living stature of 161.63±4.52cm (all stature calculations are made with Sjøvold's (1990) formula for Caucasians independent of sex) while the average male femur is 40.6mm longer at 465.2mm, and this corresponds to a living stature of 172.31±4.52cm. The femur maximum length data is presented in table 98. Figure 22 gives a representation of the sexual dimorphism in femur lengths and it is evident that the majority of the female femur lengths are between 430mm-450mm and the majority of the male femurs have a maximum length of between 450mm-470mm. In living stature terms, this means that most women were between 163.10±4.52cm and 168.31±4.52cm tall while most males were between 168.31±4.52cm and 173.57±4.52cm tall.

Table 98. Femur maximum lengths (millimetres) according to sex

	N	**Mean**	**Min.**	**Max.**	**Std. dev.**
Male	21	465.2	413	506	22.6
Female	24	424.6	390	455	18.4

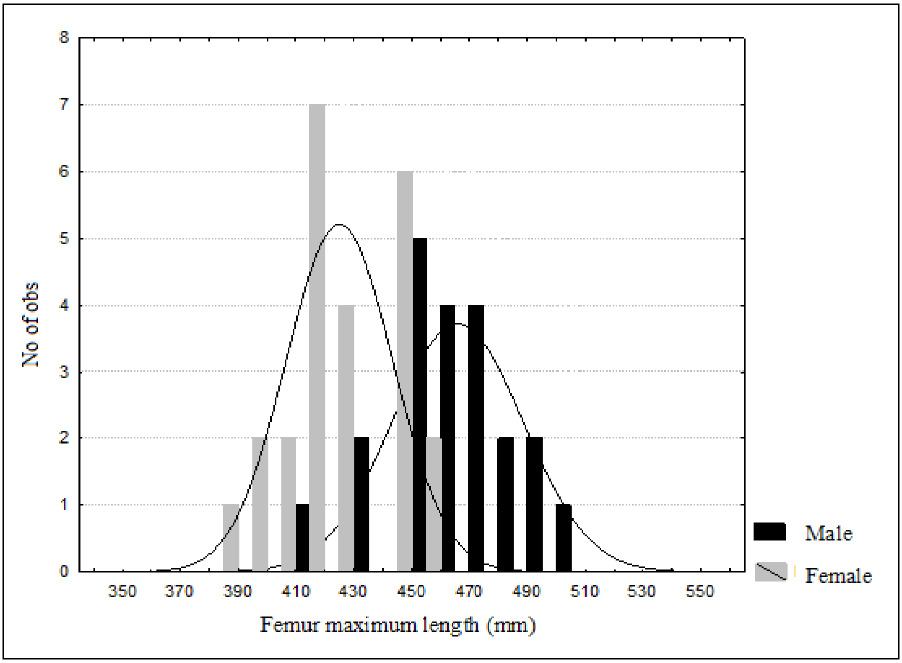


Figure 22. Representation of the femur maximum lengths according to sex.

Analysing the distribution of the femur lengths across the graveyard, it becomes clear that the average lengths, for both males and females, are longer on the outer half of the graveyard than on the inner. The average femur lengths for the two halves of the graveyard are presented in table 99.

Table 99. Average femur lengths (millimetres) according to sex and burial area

	Male			**Female**		
	Outer (N 5)	**Inner (N 12)**	**Inside church (N 4)**	**Outer (N 6)**	**Inner (N 16)**	**Inside church (N 2)**
Average femur maximum length (mm)	464.2	461.3	478.5	435.5	422.3	410

7.5.4.2 Degenerative joint disease (DJD)

Altogether 20 individuals showed signs of DJD, which constitutes 43.5% of the adult sample. Looking only at the younger individuals (adults below 50 years at the time of death), 35.0% showed similar changes. As seen in table 100, the prevalence for DJD is higher on the outer half of the graveyard compared to the inner. The difference is far from statistically significant (P=0.78) but it increases when only including the younger adults (P=0.53). Although significance was not reached, the fact that the prevalence is higher on the outer half and that the difference is more marked when omitting the oldest individuals is what one would expect to find in a socially stratified graveyard.

Looking at the difference in prevalence between the sexes, it is seen that a greater proportion of the females suffered from this condition compared to males (P=0.58) (table 101). This difference increases when looking at the younger adults only (P=0.20).

DJD will be discussed further below in comparison with the other graveyards.

Table 100. Prevalence of DJD according to age and burial area

	N	**Inner**	**N**	**Outer**	**N**	**Inside church**
Adults with DJD	12	41.4%	8	53.3%	0	0
Adults below 50 years with DJD	7	29.2%	7	50.0%	0	0

Only individuals with at least half of their joints preserved are included in these calculations.
N46 for all adults (inner 29, outer 15 and inside church 2).
N40 for adults below 50 (inner 24, outer 14 and inside church 2).

Table 101. Prevalence for DJD according to sex and age

	Male (N22)* (N18)		**Female (N23) (N21)**	
	N	%	N	%
Adults with DJD	7	31.8	11	47.8
Adults below 50 years with DJD	3	16.7	10	47.6

Only individuals with at least half of their joints preserved were included in these calculations.
*The top (N) is the total number of that sex in the sample and the bottom (N) is the number of that sex below 50 years. Thus, the total number of individuals is 45 and the number of individuals below 50 years is 39.

7.5.4.3 Spinal degeneration (SD)

Altogether 49 individuals showed signs of SD which equates to 71.0% of adult sample. Looking only at the younger adults, 67.7% showed similar changes. As seen in table 102, the prevalence for SD is higher on the outer half of the graveyard compared to the inner. The difference in prevalence between the two halves is not statistically significant (P=0.54). The difference only increases slightly when omitting the oldest individuals (P=0.52). Considering the prevalence for sexes separately, it is seen that there is no real difference (table 103).

SD will be discussed further below in comparison with the other graveyards.

Table 102. Prevalence of SD according to burial area

	N	Inner	N	Outer	N	Inside church
Adults with DJD	25	64.1%	19	86.4%	5	62.5%
Adults below 50 years with DJD	20	58.8%	17	81.0%	5	71.4%

Only individuals with at least half of their joints preserved are included in these calculations.
N69 for all adults (inner 39, outer 22 and inside 8).
N62 for adults below 50 (inner 34, outer 21 and inside 7).

Table 103. Prevalence for SD according to sex and age

	Male (N28)* (N23)		**Female (N36) (N32)**	
	N	%	N	%
Adults with DJD	21	75.0	24	66,7
Adults below 50 years with DJD	16	69.6	22	68.8

Only individuals with at least half of their joints preserved were included in these calculations.
*The top (N) is the total number of that sex in the sample and the bottom (N) is the number of that sex below 50 years. Thus, the total number of individuals is 64 and the number of individuals below 50 years is 55.

7.5.4.4 Cribra orbitalia and porotic hyperostosis

Only six individuals showed signs of cribra orbitalia which equates to 14.0% of the population. Studying the difference in prevalence between the inner and outer halves of the graveyard is not possible, as only three individuals from the outer half had an orbital ceiling well enough preserved for this trait to be examined (table 104).

No examples of porotic hyperostosis were identified among the 64 individuals for whom this condition could be examined.

Table 104. Prevalence for cribra orbitalia according to burial area

	N	Inner	N	Outer	N	Inside church
Individuals with cribra orbitalia	3	10.4%	0	0%	3	27.3%

Only individuals with at least one orbital ceiling preserved are included in these calculations.
N43 (Inner N29, Outer N3 and inside church N11).

7.5.4.5 Dental conditions

Seven individuals showed evidence of dental abscesses and this equates to 19.4% of the population (table 105). The prevalence for ante-mortem tooth loss is somewhat higher at 30.5% (table 106).

Table 105. Prevalence for dental abscesses according to burial area

	N	Inner	N	Outer	N	Inside church
Individuals with dental abscesses	7	27.9%	0	0	0	0

Only adult individuals with at least 2/3s of the jaws present are included in these calculations.
N36 (inner N26, outer N6 and inside church N4).

Table 106. Prevalence for ante-mortem tooth loss according to burial area

	N	Inner	N	Outer	N	Inside church
Individuals with ante-mortem tooth loss	7	27.9%	2	33.3%	2	50%

Only adult individuals with at least 2/3s of the jaws present are included in these calculations.
N36 (inner N26, outer N6 and inside church N4).

Looking at which teeth had been lost ante-mortem (table 107), it is seen that 10 of the individuals with ante-mortem tooth loss had lost one or more of their molars or premolars, while the front teeth (canines and incisors) were involved in only 2 of the cases. The sexes are fairly evenly represented with 4 males and 7 females having suffered tooth loss during their lifetime. Two of these people were over 50 years at the time of death, while 9 were below this age (1 below the age of 30).

Table 107. Presentation of which teeth were lost ante-mortem

ID	**Left**								**Right**							
	M^3	M^2	M^1	P^2	P^1	C^1	I^2	I^1	I^1	I^2	C^1	P^1	P^2	M^1	M^2	M^3
	M_3	M_2	M_1	P_2	P_1	C_1	I_2	I_1	I_1	I_2	C_1	P_1	P_2	M_1	M_2	M_3
HS31																
F30-50			X	X									X			
HS85																
M30-50				X									X			
HS147								X								
F30-50																
HS162	X															
F50+																
HS223	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
F50+								X	X	X	X	X	X	X		X
HS231	X		X													
M30-50																
HS247		X													X	
M30-50			X	X	X								X			
HS253	X															
M30-50																X
HS284					X											
F18-30																
HS363																
F30-50				X										X	X	
HS441													X	X		
F30-50														X		

The ID column gives the skeleton no. in addition to information about the sex and the age of the individual.
The grey rows represent the maxillary dentition while the mandibular dentition is represented by the white rows. M=molar, P=premolar, C=canine, I=incisor. The numbers in superscript and subscript represent the tooth number in the maxillary and mandibular dentition respectively.

7.5.4.6 Enamel hypoplasia

Three individuals had hypoplastic enamel on one or more teeth. All of these were found on the outer half of the graveyard and one on the inner (table 108).

Table 108. Prevalence for enamel hypoplasia

	N	**%**
Enamel hypoplasia	3	8.3

This trait could be examined for 36 individuals.

As seen in table 109, one individual had hypoplastic enamel on the mandibular canines and first premolar and another person had the defect on the mandibular first premolar alone. The first person would have a period of severe stress sometime between the age of 3 months and 7 years, while for the other the problems would have happened between 1.5 years and 6 years (table 16). The last individual with all maxillary incisors and both the maxillary and mandibular canines involved would have had an episode of sever metabolic stress between the age of 3 months and 7 years.

Table 109. Presentation of the teeth with hypoplastic enamel

ID	Left								Right							
	M^3	M^2	M^1	P^2	P^1	C^1	I^2	I^1	I^1	I^2	C^1	P^1	P^2	M^1	M^2	M^3
	M_3	M_2	M_1	P_2	P_1	C_1	I_2	I_1	I_1	I_2	C_1	P_1	P_2	M_1	M_2	M_3
HS16																
A12-18					X	X						X				
HS257						X	X	X	X	X	X					
F30-50						X					X					
HS482																
F18-30					X											

The ID column gives the skeleton no. in addition to information about the sex and the age of the individual.
The grey rows represent the maxillary dentition while the mandibular dentition is represented by the white rows. M=molar, P=premolar, C=canine, I=incisor. The numbers in superscript and subscript represent the tooth number in the maxillary and mandibular dentition respectively.

7.5.4.7 Health index

The health index was calculated for 24 of the individuals from this graveyard. The average index for this sample is 0.87 with a score of 0.88 for the individuals buried on the inner half the graveyard and 0.83 for those buried on the outer half (table 110).

Table 110. Health index data according to burial area

	N	Mean	Min.	Max.	Std. Dev.
Inner	20	0.88	0.64	1.00	0.09
Outer	4	0.83	0.82	0.87	0.03
All	24	0.87	0.64	1.00	0.09

7.5.4.8 Discussion of social differences

With regard to the distribution of the features used as indicators of social differences, the patterns are very similar to the ones described above for the Public Library site. Looking at the distribution of maximum femur lengths, it is seen that, on average, the tallest people were exhumed from the outer half of the burial area. For the degenerative conditions, the highest prevalence was on the outer half of the graveyard and for DJD the difference increases when omitting the oldest individuals. This difference in prevalence between the outer and the inner halves of the graveyard, with an increased difference among the younger individuals, is what one would expect in a socially stratified graveyard. The difference between the two halves does, however, not increase for SD when only including the younger individuals. This can probably be explained by the time of onset of spinal degeneration and inaccuracies in adult age estimation (this is discussed above, page 137) and should not necessarily be seen as an argument against stratification. The differences were not found to be statistically significant, but the general patterns are exactly what one would expect to find if the graveyard was socially divided. Although, the evidence is not as strong as it could have been, it seems reasonable to suggest that social status played a determining role in deciding where an individual should be buried.

The other conditions used in this study did not provide any reliable comparisons as the number of individuals for which the condition could be examined were too low on the outer half of the graveyard.

7.5.5 Family plots

None of the non-metric traits used in this study have a distribution on the graveyard which could suggest the presence of family plots.

8. Discussions with regard to regional differences and similarities

8.1 Biological affiliation

From all four graveyards, only 40 crania were well enough preserved for the full set of Cranid measurements to be taken. The results suggest that some of these individuals were foreign to the Norwegian population, but there are reasons why it might be difficult to draw general conclusions about the ethnic composition of the mediaeval population in Norway. Firstly, only a very small portion of the total sample could be included in the Cranid analysis and one should thus be careful when making general statements about the proportion of individuals of possible foreign descent in the Norwegian population. Secondly, and more importantly, the morphometric method is not able to accurately distinguish between closely related groups of people. Immigration to Norway in the Middle Ages would mainly have come from Europe and probably mostly from northern Europe. Immigrants would have included individuals from all levels of society, including members of the clergy, pilgrims, craftsmen, individuals involved in trade and people coming to Norway as slaves (Opsahl, 2003). There is also historical evidence suggesting that people travelled over large geographic areas. Opsahl (2003:25) mentions letters describing travels to geographically distant places like Rome, Jerusalem and Santiago de Campostela in Spain. The oldest known travel description from the Nordic countries dates from the 1150s and was written by an abbot from Iceland. This describes the route from Iceland to Jerusalem and includes information about attractions and resting places along the way (Opsahl, 2003:25). This suggests that long distance travels were not uncommon during the Middle Ages, something which is also supported by the recently published articles by Leach et al. (2010) and Ebeneserdottir et al. (2010), which shows the presence of a North African lady in Roman period York, England, and the possible influence from Native Americans in the Icelandic gene pool. Although it might be difficult to distinguish between different populations within a relatively limited geographical area, the Cranid analysis can be quite effective in relating a cranium to a generally larger area. Thus, an analysis of the mediaeval crania in this project would flag up individuals which clearly differ in morphology from the Norwegian samples, individuals which are, therefore, likely to have their geographical origins elsewhere.

So, what do the results from the Cranid analyses tell about the Norwegian mediaeval society? Firstly, it gives a picture of a society where people were mobile rather than static and sedentary. It suggests that a significant proportion of society was of foreign descent. From the percentages presented in table 111, it could look like that as much as a quarter of the population was of foreign origin. One should, however, not put too much emphasis on these percentages. The number of measured crania is quite small. The only site with a reasonable amount of crania to be analysed was the Public Library site, and even there the measured crania only amount to about 10% of the total sample. Thus, one should be careful in suggesting the size of the immigrant population, but it seems safe to suggest that it would not have been rare to meet people of foreign descent in these mediaeval towns.

Table 111. Possible foreigner according to graveyard

	Measured crania	**Possible foreigners**
St. Mary's church	4	1 (25.0%)
Public Library site	22	4 (18.2%
Hamar cathedral	10	3 (30.0%)
St. Peter's church	4	1 (25.0%)

8.1.1 Burial of foreigners

The data regarding possible foreigners give no information suggesting any special treatment in a burial context. These individuals' placements on the graveyards do not appear to follow any particular pattern.

8.2 Sex distribution

The analyses, with regard to the distribution of the sexes on the graveyards, suggest that the burial practices differed between the regions. Although, it has not been possible to prove that a strict segregation of the sexes has taken place, it has been shown that the sex of the diseased affected the placement of the body on the graveyard for three of the cemeteries in this study (the Public Library site, the Hamar cathedral and the St. Peter's church).

The Hamar cathedral is located in the area where the Eidsivating law pertained and, thus, this is where one would expect to see signs of a sexually segregated graveyard. A north-south division of the cemetery has been impossible to enforce due to the topography of the graveyard: there was not enough top soil north of the cathedral to allow for this area to be used for burials. However, the graveyard still shows signs of sexual segregation as there is a clear majority of males buried to the west and to the south of the building. The east side of the cathedral was clearly the preferred area for female burials, but this area was also used for burying males, so a complete separation of the sexes does not seem to have been practiced. In this respect, it was interesting to see whether the males on the east side differ, in any respect, from the rest of the males in the sample. This could, however, not be shown. For neither of the criteria used for showing social differences (DJD, spinal degeneration, cribra orbitalia) could a significant difference in prevalence be shown between the males of the south and the east side. Thus, there is nothing to suggest that social differences played a part in determining what side of the church an individual should be buried.

The St. Peter's church graveyard also displays a sex distribution which suggests that the sex of an individual was a determining factor when deciding where a person should be buried. As all the skeletons in this sample came from the northern side of the church, it is not possible to directly compare the sex distribution on the different areas of the graveyard, but this material has a composition which is not likely to be the result of a random burial practice. Of the adult skeletons in this sample, 32% were male, 57% were female and 11% could not be sexed. Testing this sex distribution against the hypothesis that the sexes should be equally represented, shows that the difference between the sexes is statistically significant (P=0.04). So, what may have caused a sex distribution like this? There are two likely explanations (at least): the sexes were segregated for only a shorter period or the segregation was only partial. If the north side was only used for female burials for a limited period and later used for both sexes, one would end up with a burial area with mainly females but with a fair few males included. Exactly as is found on the northern side of the St. Peter's church. Considering that there is a connection between the sexual segregation described in the Eidsivating law, although it did not pertain to this region, and the sexual separation on the St. Peter's church graveyard, one could argue that this explanation is the more likely. According to the Eidsivating law, the practice of segregating the sexes was abandoned after some time and the sex of an individual did no longer dictate which side of the church the individual should be buried. Thus, if this was followed at the St. Peter's church, although this graveyard was not part of the Eidsivating law district, one would end up with a sex distribution like the one described here. Although the sample is limited, the sex composition of the individuals pre-dating the stone church can be taken in support of sexual segregation being practiced on the graveyard for an earlier church. There is only one male among the 11 individuals pre-dating the stone church and it has thus, been suggested that these skeletons came from the northern part of the graveyard for a church preceding the stone church.

The sex distribution found at the Public Library site church presents a similar picture. There is a clear majority of women buried in phase A, but the number of individuals excavated from this phase is quite small (20 adults) and nearly half of these could not be sexed accurately, so, even though there is a clear difference in representation of the sexes, it would be more convincing if this was based on a larger and better preserved sample. The sexual segregation hinted at in phase A is, however, supported by the evidence from phase B. Although, there is no marked difference in the representation of the sexes in phase B when the graveyard is seen as a whole, the evidence is very different when looking at the graveyard in the form of a northern and a southern section. There is a significant difference in the sex composition between the two halves of the graveyard which suggests that the northern part of the graveyard was preferred for female burials while the southern section was preferred for males. This sexual division of the burial area north of the Public Library site church is not reflected in the sex distribution at the St. Peter's church where there is an overrepresentation of females on both halves of the burial area north of the church building. This difference between the two sites can probably be explained by the extent of the burial area for the different sites. It is known that burials took place on both the north and the south side of the St. Peter's church, while the area south of the Public Library site church was most likely not used for this purpose. Thus, as a division based on a northern and a southern section of the graveyard with the church in the middle was not possible to enforce at the Trondheim site, a division of the burial area north of the church seems to have been employed instead.

The St. Mary's church cemetery tells a different story from the other graveyards. The sexes are evenly represented on the graveyard for all burial phases and it should be concluded that this graveyard was not sexually segregated at any point in time.

What these results show is that there were regional differences with regard to the practice of separating the sexes on the graveyards and that the differences are partly corresponding to the legislation given in the early Norwegian Christian laws. The correspondence with the laws is only partial as sexual segregation seems to have been practiced in areas where this was not required by the law. However, there is no reason to think that every practice carried out was mentioned in the laws, so this should not be surprising. On the other hand, it is satisfactory to see that a form of sexual segregation was practiced at Hamar were this was required by the law. This suggests that the law was followed in this respect.

8.3 Age distribution

When looking at how the different age groups are distributed on the graveyards, there is one feature which is particularly striking: the placement of the youngest children. The rule seems to be that the children in the youngest age group (0-1 years at the time of death) are buried relatively close to the church. On the Public Library site graveyard, all but one of these children were buried on the inner half of the graveyard, relatively close to the church. At the St. Peter's church, the situation is similar with 28 of the youngest children buried on the inner half of the graveyard and only six on the outer half. At Hamar, there are only three of the youngest children among the individuals buried before 1350 and they are all buried close to the cathedral's east side wall. The St. Mary's church graveyard also fits this pattern, although indirectly. This is the only graveyard where the total sample comes from the outer half of the cemetery and the youngest age group is completely absent. This lack of the youngest children is not likely to be the result of no children being buried at this graveyard, but judging from the pattern from the other graveyards, the youngest children have probably just not been excavated from this site (only the outer half of the graveyard has been excavated).

A more general question regarding the burial of infants on the Christian graveyard, which puzzled the author, was if these children were legally interred in Christian soil. Had these children been baptised? Being baptised is a prerequisite for being buried on a Christian graveyard, and the Frostating and the Eidsivating law also make specific statements to this fact. The Frostating law states that a person who has been separated from Christianity shall not be buried on the graveyard, and the Eidsivating law states that people and children who are not baptised before death are not allowed to be buried on the churchyard. As it turned out, this problem is dealt with by the early Christian laws. The laws operate with a practice called “emergency baptism” (*nøddåp*) which is designed to solve this problem. In situations where a clergyman could not be reached, baptism rituals could be performed by a layperson and this would be satisfactory for burial on a Christian graveyard (Landro, 2010:30-31).

8.3.1 Average age at death

Comparing the different graveyards with regard to average age at death, it could be suggested that the people in Bergen and Hamar lived, on average, about ten years longer than the people in Trondheim and Tønsberg. This is, however, probably a product of sampling rather than reality. As discussed above, the youngest children were absent in the St. Mary’s sample and nearly absent in the Hamar sample and when this age group is not properly represented the average age at death figures are artificially inflated. This corresponds with the fact that around 40% of the samples from the St. Peter’s church and the Public Library site were sub-adults and only 15% and 21% of the samples from the St. Mary’s church and the Hamar cathedral were sub-adults. Therefore, it may be a more useful comparison if only the adult individuals are included (table 112 and figure 23). Then, it becomes apparent that the difference in average age at death is considerably less. The numbers still show that the average age at death is somewhat higher for the samples from Bergen and Hamar, but the difference is not more than 4 years between Hamar and Trondheim with the highest and lowest averages respectively.

Table 112. Average age at death for the different graveyards

	Average age	**Average age adults**
St. Mary’s church	35.2 years	39.2 years
Public Library site	24.5 years	35.8 years
Hamar cathedral	33.3 years	39.8 years
St. Peter’s church	24.2 years	37.5 years

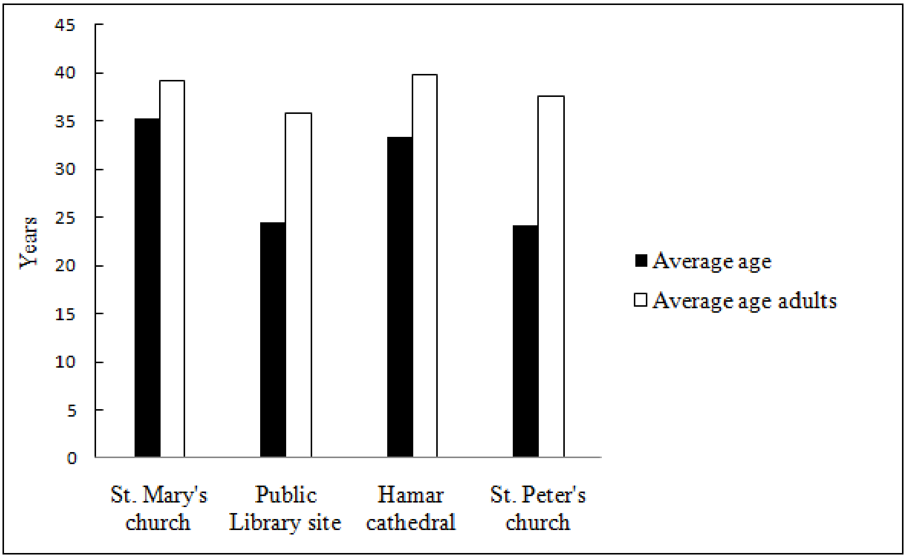


Figure 23. Average age at death comparison between the different sites.

8.4 Stature distribution

There is not much difference in femur lengths between the different samples (table 113 and figure 24). For males, the difference between the sample with the lowest mean, St. Mary's, and Hamar with the highest mean is only 10.9mm and the difference between the female samples with highest and lowest means (St. Peter's and St. Mary's respectively) is no more than 8.8mm. A ten millimetre difference in femur length equates to approximately 2-3cm in living stature. Thus, there is no marked difference between the different populations with regard to living stature.

Considering only the two samples where comparisons could be made between the inner and the outer halves of the graveyard (Public Library site and St. Peter's church), it is interesting to note that the average femur lengths are greater on the outer half of the graveyard for all categories (table 114 and figure 25). Living stature is generally considered to have a correlation to social status and it is also believed that the higher social classes are buried closest to the church building. In the case of these two graveyards, one of these assumptions is wrong. As argued below, it seems like the higher social classes were indeed buried closer to the church buildings than the lower classes and, thus, the use of stature as a social indicator should be approached with caution.

As mentioned above, the difference between the different samples is quite small, so it is difficult to argue that there was a real difference in stature between the social classes or between the different geographical regions. On the background of this, it seems like one should be careful in using an individual's stature as measure for social status or geographical origin. What this material rather shows, is that the living stature of the Norwegian mediaeval population was reasonably uniform across the country and across social boundaries. Thus, stature has been excluded from the social stratification discussion below.

Table 113. Femur maximum length (millimetres) data for the four graveyards

	N	**Mean**	**Min.**	**Max.**	**Std. dev.**
St. Mary's church					
Male	27	458.5	426	508	20.9
Female	15	415.8	390	457	20.1
Public Library site					
Male	27	464.2	416	513	23.5
Female	37	419.6	386	458	15.4
Hamar cathedral					
Male	78	469.4	402	535	23.1
Female	42	423.6	388	468	16.8
St. Peter's church					
Male	21	465.2	413	506	22.6
Female	24	424.6	390	455	18.4

Table 114. Femur maximum lengths (millimetres) according to burial area

	Male		**Female**	
	Inner	**Outer**	**Inner**	**Outer**
Public Library site	459.5 (N12)	468.0 (N15)	410.3 (N6)	421.4 (N31)
St. Peter's church	461.3 (N12)	464.2 (N5)	422.3 (N16)	435.5 (N6)

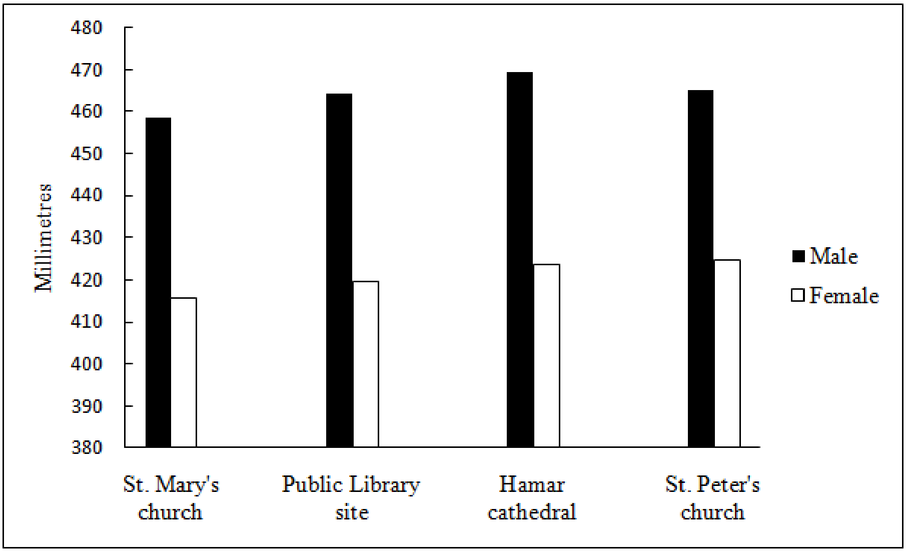


Figure 24. Comparison of average femur lengths between the different sites.

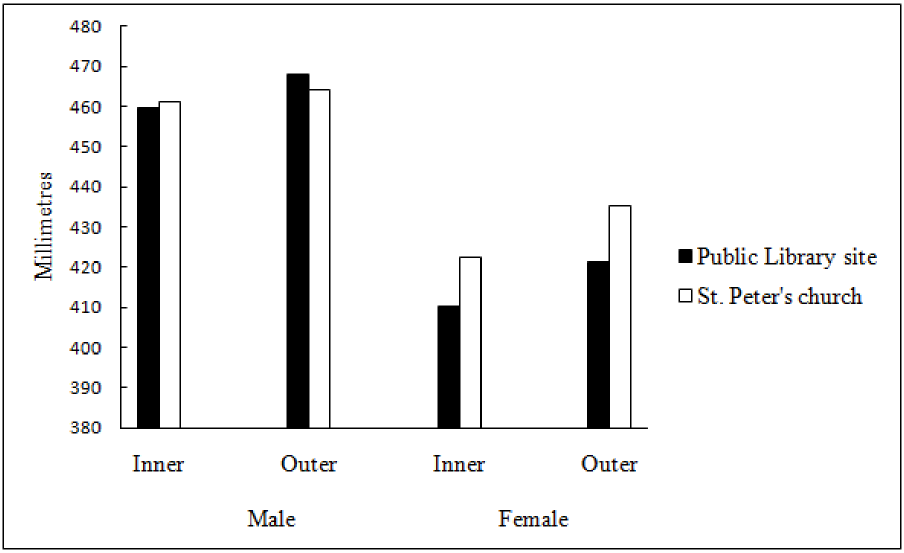


Figure 25. Femur length comparison between different burial areas.

8.5 Social differences

8.5.1 Degenerative joint disease and spinal degeneration

These degenerative changes are used in this study primarily as two of the criteria indicating social differences on the graveyard. The reasoning behind this is discussed above, but what one would expect to find in a socially stratified graveyard is that the prevalence of these conditions is higher in the area where the lower classes were buried and one would also expect to see an increased difference in prevalence between the burial areas when omitting the oldest age group. This pattern is pretty much what appears from the analyses of the Public Library site and St. Peter's church graveyards. For both DJD and SD, the occurrence is always higher on the outer half of the graveyards. The difference is, however, not statistically significant; but, for DJD the difference increases when omitting the oldest age group. For SD there is no such increase in difference when looking at the younger adults alone. This does, however, not necessarily mean that the time of onset for SD was the same for both groups. This is rather likely to be a product of the nature of spinal degeneration and inaccurate age determination for adult individuals. Degenerative changes to the vertebrae generally start a fair bit earlier in life than DJD, so if one puts the cut off point at 40 years instead of 50 one could possibly see a similar pattern as for DJD. At the age of 50 years, it is likely that a larger portion of the population would display some degenerative changes to the vertebrae due to age alone.

The evidence from the analysis of the degenerative conditions points in the direction of social stratification of the graveyards at the Public Library site and the St. Peter's church.

8.5.1.1 Regional differences with regard to DJD and SD

The prevalence for DJD and SD varies between the different graveyards. The general pattern for DJD corresponds with the pattern for SD and, therefore, the two conditions will be discussed as one (tables 115 and 116, figures 26 and 27). The site which clearly has the lowest proportion of individuals with degenerative skeletal changes is the Public Library site. This site also has a lower number of individuals above 50 years and this could explain the low prevalence of the degenerative conditions as they are age progressive. This, does, however, not seem to explain the situation at the Public Library site as the incidence of these conditions is also clearly lowest when excluding the oldest individuals. It should be concluded that the people buried on the Public Library site graveyard actually suffered less from these conditions compared to the other sites in this study.

The occurrence for DJD appears to be fairly similar between the other graveyards with a prevalence of about 20% higher than at the Trondheim site. One could, however, interpret these data differently if it is assumed that there is a difference between the inner and outer halves of the St. Mary's and the Hamar graveyards, as is evident from the Public Library site and the St. Peter's church. As the data indicates, the prevalence is nearly identical between the inner halves of the graveyards from Hamar and Tønsberg and the outer half of the Bergen graveyard. Taking into account the missing data from Bergen and Hamar it can be suggested that the general occurrence should be somewhat higher at Hamar and a bit lower for the Bergen site. Thus, it seems like the prevalence for DJD is very similar for the Hamar cathedral and the St. Peter's church graveyards, but slightly lower at the St. Mary's church graveyard. The SD data presents a similar picture with the lowest incidence found at the Public Library site and the highest at the Hamar cathedral and the St. Peter's church. The SD data also strengthens the impression that the prevalence for the St. Mary's graveyard actually was lower than for two of the other graveyards.

Table 115. Prevalence for DJD for the different graveyards

		Inner	Outer	Total
St. Mary's church	DJD		42.7%	
	DJD <50 years		32.3%	
Public Library site	DJD	19.2%	25.5%	23.4%
	DJD <50 years	4.8%	20.5%	15.6%
Hamar cathedral	DJD	41.4%		
	DJD <50 years	33.3%		
St. Peter's church	DJD	41.4%	53.3%	43.5%
	DJD <50 years	29.2%	50.0%	35.0%

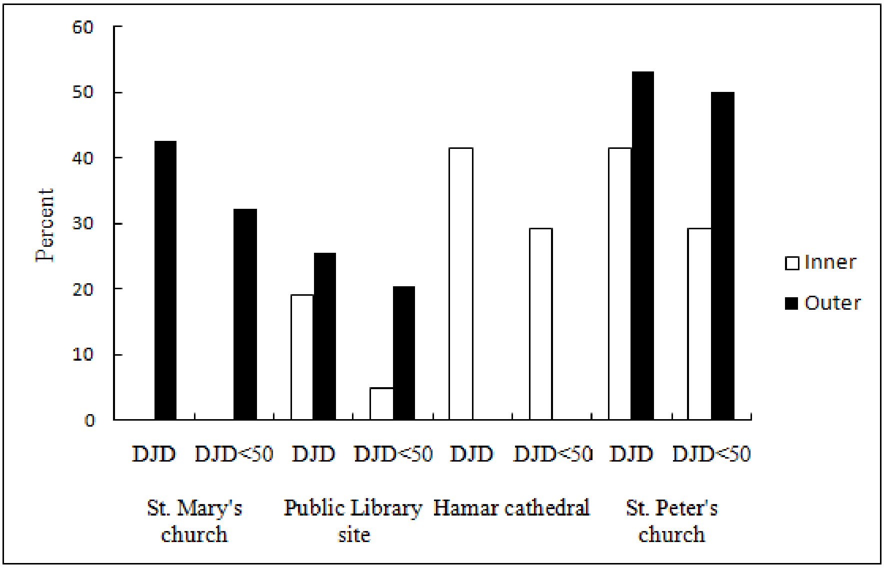


Figure 26. Comparison between the different sites with regard to prevalence for DJD, according to age and burial area.

Table 116. Prevalence for SD for the different graveyards

		Inner	Outer	Total
St. Mary's church	SD		55.9%	
	SD <50 years		47.3%	
Public Library site	SD	34.8%	40.8%	38.9%
	SD <50 years	25.0%	31.0%	29.0%
Hamar cathedral	SD	59.3%		
	SD <50 years	47.8%		
St. Peter's church	SD	64.1%	86.4%	72.1%
	SD <50 years	58.8%	81.0%	67.3%

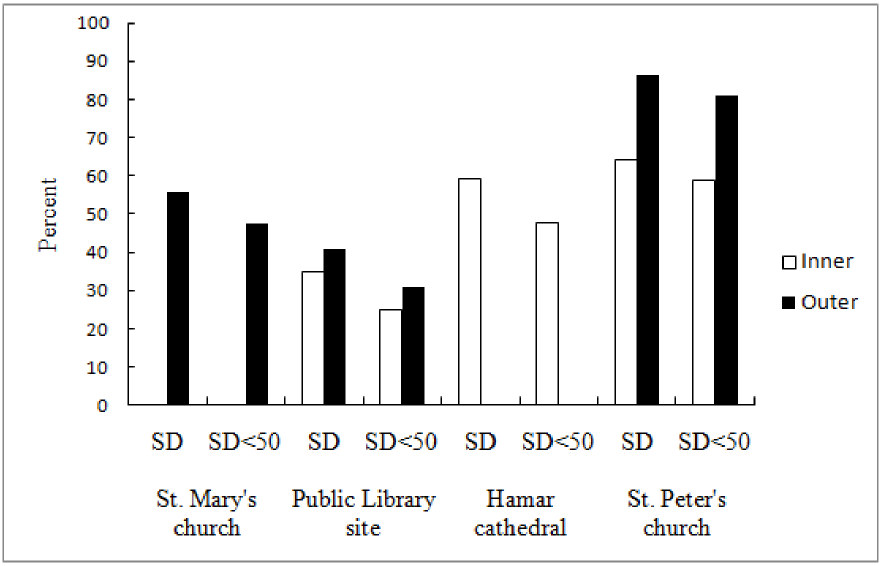


Figure 27. Comparison between the different sites with regard to prevalence for SD, according to age and burial area.

8.5.2 Cribra orbitalia

The occurrence of cribra orbitalia appears to be fairly uniform between the different sites, with a possible exception at the St. Peter's church. While about one in four showed signs of cribra orbitalia at three of the graveyards, only 10% of the skeletons from the St. Peter's church graveyard showed similar changes. A comparison between the inner and outer graveyard halves could only be performed for the Public Library site (this trait could only be examined on 3 of the skeletons from the outer half of the St. Peter's church graveyard and thus, no valid comparisons could be made), but the prevalence is also here greater on the outer half which is in support of social stratification.

8.5.3 Dental conditions

The number of individuals with dental abscesses and ante-mortem tooth loss is fairly similar between the different graveyards. As with the other conditions, the prevalence is also here greater on the outer half of the graveyard. This could, however, only be properly analysed for the Public Library site material as these dental conditions could only be examined on a very small sample from the outer half of the St. Peter's church graveyard and one should be careful drawing conclusions from this material.

The last dental feature which was looked at was enamel hypoplasia. The proportion of individuals with hypoplastic enamel lies between 8% and 10% for the different sites, with the exception of the Public Library site with a prevalence as low as 4%.

8.5.4 The health index

The results of the health index show the same trends as the individual conditions: the index scores are higher on the inner half of the graveyards than on the outer half. This index does not show major differences between the different sites with the scores for all the sites being between 0.84 and 0.87. These scores are in correspondence with the score reported by Kjellström (2005:IV25) for mediaeval Sigtuna in Sweden of 0.83.

8.5.5 Social stratification conclusion

The evidence from the analyses outlined above is all in favour of the mediaeval graveyard being socially stratified. The social differences appear to be related to the distance from the church rather than different sides of the church. At least there is no evidence to suggest social difference between the different sides of the Hamar cathedral, as evident from the analysis of the male skeletons from that site.

8.6 Differences between the sexes

With regard to the degenerative conditions, there is no consistent pattern suggesting that one sex was more affected than the other. The differences in prevalence between the sexes seem more likely to be related to regional differences rather than being related to the sexes as such. The prevalence for DJD is higher for males at the sites in Bergen and Trondheim while higher for women at the sites in Hamar and Tønsberg (figure 28). There are, however, some features which should be pointed out. There is a larger difference between the sexes at the Hamar and Tønsberg sites than for the other sites. With the exception of the site from Bergen, it also appears that the onset of this condition was somewhat earlier for women than for men. As seen in figure 28, there is generally little difference in prevalence according to age for the female groups while the prevalence seems to increase more with age in the male groups. This suggest that more women experienced degerative joint problems earlier than the men and, as discussed above, an early onset of this condition can be related to secondary causes like hard physical labour. This could suggest, in very general terms, a difference in types of work between the sexes with a tendency for women to have more physical labour than men.

The degenerative changes to the spine present a picture where there is generally very little difference between the sexes (figure 29). With the exception of Hamar, the sexes seem to be equally troubled with back problems. The picture drawn from the Hamar material is, however, very different. The prevalence of degenerative changes to the spine is much higher for women than for men: corresponding well to the pattern seen for DJD. The difference between the women and men from the Hamar site is discussed further below.

Another feature which could be interesting to look at with regard to sexual differences is ante-mortem tooth loss: especially the loss of the front teeth. Generally speaking, the teeth which are most prone to be lost ante-mortem are the molars. One contributing factor to this is that the molars are used to grind food more than the other teeth and are therefore more subjected to severe attrition which can lead to the teeth being lost. If the front teeth (the incisors) are lost, it is more likely to have other causes. One reason for lost front teeth is injury. These teeth are handily placed for being knocked out. The incisors can also be lost due to periodontal disease, but then one would expect to see loss of molar and premolar teeth as well. With individuals having lost one or more of their front teeth without significant involvement of other teeth, it can be suggested that the teeth may have been lost due to injury rather than other causes. In this respect, it could be interesting to see if there are sexual differencs. The data from the four sites does not show any real difference between the sexes. From the St. Mary's church graveyard, 4 males and 2 females fit this pattern and at the Public Library site the numbers are 2 males and 1 female. For the Hamar cathedral and the St. Peter's church, the data presents 1 male and 3 females, and 0 males and 1 female respectively. Thus, there is no clear pattern of sexual differences here either.

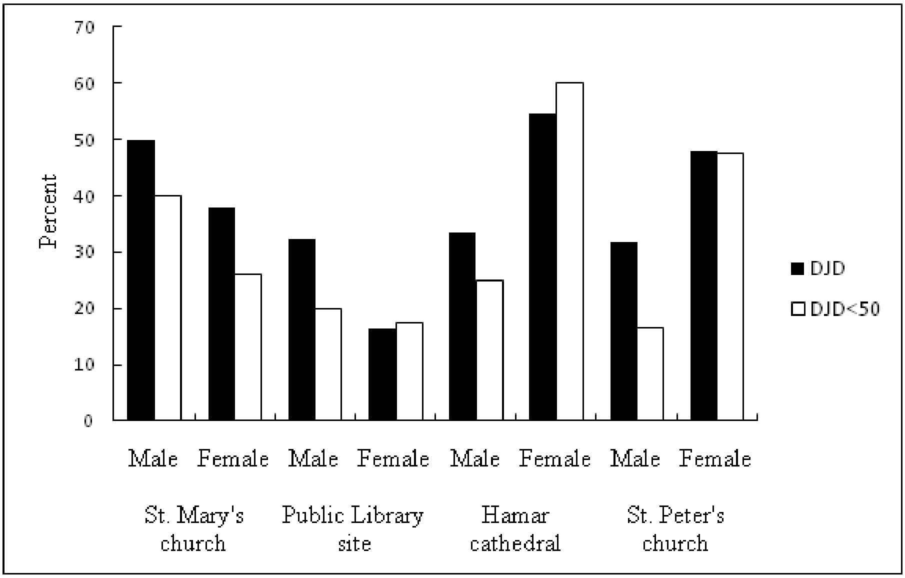


Figure 28. Representation of DJD data according to site, sex and age.

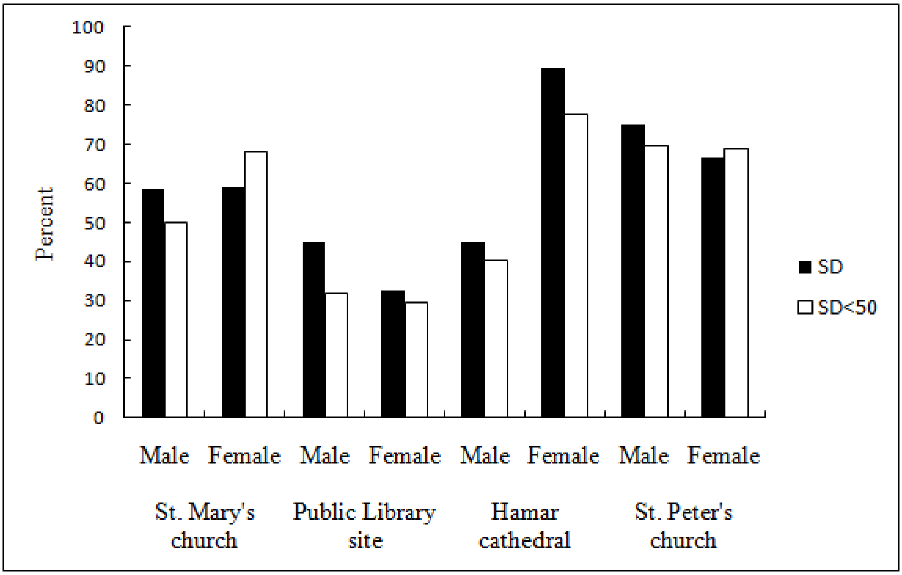


Figure 29. Representation of SD data according to site, sex and age.

8.7 Family plots

The investigation into the possible presence of family plots on these graveyards has not provided any conclusions, but the analyses have rather presented some vague suggestions supporting that family areas were part of the mediaeval graveyard. The distribution of septal apertures on the Public Libray site graveyard and metopic sutures on the graveyard for the Hamar cathedral showed clusters of possibly related individuals which again could represent family plots. The distribution of the non-metric traits did not give any clues about this question for the two other sites.

9. General discussion

This study has produced results which have added new information to the knowledge base for the Norwegian Middle Ages and it has presented new methodology as well as having questioned the validity of previously used methods with regard to determining social differences from skeletal remains.

The first sexually segregated graveyard was detected on Iceland nearly 70 years ago (Steffensen, 1943) and since then, there has been a steady increase in places where these burial practices have been shown to have been carried out. The most recent addition to this group is the site in Varnhem, Sweden (Vretemark, 2009). Up until this point, Norway (situated inbetween areas where this practive has been shown), has been a place where no substantiated claims of sexually segregated graveyards have been made. As discussed above, the topic has been touched upon several times for Norwegian sites but it has generally been concluded that such a practice was not carried out. What this study has shown is that Norway was not that different from the neighbouring countries in this respect as a form of sexual division seems to have been practiced on three of the four graveyards examined. There may be many reasons why these claims have not been made earlier, but a likely factor is that the evidence is fairly well hidden. It has been argued, based on the temporal changes in the Eidsivating law and the evidence from the other segregated graveyards, that the practice of segregating the sexes on graveyard was largely abandoned during the 13th century. All of the four graveyards were in use substantially longer than that and thus, this practice has been hidden by later burials. It has also been shown that the form of sexual division was adapted to local conditions rather than following a strict north-south division as presecribed in the Eidsivating law and this has made it less obvious that a form of sexual segregation was practiced.

That social differences were reflected on the graveyard has been claimed many places (discussed above, chapter 4.2) and different types of evidence have been used to support these claims. Of anthropological characteristics often suggested to distinguish between social classes, stature is the most commonly used (e.g. Cinthio and Boldsen, 1984, Gejvall, 1960, Sellevold, 2001). An individual's stature is partly influenced by nutritional factors and it is thus assumed that the lower classes would have had less chance of reaching their full height potential as they would have had less access to food. In the context of this study, stature has been shown to be a poor indicator of social differences. There is generally little difference in stature between geographical regions and across social boundaries. One reason for the minimal differences in stature can possibly be found by looking at one of the dental features: enamel hypoplasia. Enamel hypoplasia can have many causes but prolonged starvation during childhood will result in this disruption in tooth formation. In the samples examined, less than 10% of the individuals displayed these defects. Some of these may have been the result of starvation but it is just as possible that some have had other causes and thus, the number of individuals having experienced starvation during childhood must have been quite low. This suggests a community where all social levels had access to sufficient amounts of food.

Age is a factor which has a clear correlation with social status in the modern world and this has sometimes been assumed to also be the case in the past. This may, however, not be a good differentator between social groups either. For wealth to result in better health and a longer life, a proper knowledge of disease causation, prevention and treatment is required. This is not likely to have been the case in the Middle Ages. It has actually been shown that the correlation between socioeconomic status and survival was weak as late as at the turn of the 20th century (Preston and Haines, 1991).

The method advocated in this study is more directly related to labour differences between social classes. The assumption is that the lower classes would have had more physically demanding work than the upper classes. Considering this is true, the prevalence of degenerative changes to the skeleton should be higher among the lower classes and the onset of these changes should also be earlier at a lower social level. Thus, if the lower classes were buried further away from the church building than the upper classes, one would expect, not only a greater occurrence of these conditions on the outer areas of the graveyard, but also an increased difference when omitting the oldest age group. This was the theory this project started with. Using this method on the material from the Public Library site and the St. Peter's church, the distribution of the degenerative conditions was as proposed by the theory. This correspondence between theory and practice suggests that this method is functional and on the basis of this method, it has been shown that the graveyards were socially stratified.

9.1 Revisiting representativity

In chapter 3 it was suggested for all of the included graveyards that there was no reason to believe that the material did not give a fair representation of the general population. Looking at the results of this study, it is now appropriate to make some adjustments to two of those statements.

There are a couple of features at the Public Library site which set it apart from the other sites. What is particularly interesting is that the prevalence for the degenerative conditions is markedly lower than for the other graveyards. It has been argued that skeletal degeneration can be a good indicator of social differences. In many ways, skeletal degeneration is a better differentiator between groups of different social standing as it can be directly related to differences in the amount of hard physical labour. The fact that these degenerative changes are much less prevalent in the Public Library site material compared to the other sites, may suggest that this site is different from the others. It could be suggested that the graveyard at the Public Library site was mainly used for members of the upper layers of the social hierarchy. Based on the present evidence, this can only be seen as a suggestion. However, a comparative study of the skeletal material from different contemporary graveyards within mediaeval Trondheim could provide more conclusive answers to whether or not there were social differences between graveyards as well as within graveyards. Social differences between graveyards have also been suggested elsewhere. Kjellström (2005:89) concludes that there were differences between contemporary graveyards in mediaeval Sigtuna, Sweden, which can probably be attributed to social differences.

There are also reasons to suggest that the Hamar cathedral graveyard was not for all members of mediaeval Hamar. Both the sex and age composition of the individuals in the sample buried before 1350 are very unlikely to be a reflection of the general public in Hamar at the time. Firstly, only about one in five people buried there were women, which is not likely to reflect the rest of society. In addition to this, it can be suggested that the women actually buried in this graveyard were not representative of the general female population. These women appear to have been subjected to hard physical labour to a much greater extent than the males buried there. They differ in the same way from the women buried in the other graveyards in this study. The prevalence for both DJD and SD is around twice as high for the women buried at the Hamar cathedral compared to the men. Such a large difference between the sexes is not found on the other sites. Judging from the other sites, there is no reason to suggest that women were more prone to skeletal degeneration than men as a general rule, but this is definitely the case at the Hamar cathedral. Comparing these Hamar women to the women from the other sites, it is seen that the occurrence of these conditions is clearly higher at the Hamar site. Especially the SD prevalence of around 90% is strikingly high. The question then is who were these women?

A burial composition with a low number of women and young children could suggest that a graveyard was mainly used for the ecclesiastical community (Sellevold, 2001:227), and that is a fair description of the composition of the people buried in this graveyard before 1350. The fact that Sellevold concludes differently, suggesting that the graveyard was used by the wider public, although probably restricted to the upper layers of society, is possibly due to differences in sampling between this study and hers. While this study has been mainly concerned with the individuals buried during the first 200 years of the graveyard's existence, Sellevold (2001) studied the whole sample from the graveyard's nearly 400 years history. Thus, it is possible that the Hamar cathedral graveyard initially was reserved for the ecclesiastical community, but was later opened up for a wider part of the public.

Getting back to the question of who these women were, these women who appear to have been carrying out back breaking work and been subjected to hard physical labour to a much greater extent than the males. Could these women have been servants in the bishop's household, women working on the farms connected to the church? Whoever they were, these women were hard labouring individuals.

9.2 Practice vs. legislation

The starting point for this study, were the burial regulations found in the Norwegian mediaeval ecclesiastical legislation. In short, the laws stated the sex, social position and possibly family relations should be determining factors when deciding where on the graveyard an individual should be buried. The regulation regarding the sexual division of the graveyard is given in the Eidsivating law and states clearly that women should be buried north of the church and men to the south. It can be confidently concluded that this regulation was not strictly followed as the only place where this seems to have been practiced was on the graveyard for the St. Peter's church in Tønsberg; although, it has not been possible to prove that this was strictly followed here either. The evidence, however, does not suggest that the sexes were treated equally. For three of the sites (Public Library site, Hamar cathedral, St. Peter's church), it is clear that the sex of an individual could determine the burial location of that individual. These three sites show three different approaches to the sexual segregation and thus, it looks like the organisation of the sexual segregation was adapted to the individual graveyard. There is, however, no evidence that the graveyard for the St Mary's church in

Bergen was ever sexually segregated, so it does not look like sexual segregation was applied on every graveyard.

The question of social stratification could only be properly investigated for two of the sites (The Public library site and the St. Peter's church) but the evidence from both sites points in the direction that social differences were reflected on the graveyard with the upper classes being buried closer to the church building than the lower classes.

10. Final conclusions

This study set out to shed some light on the burial practices carried out in early Christian Norway, and has through the examination of the skeletal material and detailed analysis of the skeletal data shown that sex, social status, and, to some extent, age, were factors determining an individual's placement on the graveyard.

It has been shown that the sexes were not treated equally on three of the four graveyards: there was no evidence suggesting that the sexes were ever segregated on the graveyard for the St. Mary's church in Bergen. It has also become apparent that the separation of the sexes was adapted to the individual graveyard and did not necessarily follow the north-south division prescribed in the Eidsivating law and a pattern which has been shown on many graveyards in Sweden, Denmark, Iceland and Greenland.

It has been argued that pathological conditions, especially degenerative changes to the joints and vertebrae, can be good indicators of social differences. Based on the distribution of these pathological conditions, evidence has been presented in favour of the graveyards having been socially stratified. It seems very likely that an individual's social status decided that person's placement on the graveyard at the Public Library site in Trondheim and for the St. Peter's church in Tønsberg. Social differences could not be properly investigated for the two other sites in this study.

With the exception of the youngest children, it seems like an individual's age had little influence on burial placement. It has, however, been shown that the youngest children generally were buried within a relatively short distance from the church building.

On a methodological note, it has been argued that the use of stature as a social indicator may not be accurate. Stature has often been used for this purpose but this study has shown that there was very little difference in stature between social groups and geographical regions in mediaeval Norway. Thus, it has been suggested that one should be careful with using stature for this purpose as there does not seem to be a strong correlation between an individual's height and social standing.

In addition to presenting some answers to the main questions in this study, regarding burial practices, this research has also provided information which can give a picture of the mediaeval society. Generally speaking, it appears to have been a society with social differences and a society where men and women were treated differently (at least in a burial context). This is not very surprising, to the author's knowledge, no one has ever proposed that the mediaeval society was a society with total equality. What is more noteworthy is perhaps the lack of differences in some respects. The low number of individuals with hypoplastic enamel suggests that starvation was not a big problem in the communities represented by these graveyards. Enamel hypoplasia can have many causes but prolonged starvation is likely to result in this disruption in tooth formation. In the samples examined, less than 10% of the individuals displayed these defects. Some of these may have been the result of starvation but it is just as possible that some have had other causes and thus, the number of individuals having experienced starvation during childhood must have been quite low. This suggests a community where all social levels had access to sufficient amounts of food. There may, however, still have been social differences with regard to food. Kjellström et al. (2005) showed that the upper classes had a more animal based diet as opposed to a diet with a higher content of vegetables among the lower classes, and such a distinction between social levels could also have been present in the communities in this study.

This has been a study into the mediaeval past, primarily based on the examination and analysis of human skeletal remains. It is clear that such a study can provide a lot of information about people and society and should generally be an important component in any study into the past. Combining the osteological information with information from other archaeological sources, historical sources and information provided by the natural sciences has an even better potential for gaining accurate knowledge of the past, and true indisciplinary studies should be encouraged.

References

ALBANESE, J. 2003. A metric method for sex determination using the hipbone and the femur. *Journal of Forensic Sciences,* 48.

ANDERSON, T. & GÖTHBERG, H. 1986. Fortiden i Trondheims bygrunn: Folkebibliotekstomten. Olavskirkens kirkegård. Human-osteologisk analyse og faseinndeling. *Meddelelser.* Trondheim: Riksantikvaren, utgravningskontoret for Trondheim.

AUFDERHEIDE, A. C. & RODRIGUEZ-MARTIN, C. 1998. *The Cambridge Encyclopedia of Human Paleopathology,* Cambridge, Cambridge University Press.

BACH, H. 1965. Zur Berechnung der Körperhöhe aus den langen Gliedmassenknochen weiblicher Skelette. *Anthropologischer Anzeiger,* 29**,** 12-21.

BAHN, P. 1992. Collins Dictionary of Archaeology. *In:* BAHN, P. (ed.) *Collins Dictionary of Archaeology.* Glasgow: Harper Collins Publishers.

BAINBRIDGE, D. & TARAZAGA, S. G. 1956. A study of sex differences in the scapula. *The Journal of the Royal Anthropological Institute of Great Britain and Ireland,* 86**,** 109-134.

BELLO, S. & ANDREWS, P. 2006. The intrinsic pattern of preservation of human skeletons and its influence on the interpretation of funerary behaviours. *In:* GOWLAND, R. & KNÜSEL, C. (eds.) *Social Archaeology of Funerary Remains.* Oxford: Oxbow Books.

BELLO, S. M., THOMANN, A., SIGNOLI, M., DUTOUR, O. & ANDREWS, P. 2006. Age and sex bias in the reconstruction of past population structures. *American Journal of Physical Anthropology,* 129**,** 24-38.

BENNIKE, P. 1985. *Paleopathology of Danish Skeletons: A Comparative Study of Demograpgy, Disease and Injury,* Copenhagen, Akademisk Forlag.

BERG, G. E. 2008. Pubic bone age estimation in adult women. *Journal of Forensic Sciences,* 53**,** 569-577.

BERRIZBEITIA, E. L. 1989. Sex determination with the head of the radius. *Journal of Forensic Sciences,* 34**,** 1206-1213.

BIDMOS, M. A. 2008. Stature reconstruction using fragmentary femora in South Africans of European descent. *Journal of Forensic Sciences,* 53**,** 1044-1048.

BLOHME, M. & RUNEBY, C. 1986a. Innberetning over de Arkeologiske Utgravningene i Øvre Langgate 65/67, Tønsberg, 1985. Del 1: Tekst. Tønsberg: Riksantikvaren, Utgravningskontoret for Tønsberg.

BLOHME, M. & RUNEBY, C. 1986b. Innberetning over de Arkeologiske Utgravningene i Øvre Langgate 65/67, Tønsberg, 1985. Del 2: Illustrasjoner. Tønsberg: Riksantikvaren, Utgravningskontoret for Tønsberg.

BOAZ, N. T. & BEHRENSMEYER, A. K. 1976. Hominid taphonomy: transport of human skeletal parts in an artificial fluviatile environment. *American Journal of Physical Anthropology,* 45**,** 53-60.

BRENDALSMO, A. J. 1989. Peterskirken, dens kirkegård og det eldste Tønsberg. *Arkeologiske rapporter fra Tønsberg.* Tønsberg: Riksantikvaren, utgravningskontoret for Tønsberg.

BRIDGES, P. S. 1992. Prehistoric arthritis in the Americas. *Annual Review of Anthropology,* 21**,** 67-91.
BROBERG, A. 1990. Bönder och samhälle i stadsbildningstid. *Upplands Fornminnesförenings Tidskrift,* 52.
BROOKS, S. & SUCHEY, J. M. 1990. Skeletal age determination based on the os pubis: A comparison of the Acsádi-Nemeskéri and Suchey-Brooks methods. *Human Evolution,* 3**,** 227-238.
BROTHWELL, D. R. 1981. *Digging up Bones. The Excavation, Treatment and Study of Human Skeletal Remains,* London, Oxford University Press.
BRUZEK, J. 2002. A method for visual determination of sex, using the human hip bone. *American Journal of Physical Anthropology,* 117**,** 157-168.
BUCKBERRY, J. 2000. Missing, presumed buried? Bone diagenesis and the under-representation of Anglo-Saxon children. Available: http://www.assemblage.group.shef.ac.uk/5/buckberr.html [Accessed 21.09.2010].
BUCKBERRY, J. L. & CHAMBERLAIN, A. T. 2002. Age estimation from the auricular surface of the ilium: A revisited method. *American Journal of Physical Anthropology,* 119**,** 231-239.
BUIKSTRA, J. E. & UBELAKER, D. H. 1994. *Standards for Data Collection from Human Skeletal Remains*, Arkensas Archaeological Survey Research Series.
CHRISTOPHERSEN, A. 1994. Strete, havn og kirkegård. *In:* CHRISTOPHERSEN, A. & NORDEIDE, S. W. (eds.) *Kaupangen ved Nidelva.* Trondheim: Riksantikvaren.
CHRISTOPHERSEN, A., JONDELL, E., MARSTEIN, O., NORDEIDE, S. W. & REED, I. W. 1988. Fortiden i Trondheim bygrunn: Folkebibliotekstomtem. Utgravning, kronologi og bebyggelsesutvikling. *Meddelelser.* Trondheim: Riksantikvaren, Utgravningskontoret for Trondheim.
CHRISTOPHERSEN, A. & NORDEIDE, S. W. 1994. *Kaupangen ved Nidelva,* Trondheim, Riksantikvaren.
CINTHIO, H. & BOLDSEN, J. 1984. Patterns of distribution in the early medieval cemetery at Löddeköpinge. *Meddelanden från Lunds Universitets Historiska Museum 1983-1984.* Lund: Lunds Universitets Historiska Museum.
CLAASSEN, C. (ed.) 1992. *Exploring Gender Through Archaeology. Selected papers from the 1991 Boone Conference,* Boone: Prehistory Press.
COX, M., FLAVEL, A., HANSON, I., LAVER, J. & WESSLING, R. (eds.) 2008. *The Scientific Investigation of Mass Graves. Towards Protocols and Standard Operating Procedures,* New York: Cambridge University Press.
CUTRESS, T. W. & SUCKLING, G. W. 1982. The assessment on non-carious defects of enamel. *International Dental Journal,* 32**,** 117-122.
DAVIN, E. L. 1993. The era of the common child: Egalitarian death in antebellum America. *Mid America,* 75**,** 135-163.
DEMIRBAG, D., OZDEMIR, F., KOKINO, S. & BERKARDA, S. 2005. The relationship between bone mineral density and immobilization duration in hemiplegic limbs. *Annals of Nuclear Medicine,* 19**,** 695-700.
DORANDEU, A., COULIBALY, B., PIERCECCHI-MARTI, M.-D., BARTOLI, C., GAUDART, J., BACCINO, E. & LEONETTI, G. 2008. Age-at-death estimation based on the study of frontsphenoidal sutures. *Forensic Science International,* 177**,** 47-51.

DUPERTUIS, C. W. & HADDEN, J. A. 1951. On the reconstruction of stature from long bones. *American Journal of Physical Anthropology,* 9**,** 15-54.

DURIC, M., RAKOCEVIC, Z. & DONIC, D. 2005. The reliability of sex determination of skeletons from forensic centext in the Balkans. *Forensic Science International,* 147**,** 159-164.

EBENESERDOTTIR, S. S., SIGURDSSON, A., SANCHEZ-QUINTO, F., LALUEZA-FOX, C., STEFANSSON, K. & HELGASON, A. 2010. A new subclade of mtDNA haplogroup C1 found in Icelanders: Evidence of pre-Columbian contact? *American Journal of Physical Anthropology*.

EFREMOV, J. A. 1940. Taphonomy: New branch of paleontology. *Pan-American Geologist,* LXXIV**,** 81-93.

FALSETTI, A. B. 1995. Sex assessment from metacarpals of the human hand. *Journal of Forensic Sciences,* 40**,** 774-776.

FALYS, C. G., SCHUTKOWSKI, H. & WESTON, D. A. 2006. Auricular surface aging: Worse than expected? A test of the revised method on a documented historic skeletal assemblage. *American Journal of Physical Anthropology,* 130**,** 508-513.

FERNÁNDEZ COMACHO, F. J., GÓMEZ PELLICO, L. & FERNÁNDEZ-VALENCIA RODRÍGUES, R. 1993. Osteometry of the human iliac crest: Patterns of normality and its utility in sexing human remains. *Journal of Forensic Sciences,* 38**,** 779-787.

FLANDER, L. B. 1978. Unvariate and multivariate methods for sexing the sacrum. *American Journal of Physical Anthropology,* 49**,** 103-110.

FLODIN, L., GERMER, P. & LINDH, J. 1986. Innberetning over de Arkeologiske Utgravningene i Øvre Langgate 57/59, Tønsberg, 1982. Tønsberg: Riksantikvaren, Utgravningskontoret for Tønsberg.

FLODIN, L. & RUNEBY, C. 1986a. Innberetning over de Arkeologiske Utgravningene i Tollbodgaten 9-11, Øvre Langgate 65, Tønsberg, 1983. Del 1: Tekst. Tønsberg: Riksantikvaren, Utgravningskontoret for Tønsberg.

FLODIN, L. & RUNEBY, C. 1986b. Innberetning over de Arkeologiske Utgravningene i Tollbodgaten 9-11, Øvre Langgate 65, Tønsberg, 1983. Del 2: Illustrasjoner. Tønsberg: Riksantikvaren, Utgravningskontoret for Tønsberg.

FORSÅKER, A.-L. & GÖTHBERG, H. 1986. Fortiden i Trondheim Bygrunn: Folkebibliotekstomten. Stratigrafisk Analyse, Delfelt FJ, FN og FW. *Meddelelser.* Trondheim: Riksantikvaren, Utgravningskontoret for Trondheim.

FULLY, G. 1960. Une nouvelle méthode de détermination de la taille. *Annales de Médicine Légale,* 36**,** 266-273.

FULLY, G. & PINEAU, H. 1956. Détermination de la stature au moyen du squelette. *Annales de Médicine Légale,* 36**,** 266-273.

GALERA, V., UBELAKER, D. H. & HAYEK, L.-A. C. 1998. Comparison of macroscopic cranial methods of age estimation applied to skeletons from the Terry collection. *Journal of Forensic Sciences,* 43**,** 933-939.

GARN, S. 1970. *The Earlier Gain and the Later Loss of Cortical Bone,* Springfield, Charles C. Thomas.

GEJVALL, N.-G. 1960. *Westerhus. Medieval Population and Church in the Light of Skeletal Remains,* Lund, Håkan Ohlssons Boktryckeri.

GELLER, P. L. 2005. Skeletal analysis and theoretical complications. *World Archaeology,* 37**,** 597-609.
GILES, E. 1964. Sex determination by discriminant function analysis of the mandible. *American Journal of Physical Anthropology,* 22**,** 129-136.
GILL-KING, H. 1997. Chemical and ultrastructural aspects of decomposition. *In:* HAGLUND, W. D. & SORG, M. H. (eds.) *Forensic Taphonomy: The Postmortem Fate of Human Remains.* Boca Raton: CRC Press.
GILL, G. W. 1998. Craniofacial criteria in the skeletal attribution of race. *In:* REICHS, K. J. (ed.) *Forensic Osteology. Advances in the Identification of Human Remains.* Springfield: Charles C Thomas.
GIROUX, C. L. & WESCOTT, D. J. 2008. Stature estimation based on dimensions of the bony pelvis and proximal femur. *Journal of Forensic Sciences,* 53**,** 65-68.
GORDON, C. C. & BUIKSTRA, J. E. 1981. Soil pH, bone preservation, and sampling bias at mortuary sites. *American Antiquity,* 46**,** 566-571.
GOWLAND, R. & KNÜSEL, C. J. 2006. Introduction. *In:* GOWLAND, R. & KNÜSEL, C. (eds.) *Sicial Archaeology of Funerary Remains.* Oxford: Oxbow Books.
GRAW, M., CZARNETZKI, A. & HAFFNER, H.-T. 1999. The form of the supraorbital margin as a criterion in identification of sex from the skull: Investigations based on modern human skulls. *American Journal of Physical Anthropology,* 108**,** 91-96.
GUTHRIE, R. D. 1967. Differential preservation and recovery of pleistocene large mammal remains in Alaska. *Journal of Paleontology,* 41**,** 243-246.
GUY, H., MASSET, C. & BAUD, C.-A. 1997. Infant taphonomy. *International Journal of Osteoarchaeology,* 7**,** 221-229.
HAGLUND, W. D. 1997a. Dogs and coyotes: postmortem involvement with human remains. *In:* HAGLUND, W. D. & SORG, M. H. (eds.) *Forensic Taphonomy: The Postmortem Fate of Human Remains.* Boca Raton: CRC Press.
HAGLUND, W. D. 1997b. Rodents and human remains. *In:* HAGLUND, W. D. & SORG, M. H. (eds.) *Forensic Taphonomy: The Postmortem Fate of Human Remains.* Boca Raton: CRC Press.
HAMLIN, A. & FOLEY, C. 1983. A women's graveyard at Carrickmore, County Tyrone, and the separate burial of women. *Ulster Journal of Archaeology,* 46**,** 41-46.
HANSEN, G. 1994. *Den Overordnede Bebyggelsestopografi Omkring 1190 i Bergen. Belyst ut fra Arkæologiske, Naturtopografiske og Skriftlige Kilder* Bergen, Riksantikvaren Utgravningskontoret for Bergen.
HANSEN, G. 2005. *Bergen c800-c1170. The Emergence of a Town,* Bergen, Fagbokforlaget.
HELLE, K. 1982. *Bergen Bys Historie. Kongssete og Kjøpstad, fra Opphavet til 1536,* Bergen, Universitetsforlaget.
HERTEIG, A. E. 1990a. *The Buildings at Bryggen. Their Topographical and Chronological Development,* Bergen, Norwegian University Press.
HERTEIG, A. E. 1990b. *The Buildings at Bryggen. Their Topographical and Chronological Development. Plates,* Bergen, Norwegian University Press.
HOLCK, P. 1989. Skjelettmaterialet fra Peterskirken, Tønsberg. Oslo: University of Oslo.

HOLLAND, T. D. 1991. Sex assessment using the proximal tibia. *American Journal of Physical Anthropology,* 85**,** 221-227.

HOLLAND, T. D. 1995. Estimation of adult stature from the calcaneus and talus. *American Journal of Physical Anthropology,* 96**,** 315-320.

HOLMAN, D. J. & BENNET, K. A. 1991. Determination of sex from arm bone measurements. *American Journal of Physical Anthropology,* 84**,** 421-426.

HOWELLS, W. W. 1989. *Skull Shapes and the Map. Craniometric Analyses in the Dispersion of Modern Homo,* Cambridge, Massachusetts, Harvard University Press.

INTRONA, F., DI VELLA, G. & CAMPOBASSO, C. P. 1998. Sex determination by discriminant analysis of patella measurements. *Forensic Science International,* 95**,** 39-45.

INTRONA, F., DI VELLA, G., CAMPOBASSO, C. P. & DRAGONE, M. 1997. Sex determination by discriminant analysis of calcanei measurements. *Journal of Forensic Sciences,* 42**,** 725-728.

ISCAN, M. Y. & DERRICK, K. 1984. Determination of sex from the sacroiliac joint: A visual assessment technique. *Social Sciences,* 47**,** 94-98.

JONSSON, K. 2009. *Practices for the Living and the Dead. Medieval and Post-Reformation Burials in Scandinavia.* PhD, Stockholm University.

KARLBERG, I. 1992. *Tidens Tann og Tidens Tenner.* Magister, University of Oslo.

KEMKES-GROTTENTHALER, A. 2005. Sex determination by discriminant analysis: An evaluation of the reliability of patella measurements. *Forensic Science International,* 147**,** 129-133.

KIEFFER-OLSEN, J. 1993. *Grav og gravskikk i det middelalderlige Danmark: 8 kirkegårdsudgravninger.* PhD, Aarhus University.

KIMMERLE, E. H., KONIGSBERG, L. W., JANTZ, R. L. & BARAYBAR, J. P. 2008. Analysis of age-at-death estimation through the use of pubic symphyseal data. *Journal of Forensic Sciences,* 53**,** 558-568.

KJELLSTRÖM, A. 2005. *The Urban Farmer. Osteoarchaeological Analysis of Skeletons from Medieval Sigtuna Interpreted in a Socioeconomic perspective.* PhD, Stockholm University.

KJELLSTRÖM, A., STORÅ, J. & POSSNERT, G. 2005. Dietary patterns and social structures in medieval Sigtuna, Sweden, as reflected in stable isotope and trace element values in human skeletal remains. *The Urban Farmer. Osteoarchaeological Analysis of Skeletons from Medieval Sigtuna Interpreted in a Socioeconomic perspective.* Stockholm: Stockholm University.

KLIPPEL, W. E. & SYNSTELIEN, J. A. 2007. Rodents as taphonomic agents: Bone gnawing by brown rats and gray squirrels. *Journal of Forensic Sciences,* 52**,** 765-773.

KOCH, H. D. 1992. Utgravninger ved Hamar Domkirkeruin 1991. Innberetning (foreløpig manuskript) Oslo 1992. Oslo: Universitetets Oldsaksamling.

KONIGSBERG, L. W. & HENS, S. M. 1998. Use of ordinal categorical varables in skeletal assessment of sex from the cranium *American Journal of Physical Anthropology,* 107**,** 97-112.

KONIGSBERG, L. W., HERRMANN, N. P., WESCOTT, D. J. & KIMMERLE, E. H. 2008. Estimation and evidence in forensic anthropology: Age-at-death. *Journal of Forensic Sciences,* 53**,** 541-557.

KRANE, S. M. & HOLICK, M. F. 1991. Metabolic bone disease. *In:* WILSON, J. D., BRAUNWALD, E. & ISSELBACHER, K. J. (eds.) *Harrison's Principles of Internal Medicine.* New York: McGraw-Hill.

KROGH, K. J. 1967. *Erik den Rødes Grønland,* Odense, Nationalmuseet.

KRONENBERG, H. M. 1993. Parathyroid hormone: Mechanism of action. *In:* FAVUS, M. J. (ed.) *Primer on the Metabolic Bone Disease Disorders of Mineral Metabolism.* New York: Raven Press.

KUNOS, C. A., SIMPSON, S. W., RUSSELL, K. F. & HERSHKOVITZ, I. 1999. First rib metamorphosis: Its possible utility for human age-at-death estimation. *American Journal of Physical Anthropology,* 110**,** 303-323.

LAMENDIN, H., BACCIANO, E., HUMBERT, J. F., TAVERNIER, J. C., NOSSINTCHOUK, R. M. & ZERILLI, A. 1992. A simple technique for age estimation in adult corpses: The two criteria dental method. *Journal of Forensic Sciences,* 37**,** 1373-1379.

LANDRO, T. 2005. *Dei Eldste Norske Kristenrettane Innhald og Opphav.* Hovedoppgave, University of Bergen.

LANDRO, T. 2010. *Kristenrett og Kyrkjerett. Borgartingsretten i et Komparativt Perspektiv.* PhD, University of Bergen.

LARSEN, C. S. 1999. *Bioarchaeology. Interpreting Behavior from the Human Skeleton* Cambridge, Cambridge University Press.

LÁRUSSON, M. M. 1965. Leysingi. *Kulturhistorisk Leksikon for Nordisk Middelalder.* København: Rosenkilde og Bagger.

LAZENBY, R. A. 1994. Identification of sex from metacarpals: Effect of side asymmetry. *Journal of Forensic Sciences,* 39**,** 1188-1194.

LEACH, S., ECKARDT, H., CHENERY, C., MÜLDNER, G. & LEWIS, M. 2010. A lady of York: migration, ethnicity and identity in Roman Britain. *Antiquity,* 84**,** 131-145.

LIDÉN, H.-E. 2000. *Mariakirken i Bergen,* Bergen, Mangschou.

LIDÉN, H. E. & MAGERØY, E. M. 1990. *Norges kirker, Bergen. Bind III,* Oslo, Norske Minnesmerker.

LINDEN, F. P. G. M. V. D. & DUTERLOO, H. S. 1976. *Development of the human dentition: an atlas,* Hagerstown, Md., Harper & Row.

LIVERSIDGE, H. M. 1994. Accuracy of age estimation from developing teeth of a population of known age (0-5.4 years). *International Journal of Osteoarchaeology,* 4**,** 37-45.

LIVERSIDGE, H. M., CHAILLET, N., MÖRNSTAD, H., NYSTRÖM, M., ROWLINGS, K., TAYLOR, J. & WILLEMS, G. 2006. Timing of Demirjian's tooth formation stages. *Annals of Human Biology,* 33**,** 454-470.

LORVIK, K. 2007. *Life and Death in the Early Town.* MA, Bergen University.

LORVIK, K. 2009. Life and death in the early town. An osteoarchaeological study of the human skeletal remains from St Mary's churchyard, Bergen. *In:* ØYE, I. (ed.) *Osteoarchaeological Analyses From Medieval Bergen.* Bergen: Fagbokforlaget.

LOTH, S. R. & HENNEBERG, M. 1996. Mandibular ramus flexure: A new morphologic ndicator of sexual dimorphism in the human skeleton. *American Journal of Physical Anthropology,* 99**,** 473-485.
LOTH, S. R. & HENNEBERG, M. 2001. Sexually dimorphic mandibular morphology in the first few years of life. *American Journal of Physical Anthropology,* 115**,** 179-186.
LOVEJOY, C. O., MEINDL, R. S., PRYZBECK, T. R. & MENSFORTH, R. P. 1985. Chronological metamorphosis of the auricular surface of the ilium: A new method for for the determination of adult skeletal age. *American Journal of Physical Anthropology,* 68**,** 15-28.
LUO, Y.-C. 1995. Sex determination from the pubis by discriminant function analysis. *Forensic Science International,* 74**,** 89-98.
LYNNERUP, N., SCHULZ, M., MADELUNG, A. & GRAW, M. 2006. Diameter of the human internal acoustic meatus and sex determination. *International Journal of Osteoarchaeology,* 16**,** 118-123.
MACLAUGHLIN, S. M. & BRUCE, M. F. 1986. The sciatic notch/acetabular index as a discriminator of sex in European skeletal remains. *Journal of Forensic Sciences,* 31**,** 1380-1390.
MANN, R. W., SYMES, S. A. & BASS, W. M. 1987. Maxillary suture obliteration: Aging the human skeleton based on intact of fragmentary maxilla. *Journal of Forensic Sciences,* 32**,** 148-157.
MARTIN, R. B. 2002. Size, structure and gender: Lessons about fracture risk. *Journal of Musculoskeletal & Neuronal Interactions,* 2**,** 209-211.
MEINDL, R. S. & LOVEJOY, C. O. 1985. Ectocranial suture closure: A revised method for the determination of skeletal age at death based on the lateral-anterior sutures. *American Journal of Physical Anthropology,* 68**,** 57-66.
MEINDL, R. S., LOVEJOY, C. O., MENSFORTH, R. P. & WALKER, R. A. 1985. A revised method of age determination using the os pubis, with a review and tests of accuracy of other current methods of pubic symphyseal aging. *American Journal of Physical Anthropology,* 68**,** 29-45.
MILLER, K. W. P., WALKER, P. L. & O'HALLORAN, R. L. 1998. Age and sex-related variation in hyoid bone morphology. *Journal of Forensic Sciences,* 43**,** 1138-1143.
MOLLESON, T. & CRUSE, K. 1998. Some sexually dimorphic features of the human juvenile skull and their value in sex determination in immature skeletal remains. *Journal of Archaeological Science,* 25**,** 719-128.
MUSGRAVE, J. H. & HARNEJA, N. K. 1978. The estimation of adult stature from metacarpal bone length. *American Journal of Physical Anthropology,* 48**,** 113-120.
NILSSON, B. 1989. *De Sepulturis. Gravrätten i Corpus iuris Canonici och i Medeltida Nordisk Lagstiftning,* Stockholm, Almqvist & Wiksell International.
NORDEIDE, S. W. 1997. St. Olavs by. *In:* CHRISTOPHERSEN, A. (ed.) *Fra Nidarnes til Trondheim. Vandringer i et Bylandskap.* Trondheim: NINA-NIKU.
NORDEIDE, S. W. 2011. *The Viking Age as a Period of Religious Transformation. The Christianization of Norway from AD 560 to 1150/1200*, Brepols.

O'SULLIVAN, J., CARTER, S., DIXON, D., LORIMER, D. & TURNBULL, G. 1994. Excavation of an early church and a women's cemetery at St Ronan's medieval parish church, Iona. *Proceedings of the Society of Antiquaries of Scotland* 124**,** 327-365.

OPSAHL, E. 2003. Del I. 900-1537. *In:* KJELSTADLI, K. (ed.) *Norsk Innvandringshistorie.* Oslo: Pax Forlag.

PARSONS, F. G. & BOX, C. R. 1905. The relation of the cranial sutures to age. *The Journal of the Royal Anthropological Institute of Great Britain and Ireland,* 35**,** 30-38.

PEDERSEN, E. A. 1994. Utgravningene ved Hamar Domkirkeruin 1992. Innberetning (foreløpig manuskript) november 1994 Oslo: Universitetets Oldsaksamling.

PHENICE, T. W. 1969. A newly developed visual method of sexing the os pubis *American Journal of Physical Anthropology,* 30**,** 297-301.

PRESTON, S. H. & HAINES, M. R. 1991. *Fatal Years: Child Mortality in Late Nineteenth Century America,* New Jersey, Princeton University Press.

PRINCE, D. A., KIMMERLE, E. H. & KONIGSBERG, L. W. 2008. A bayesian approach to estimate skeletal age-at-death utilizing dental wear. *Journal of Forensic Sciences,* 53**,** 588-593.

PRINCE, D. A. & KONIGSBERG, L. W. 2008. New formulae for estimating age-at-death in the Balkans utilizing Lamendin's dental technique and bayesian analysis. *Journal of Forensic Sciences,* 53**,** 578-587.

PURKAIT, R. 2001. Measurements of ulna - A new method for determination of sex. *Journal of Forensic Sciences,* 46**,** 924-927.

PURKAIT, R. 2005. Triangle identified at the proximal end of femur: A new sex determinant. *Forensic Science International,* 147**,** 135-139.

RAISZ, L. G. 1982. Osteoporosis. *Journal of the American Geriatrics Society,* 30**,** 127-138.

RAUCH, F. & SCHOENAU, E. 2001. Changes in bone density during childhood and adolescence: An approach based on bone's biological organization. *Journal of Bone and Mineral Research,* 16**,** 597-604.

RAXTER, M. H., AUERBACH, B. M. & RUFF, C. B. 2006. Revision of the Fully technique for estimating statures. *American Journal of Physical Anthropology,* 130**,** 374-384.

REESINK, E. M., VAN IMMERSEEL, A. A. H., BRAND, R. & BRUINTJES, T. D. 1999. Sexual dimorphism of the hyoid bone? *International Journal of Osteoarchaeology,* 9**,** 357-360.

RIISØY, A. I. & SPØRCK, B. D. 2000. Dateringen av nyere Borgartings kristenretter. *Collegium Medievale,* 12**,** 57-74.

RINDAL, M. 1995. Dei norske mellomalderlovene. Alder, overlevering, utgåver. *In:* RINDAL, M. (ed.) *Skriflege Kjelder til Kunnskap om Nordisk Mellomalder.* Oslo: Norges Forskningsråd.

RINDAL, M. 2004. Dei eldste norske kristenrettane. *In:* SIGURDSSON, J. V., MYKING, M. & RINDAL, M. (eds.) *Religionsskiftet i Norden. Brytinger Mellom Nordisk og Europeisk kultur 800-1200 e. Kr.* Oslo: Senter for Studier i Vikingtid og Nordisk Middelalder.

RISAN, T. 1998. *Skjelettmaterialet fra Domkirkeodden. Kristenrett, Stand, Kjønn og Plassering av Døde på Middelalderens Domkirkegård på Hamar.* Hovedfag, University of Oslo.

ROBERTS, C. & MANCHESTER, K. 1999. *The Archaeology of Disease,* New York, Sutton Publishing Limited.

ROBLING, A. G. & UBELAKER, D. H. 1997. Sex estimation from the metatarsals. *Journal of Forensic Sciences,* 42**,** 1062-1069.

RODRIGUEZ, W. C. 1997. Decomposition of buried and submerged bodies. *In:* HAGLUND, W. D. & SORG, M. H. (eds.) *Forensic Taphonomy: The Postmortem Fate of Human Remains.* Boca Raton: CRC Press.

ROGERS, T. & SAUNDERS, S. 1994. Accuracy of sex determination using morphological traits of the human pelvis. *Journal of Forensic Sciences,* 39**,** 1047-1056.

ROGERS, T. L. 1999. A visual method of determining the sex of skeletal remains using the distal humerus. *Journal of Forensic Sciences,* 44**,** 57-60.

SAFONT, S., MALGOSA, A. & EULÀLIA, S. M. 2000. Sex assessment on the basis of long bone circumference. *American Journal of Physical Anthropology,* 113**,** 317-328.

SCHEUER, L. & BLACK, S. 2000. *Developmental Juvenile Osteology,* London, Academic Press.

SCHIEBINGER, L. 1986. Skeletons in the closet: The first illustrations of the female skeleton in eighteenth-century anatomy. *Representations,* 14**,** 42-82.

SCHIWY-BOCHAT, K.-H. 2001. The roughness of the supranasal region - A morphological sex trait. *Forensic Science International,* 117**,** 7-13.

SCHOUR, I. & MASSLER, M. 1940a. Studies in tooth development: The growth pattern of human teeth. Part I. *Journal of the American Dental Association,* 27**,** 1778-1793.

SCHOUR, I. & MASSLER, M. 1940b. Studies in tooth development: The growth pattern of human teeth. Part II. *Journal of the American Dental Association,* 27**,** 1918-1931.

SCHOUR, I. & MASSLER, M. 1941. The development of the human dentition. *Journal of the American Dental Association,* 29**,** 1153-1160.

SCHULTER-ELLIS, F. P., HAYEK, L. C. & SCHMIDT, D. J. 1985. Determination of sex with a discriminant analysis of new pelvic bone measurements: Part II. *Journal of Forensic Sciences,* 30**,** 178-185.

SCHUTKOWSKI, H. 1993. Sex determination of infant and juvenile skeletons: I. Morphognostic features. *American Journal of Physical Anthropology,* 90**,** 199-205.

SEIDEMANN, R. M., STOJANOWSKI, C. M. & DORAN, G. H. 1998. The use of the supero-inferior femoral neck diameter as a sex assessor. *American Journal of Physical Anthropology,* 107**,** 305-313.

SEIP, J. A. 1937-1940. Ennu en kristenrett fra gammelnorsk tid. *Historisk Tidskrift,* 31**,** 573-627.

SELLEVOLD, B. J. 2001. *From Death to Life in Medieval Hamar. Skeletons and Graves as Historical Source Material.* Faculty of Arts, University of Oslo.

SHAHRUL HISHAM, Z. A., SAHIDAN, S., ROHAYA, M. A. W., SITI AFEEFAH, M. Y., INTAN ZARINA, Z. A., NOR HIDAYAH, J. A. N., NADIAH, R. M. A. & ZAIDAH, Z. A. 2009. Molecular gender determination of ancient human from Malay Peninsular. *American Journal of Applied Sciences,* 6**,** 1770-1775.

SJØVOLD, T. 1990. Estimation of stature from long bones utilizing the line of organic correlation. *Human Evolution,* 5**,** 431-447.

SKAGFIRÐINGA, B. 2007. *Treasure in the Earth,* Skagfirðinga Byggðasafn Skagfirðinga

SLAUS, M., STRINOVIC, D., SKAVIC, J. & PETROVECKI, V. 2003. Discriminant function sexing of fragmentary and complete femora: Standards for contemporary Croatia. *Journal of Forensic Sciences,* 48.

SMITH, S. L. 1996. Attribution of hand bones to sex and population groups. *Journal of Forensic Sciences,* 41**,** 469-377.

SMITH, S. L. 1997. Attribution of foot bones to sex and population groups. *Journal of Forensic Sciences,* 42**,** 186-195.

ST. HOYME, L. E. & ISCAN, M. Y. 1989. Determination of sex and race: Accuracy and assumptions. *In:* ISCAN, M. Y. & KENNEDY, K. A. R. (eds.) *Reconstruction of Life from the Skeleton.* New York: Alan R. Liss, Inc.

STECKEL, R. H. 1988. The health and mortality of women and children, 1850-1860. *Journal of Economic History,* 48**,** 333-345.

STECKEL, R. H., LARSEN, C. S., SCIULLI, P. W. & WALKER, P. L. 2006. *The Global History of Health Project. Data Collection Codebook*.

STECKEL, R. H. & ROSE, J. C. (eds.) 2002. *The Backbone of History,* Cambridge: Cambridge University Press.

STEEL, F. L. D. 1972. The sexing of long bones, with reference to the St Bride's series of identified skeletons. *The Journal of the Royal Anthropological Institute of Great Britain and Ireland,* 92**,** 212-222.

STEELE, G. D. & MCKERN, T. W. 1969. A method for assessment of maximum long bone length and living stature frm fragmentary long bones. *American Journal of Physical Anthropology,* 31**,** 215-228.

STEFFENSEN, J. 1943. Knoglerne fra Skeljastadir i þjórsádalur. *In:* STENBERGER, M. (ed.) *Forntida Gårdar i Island.* Copehagen: Ejnar Munksgaard.

STEWART, T. D. 1979a. Attribution of race. *In:* STEWART, T. D. (ed.) *Essentials of Forensic Anthropology, Especially As Developed in the United States* Springfield: Charles C Thomas.

STEWART, T. D. 1979b. *Essentials of Forensic Anthropology,* Springfield, CC Thomas.

STEYN, M. & ISCAN, M. Y. 1997. Sex determination from the femur and tibia in South African whites. *Forensic Science International,* 90**,** 111-119.

STIGUM, H. 1956. Alen. *Kulturhistorisk Leksikon for Nordisk Middelalder.* Copenhagen: Rosenkilde og Bagger.

STOJANOWSKI, C. M. 1999. Sexing potential of fragmentary and pathological metacarpals. *American Journal of Physical Anthropology,* 109**,** 245-252.

SULZMANN, C. E., BUCKBERRY, J. L. & PASTOR, R. F. 2008. The utility of carpals for sex assessment: A preliminary study. *American Journal of Physical Anthropology,* 135**,** 252-262.

SUTHERLAND, L. D. & SUCHEY, J. M. 1991. Use of the ventral arc in pubic sex determnation. *Journal of Forensic Sciences,* 36**,** 501-511.
SÆLEBAKKE, I. 1985. En Osteologisk Rapport om det Humane Skjelettmaterialet fra Peterskirken og dens Kirkegård. Tønsberg: Riksantikvaren.
SÆTHER, T. 1998. Hamar domkirke: En byggeplass i 430 år. *Fra Kaupang og Bygd. Vernebygg Over en Ruin.* Hamar: Hedmarksmuseet og Domkirkeodden.
SÆTHER, T. 2005. *Hamar i Middelalderen,* Hamar, Domkirkeodden.
SAAVEDRA DE PAIVA, L. A. & SEGRE, M. 2003. Sexing the human skull through the mastoid process. *Revista do Hospital das Clínicas Sao Paulo,* 58**,** 15-20.
TODD, T. W. 1921a. Age changes in the pubic bone. I: The male white pubis. *American Journal of Physical Anthropology,* 3**,** 285-334.
TODD, T. W. 1921b. Age changes in the pubic bone. III: The pubis of the white female. IV: The pubis of the female white-negro hybrid. *American Journal of Physical Anthropology,* 4**,** 1-70.
TRANCHO, G. J., ROBLEDO, B., LÓPEZ-BUEIS, I. & SÁNCHEZ, J. A. 1997. Sexual determination of the femur using discriminant functions. Analysis of a Spanish population of known sex and age. *Journal of Forensic Sciences,* 42**,** 181-185.
TROTTER, M. 1970. Estimation of stature from intact long limb bones. *In:* STEWART, T. D. (ed.) *Personal Identification in Mass Disasters.* Washington: Smithsonian Institution.
TROTTER, M. & GLESER, G. C. 1952. Estimation of stature from long bones of American Whites and Negroes. *American Journal of Physical Anthropology,* 10**,** 463-514.
TROTTER, M. & GLESER, G. C. 1958. A re-evaluation of estimation of stature based on measurements of stature taken during life and of long bones after death. *American Journal of Physical Anthropology***,** 79-123.
TROTZIG, G. 1969. Gegensätze zwischen Heidentum und Christentum im archäolischen Material des 11. Jahrhunderts auf Gotland. *Acta Visbyensia,* 3**,** 21-29.
UBELAKER, D. H. 1978. *Human Skeletal Remains: Excavation, Analysis, Interpretation,* Washington, Taraxacum.
UBELAKER, D. H. 1997. Taphonomic applications in forensic anthropology. *In:* HAGLUND, W. D. & SORG, M. H. (eds.) *Forensic Taphonomy: The Postmortem Fate of Human Remains.* Boca Raton: CRC Press.
VLAK, D., ROKSANDIC, M. & SCHILLACI, M. A. 2008. Greater sciatic notch as a sex indicator in juveniles. *American Journal of Physical Anthropology,* 137**,** 309-315.
VRETEMARK, M. 1982a. Osteologisk Analys av Fyra Skelett från Nödinge Kyrka i Västergötland.
VRETEMARK, M. 1982b. Osteologisk Analys av Skelett från Gamla Kyrkogården, Österlövsta sn i Uppland.
VRETEMARK, M. 1982c. Osteologisk Analys av Skelett från Gamla Kyrkogården, Österlövsta sn i Uppland.
VRETEMARK, M. 1992. Den könssegregerade kyrkogården. *META***,** 120-128.
VRETEMARK, M. 1998. *Karleby Kyrka. Traditionen som Blev Sann* Skaraborg, Skaraborg Länsmuseum.
VRETEMARK, M. 2009. Tidiga kristna spår i Varnhem - hur tolkar vi det? *Historieforum,* 2**,** 7-16.

WALKER, P. L. 2005. Greater sciatic notch morphology: Sex, age, and population differences. *American Journal of Physical Anthropology,* 127**,** 385-391.
WALKER, P. L. 2008. Sexing skulls using discriminant function analysis of visually assessed traits. *American Journal of Physical Anthropology,* 136**,** 39-50.
WALKER, P. L., DEAN, G. & SHAPIRO, P. 1991. Estimating age from tooth wear in archaeological populations. *In:* KELLEY, M. A. & LARSEN, C. S. (eds.) *Advances in Dental Anthropology.* New York: Wiley-Liss.
WALKER, P. L., JOHNSON, J. R. & LAMBERT, P. M. 1988. Age and sex biases in the preservation of human skeletal remains. *American Journal of Physical Anthropology,* 76**,** 183-188.
WEISS, K. M. 1972. On the systematic bias in skeletal sexing. *American Journal of Physical Anthropology,* 37**,** 239-250.
WESCOTT, D. J. 2000. Sex variation in the second cervical vertebra. *Journal of Forensic Sciences,* 45**,** 462-466.
WHITE, T. D. & FOLKENS, P. A. 2000. *Human Osteology,* San Diego, Academic Press.
WIENBERG, J. 1991. *De Kirkelige Institutioner i Middelalderens Tønsberg,* Tønsberg, Riksantikvaren.
WILSON, D. M. & HURST, D. G. 1967. Medieval Britain In 1966. *Medieval Archaeology,* 11**,** 262-319.
WRIGHT, R. 2009. *Guide to Using the CRANID Programs CR6aInd: For Linear and Nearest Neighbours Discriminant Analysis*.
WRIGHT, R. V. S. 1992. Correlation between cranial form and geography in Homo sapiens: CRANID - a computer program for forensic and other applications. *Archaeology in Oceania,* 27**,** 105-112.
YODER, C., UBELAKER, D. H. & POWELL, J. F. 2001. Examination of variation in sternal rib end morphology relevant to age assessment. *Journal of Forensic Sciences,* 46**,** 223-227.
YU, S.-B., LEE, U.-Y., KWAK, D.-S., AHN, Y.-W., JIN, C.-Z., ZHAO, J., SUI, H.-J. & HAN, S.-H. 2008. Determination of sex for the 12th thoracic vertebra by morphometry of three-dimensional reconstructed vertebral models. *Journal of Forensic Sciences,* 53**,** 620-625.
ZEYBEK, G., ERGUR, I. & DEMIROGLU, Z. 2008. Stature and gender estimation using foot measurements. *Forensic Science International,* 181**,** 54.e1-54.e5.
ZOËGA, G. 2008. *Keldudalur i Hegranesi. Fornleifarannsoknir 2002-2007*, Byggdasfn Skagfirdinga.
ØYE, I. 2009. Burials and human remains from medieval Bergen - an introduction. *In:* ØYE, I. (ed.) *Osteoarchaeological Analyses From Medieval Bergen.* Bergen: Fagbokforlaget.
AAPA 1996. AAPA statement on biological aspects of race. *American Journal of Physical Anthropology,* 101**,** 569-570.

Appendix

Information about individual skeletons

The St. Mary’s church

Skeleton ID	Time period	Sex	Age group	FML (mm)	DJD	SD	EH	DA	AMTL	CO	T
68354	?	F	18-30	414							
69617	?	F?	50+		X						
69618	?	F	50+		X			X	X		X
69623	?	M?	18-30	426							
69629	?	M	30-50	483	X						X
69635	?	M	12-18	451							
69637	?	A	18-30							X	
69643	?	A	8-12								
69644	?	M	18-30	481							
69645	?	F?	18-30	425							
69652	?	A	50+	446							
69655	?	F	18-30	414		X					
69657	?	F?	30-50								
69658	1248-1332	M?	20+		X	X					
69660	?	F	30-50					X	X		
69662	?	M?	30-50								
69672	?	A	4-8								
69675	?	F	30-50			X			X		
69683	?	A	18-30	417							
69686	?	F	18-30							X	
69691	?	F?	20+								
69698	?	A	18-30				X			X	
69703	?	M	30-50							X	
69706	?	F	18-30	390							
70300	?	M?	18-30	450					X		
70301	?	M	18-30	474			X				
75002	1170-1198	F	18-30			X				X	
75003	1198-1248	M	50+	508	X	X			X		X
75004	1170-1198	M?	30-50	464	X	X			X		
75005	1170-1198	A	18-30								
75007	1170-1198	F	50+								
75008	1248-1332	M	18-30	436		X					X
75009	1170-1198	F	30-50			X					
75010	1248-1332	F?	50+		X	X					
75011	1170-1198	M?	30-50		X	X					
75013	1170-1198	A	12-18	485					X		
75014	1170-1198	A	12-18								
75015	?	A	50+	465	X	X					
75016	1170-1198	F	30-50	415	X						X
75017	?	A	30-50	441							
75018	1170-1198	F	20+								
75019	Pre 1170	M	18-30	434						X	
75020	?	A	12-18								

Skeleton ID	**Time period**	**Sex**	**Age group**	**FML (mm)**	**DJD**	**SD**	**EH**	**DA**	**AMTL**	**CO**	**T**
75021	1170-1198	A	18-30								X
75022	Pre 1170	M	30-50								
75023	1198-1248	A	12-18							X	
75024	Pre 1170	M	30-50								
75025	?	M	30-50	436	X	X					
75027	?	A	30-50					X			
75028	?	M	30-50								
75029	1248-1332	M	30-50			X		X			
75030	1198-1248	F?	30-50	434		X					
75031	1198-1248	M	18-30	442					X	X	
75032	1170-1198	A	4-8								
75033	?	F?	18-30	390							
75034	1170-1198	M	30-50	457	X	X					
75035	?	F	30-50	438						X	
75036	1248-1332	F	50+			X			X		
75037	?	M?	30-50	450							
75038	1170-1198	F	30-50	397			X				
75039	1170-1198	M	18-30	431		X					
75040	1170-1198	M	30-50	491	X	X		X	X	X	
75041	1198-1248	A	12-18								
75042	1170-1198	F	1830	417		X					
75043	1170-1198	F	18-30	393	X	X					
75044	?	M?	18-30	458							
75045	1170-1198	F?	18-30								
75046	1198-1248	F?	30-50	439		X					
75047	1170-1198	F?	30-50			X					
75049	1170-1198	A	12-18							X	
75050	1198-1248	A	8-12								
75051	?	F?	18-30								
75052	?	F?	30-50		X						
75054	1170-1198	A	12-18								
75056	?	M	30-50	468		X					
75057	?	F	18-30								
75059	?	M	30-50	450	X					X	
75060	1170-1198	F	30-50		X	X				X	
75061	1170-1198	F	30-50	457		X		X	X		
75062	?	M	30-50								X
75063	?	M?	30-50	462	X						
75064	?	M	30-50	472							
75065	?	A	30-50		X						
75066	1170-1198	M	50+	454	X	X		X	X		X
75067	1170-1198	F	50+		X	X		X	X		
75068	?	M	20+	469							
75069	?	M?	30-50	483							X
75229	1170-1198	F	30-50		X	X		X	X		X
75232	1198-1248	A	4-8								
76320	Pre 1170	M	50+		X	X			X		X
76321	1170-1198	A	20+		X						
76322	1198-1248	M?	30-50								
76324	1170-1198	F?	20+								
76325	1248-1332	F?	30-50							X	X
76326	Pre 1170	F	50+						X		

Skeleton ID	Time period	Sex	Age group	FML (mm)	DJD	SD	EH	DA	AMTL	CO	T
76328	1198-1248	M	30-50	478							
76329	1248-1332	M?	50+	439	X	X		X			X
76330	1198-1248	F?	30-50								X
76331	1198-1248	F	30-50					X			
76332	1170-1198	F?	18-30								
76334	1170-1198	M?	30-50		X	X	X		X		
76335	Pre 1170	F	30-50	399	X	X					X
76336	1170-1198	A	8-12								
76337	1198-1248	M	30-50								
76338	1170-1198	F?	30-50	415							
76339	1198-1248	F	50+			X			X		
76340	1198-1248	A	12-18								
76342	1170-1198	M	30-50		X						
76343	1170-1198	A	12-18								
76344	1170-1198	A	30-50								
76345	1170-1198	A	20+								
76346	1198-1248	F?	50+		X	X		X	X		
76347	1198-1248	M	50+		X	X			X		
76348	1198-1248	M?	50+	431	X	X		X	X	X	
76349	1170-1198	M?	20+		X						
76350	1198-1248	A	12-18							X	
76351	Pre 1170	F	30-50								X
76352	1170-1198	A	50+								
76353	1198-1248	F?	30-50		X	X					X

FML=femur maximum length, DJD=degenerative joint disease, SD=spinal degeneration, EH=enamel hypoplasia, DA=dental abscess, AMTL=ante-mortem tooth loss, CO=cribra orbitlia, T=trauma

The Public Library site

Skeleton ID	Time period	Sex	Age group	FML (mm)	DJD	SD	EH	DA	AMTL	CO	T
78	1175-1275	M	18-30	472						X	
115	1175-1275	F	50+	400				X	X		
119	1175-1275	F	30-50					X	X		
135	1175-1275	A	1-4								
141	1175-1275	A	12-18								
146	1175-1275	F	18-30								
148	1175-1275	M	12-18							X	
150	1175-1275	F?	30-50						X		
152	1175-1275	F	18-30	401					X		
153	1175-1275	A	20+								
154	1175-1275	M	20+	474							
155	1175-1275	A	0-1								
157	1175-1275	A	0-1								
159	1175-1275	F	30-50	433	X	X		X			
161	1175-1275	A	1-4								
162	1175-1275	F	18-30								
167	1175-1275	A	1-4								
168	1175-1275	A	1-4								
169	1175-1275	F?	12-18						X	X	
173	1175-1275	F	30-50	408	X						
174	1175-1275	A	4-8							X	
175	1175-1275	F?	18-30	416							
176	1175-1275	A	4-8							X	
177	1175-1275	F	30-50	411	X	X			X		
178	1175-1275	F	20+								
180	1175-1275	F	18-30	419							
181	1175-1275	M	12-18	453						X	
182	1175-1275	A	4-8								
185	1175-1275	A	1-4								
187	1175-1275	F	18-30	418						X	
188	1175-1275	F	18-30							X	
191	1175-1275	M	18-30	490							X
192	1175-1275	F	18-30	418							
194	1175-1275	A	1-4								
195	1175-1275	F	30-50	417		X		X	X		
196	1175-1275	F	18-30	416						X	
198	1175-1275	A	12-18								
199	1175-1275	F?	18-30	434		X					
200	1175-1275	M?	30-50			X					X
201	1175-1275	A	1-4								
202	1175-1275	M?	20+								
205	1175-1275										
206	1175-1275	F	18-30								
207	1175-1275	F	30-50	414	X				X		
208	1175-1275	M	30-50					X			
210	1175-1275	F	30-50	414				X			
213	1175-1275	A	8-12								
214	1175-1275	A	4-8							X	
216	1175-1275	A	20+								

Skeleton ID	Time period	Sex	Age group	FML (mm)	DJD	SD	EH	DA	AMTL	CO	T
217	1175-1275	A	30-50								
218	1175-1275	M	30-50		X			X	X	X	
220	1175-1275	M	30-50		X						
221	1175-1275	F	18-30								
222	1175-1275	A	20+			X					
223	1175-1275	F?	30-50					X	X		
224	1175-1275	A	1-4								
225	1175-1275	M	30-50	468							
226	1175-1275	M	18-30			X					
227	1175-1275	F	18-30	415						X	
228	1175-1275	F?	20+								
229	1175-1275	M	20+								
230	1175-1275	M	30-50								
231	1175-1275	M	30-50								
232	1175-1275	A	1-4								
233	1175-1275	A	0-1								
234	1175-1275	A	12-18								
235	1175-1275	F	30-50	440							
236	1175-1275	F?	18-30								
237	1175-1275	M	12-18								
238	1175-1275	M	18-30				X			X	
239	1175-1275	M	30-50		X	X			X		
240	1175-1275	A	12-18								
241	1175-1275	A	4-8								
242	1175-1275	A	1-4								
243	1175-1275	F	18-30								
245	1175-1275	F	30-50								X
246	1175-1275	F	18-30	430							
247	1175-1275	M	30-50								
248	1175-1275	A	30-50								
249	1175-1275	A	8-12								
250	1175-1275	M?	50+	416							
251	1175-1275	A	4-8								
252	1175-1275	A	4-8								
253	1175-1275	M	30-50								
254	1175-1275	F?	30-50	413		X					
255	1175-1275	A	20+								
256	1175-1275	F?	30-50					X			
257	1175-1275	M	30-50	471	X			X			
258	1175-1275	M	12-18	506			X			X	
259	1175-1275	M	30-50	456		X					
260	1175-1275	A	8-12								
261	1175-1275	A	8-12								
262	1175-1275	A	8-12								
264	1175-1275	A	1-4							X	
265	1175-1275	A	20+								
266	1175-1275	F?	30-50					X	X		
267	1175-1275	A	18-30								X
268	1175-1275	F?	30-50	430	X	X			X		
269	1175-1275	F?	30-50	448							
270	1175-1275	F?	18-30	416							
271	1175-1275	F	30-50	428	X			X		X	

Skeleton ID	Time period	Sex	Age group	FML (mm)	DJD	SD	EH	DA	AMTL	CO	T
272	1175-1275	F	20+	402							
273	1175-1275	A	30-50						X		
274	1175-1275	M	20+								
275	1175-1275	A	0-1								
276	1175-1275	M	50+		X	X		X			X
277	1175-1275	A	1-4								
278	1175-1275	A	8-12								
279	1175-1275	A	20+								
280	1175-1275	F	18-30	439		X				X	
281	1175-1275	M	30-50			X		X			X
282	1175-1275	A	12-18							X	
283	1175-1275	A	0-1								
284	1175-1275	M?	30-50					X			
285	1175-1275	F	18-30								
286	1175-1275	F	18-30								
287	1175-1275	F	20+	417							
288	1175-1275	M	50+		X	X				X	
289	1175-1275	M	20+								
290	1175-1275	A	12-18							X	
291	1175-1275										
292	1175-1275	M	18-30						X		
293	1175-1275	M?	18-30								
294	1175-1275	F	30-50	419		X		X	X		X
295	1100-1175	A	20+								
296	1175-1275	A	20+								
297	1175-1275	F?	18-30			X					
299	1175-1275	M	18-30	451							
300	1175-1275	A	8-12								
301	1175-1275	F	18-30								
302	1175-1275	A	18-30								X
303	1175-1275	M?	30-50	435		X				X	X
304	1100-1175	F?	20+								
305	1175-1275	M?	30-50								X
306	1175-1275	A	4-8							X	
307	1175-1275	A	8-12							X	
308	1175-1275	M?	18-30						X		
309	1175-1275	F	20+								
310	1175-1275	M	20+								
311	1175-1275	A	30-50								
312	1100-1175	F	18-30								
313	1175-1275	F?	20+								
314	1175-1275	M	12-18								
315	1175-1275	A	18-30								
316	1175-1275	A	8-12								
317	1175-1275	F?	18-30			X					
318	1175-1275	M	18-30	469							
319	1100-1175	M?	20+								
320	1100-1175	F?	20+								
321	1175-1275	M?	50+		X	X			X		
322	1175-1275	F	30-50								
323	1175-1275	M?	20+								
324	1100-1175	A	1-4								

Skeleton ID	Time period	Sex	Age group	FML (mm)	DJD	SD	EH	DA	AMTL	CO	T
325	1175-1275	A	8-12								
326	1175-1275	F	20+		X	X			X		
327	1100-1175	F	50+								
328	1175-1275	M	30-50	494					X		X
329	1175-1275	M	50+		X	X			X		
330	1175-1275	A	20+								
331	1175-1275	A	8-12								
332	1175-1275	F	30-50	386		X		X	X		
333	1100-1175	F	18-30			X					
334	1175-1275	M	50+	456	X	X		X	X		
335	1100-1175	M	20+								
336	1175-1275	F	50+			X		X		X	X
337	1175-1275	A	20+								
338	1100-1175	F	20+			X					
339	1100-1175	A	18-30								
340	1100-1175	F	30-50	413	X						
341	1175-1275	A	30-50								
342	1175-1275	F	18-30								
343	1175-1275	A	12-18				X				
344	1175-1275	M	18-30	451						X	
345	1100-1175	A	4-8								
346	1100-1175	A	20+								
347	1175-1275	A	1-4								
350	1175-1275	M	20+								
351	1175-1275	M	18-30	513							X
352	1175-1275	F	30-50	430							
353	1175-1275	A	4-8								
354	1175-1275	M	20+	456	X						
355	1175-1275	A	0-1								
356	1175-1275	F?	18-30	458							
357	1175-1275	M	30-50	437		X				X	
358	1175-1275	M	20+								X
359	1175-1275	A	0-1								
360	1175-1275	M	20+								
361	1175-1275	F	30-50								
362	1175-1275	A	1-4								
363	1175-1275	M?	12-18								
364	1175-1275	A	0-1								
365	1175-1275	M	30-50					X			
366	1175-1275	A	0-1								
367	1175-1275	A	8-12							X	
368	1175-1275	A	0-1								
369	1175-1275	A	8-12								
370	1100-1175	F?	20+								
371	1100-1175	F?	20+								
372	1175-1275	A	12-18							X	
373	1175-1275	A	0-1								
374	1100-1175	F	18-30								
375	1100-1175	A	20+								
376	1175-1275	A	12-18							X	
377	1100-1175	A	30-50		X						
378	1100-1175	A	20+								

Skeleton ID	**Time period**	**Sex**	**Age group**	**FML (mm)**	**DJD**	**SD**	**EH**	**DA**	**AMTL**	**CO**	**T**
379	1175-1275	A	8-12								
380	1100-1175	A	20+								
381	1175-1275	M	30-50								X
382	1100-1175	A	20+								
383	1175-1275	A	20+								
384	1175-1275	A	20+								
385	1175-1275	M	50+		X	X			X	X	
386	1175-1275	F	50+			X		X	X		
387	1175-1275	M	50+								
388	1175-1275	F	20+								

FML=femur maximum length, DJD=degenerative joint disease, SD=spinal degeneration, EH=enamel hypoplasia, DA=dental abscess, AMTL=ante-mortem tooth loss, CO=cribra orbitlia, T=trauma

The Hamar cathedral

Skeleton ID	Time period	Sex	Age group	FML (mm)	DJD	SD	EH	DA	AMTL	CO	T
BG3	1250-1350	F	50+	468		X			X		
BG5	1250-1350	F	50+	439		X		X			
BG8	1250-1350	M	12-18								
BG9	1250-1350	M	18-30	488							X
BG10	1250-1350	A	0-1								
BG11	1250-1350	A	20+								
BG12	1250-1350	F	50+	418	X	X					
BG13	1250-1350	A	20+								
BG15	1250-1350	F	50+	413		X			X	X	X
BG18	1250-1350	F	20+	444							
BG20	1250-1350	F	30-50	419	X	X		X			X
BG21	1250-1350	M	30-50							X	X
BG22	1250-1350	A	20+								
BG23	1250-1350	M	30-50	470	X	X				X	
BG24	1250-1350	M	30-50	488		X		X	X		X
BG25	1250-1350	A	4-8								
BG28	1250-1350	F	50+	412		X			X		
BG29	1250-1350	A	8-12							X	
BG31	1250-1350	M	30-50	453	X	X		X	X		X
BG33	1250-1350	M	18-30								
BG34	1250-1350	F	30-50	434	X	X					
BG35	<1250	M	18-30	451							
BG36	1250-1350	M?	20+								
BG40	1250-1350	A	12-18				X				
BG41	1250-1350	F	50+					X		X	
BG42	1250-1350	M	50+			X			X		X
BG43	1250-1350	F	50+	438	X	X					
BG44	1250-1350	F	50+	423		X					
BG46	1250-1350	M	18-30	477							
BG47	1250-1350	M	30-50								
BG49	1250-1350	F	30-50	410		X					
BG53	1250-1350	M	20+			X					
BG55	1250-1350	M	30-50	479		X		X			
BG56	1250-1350	M	18-30	487							
BG57	1250-1350	M	50+					X			X
BG58	1250-1350	F?	50+	446	X	X			X	X	
BG60	1250-1350	M	30-50	443	X	X		X	X		
BG61	1250-1350	M	18-30	485		X					
BG66	1250-1350	F?	20+								
BG67	1250-1350	M	30-50	459		X				X	
BG69	1250-1350	A	0-1								
BG70	1250-1350	M	18-30	485							
BG71	1250-1350	A	20+								
BG72	1250-1350	A	0-1								
BG73	1250-1350	A	20+								
BG74	1250-1350	M	30-50								
BG75	1250-1350	F	30-50	398	X						
BG76	1250-1350	F	30-50	425	X						
CG1	?	M	30-50								

Skeleton ID	Time period	Sex	Age group	FML (mm)	DJD	SD	EH	DA	AMTL	CO	T
CG2	?	M	30-50								
CG3	?	M	30-50		X	X					X
CG4	?	M	30-50	452	X	X		X	X	X	
CG5	?	M	30-50								
CG6	?	M	18-30	456							
CG7	?	M	30-50								
CG8	?	A	8-12								
CG9	?	M	30-50			X					
CG10	?	M	18-30								
CG11	?	M	30-50	475	X	X		X		X	X
CG12	?	M	20+								
CG13	?	M	18-30								
CG14	?	M	50+								
CG15	?	M	12-18								
CG16	?	F?	12-18								
CG17	?	M	30-50	466		X					
CG18	?	M	30-50								
CG19	?	A	4-8								
CG20	?	M	50+	503	X	X		X	X		X
CG21	?	A	0-1								
CG22	?	M	30-50	464		X					
CG23	?	M	30-50	476		X		X			
CG24	?	M	18-30								
CG25	?	M	18-30								
CG26	?	M	30-50			X					
CG27	?	M	30-50								
CG28	?	M	18-30	460							
CG29	?	M	18-30	535							
CG30	?	M	30-50			X		X			
CG31	?	M	30-50								
CG32	?	A	1-4								
CG33	?	M	18-30	482						X	
CG34	?	M	30-50								
CG35	?	F	30-50	438	X	X					
CG36	?	M	30-50			X					
CG37	?	M	18-30	489							
CG38	?	F	30-50	437	X	X					X
CG39	?	A	4-8								
CG40	?	M	30-50	473		X					X
CG41	?	M	30-50			X				X	
CG42	?	A	8-12							X	
CG43	?	A	8-12								
CG44	?	M	30-50								
CG45	?	F	50+	397		X					X
CG46	?	M	30-50	442	X						X
CG47	?	M	30-50	460		X					
CG48	?	F	30-50	423		X					
CG49	?	M	30-50		X	X		X			
CG50	?	A	20+								
CG51	?	M	18-30	470							
CG52	?	M	30-50					X	X		
CG53	?	M?	30-50								

Skeleton ID	**Time period**	**Sex**	**Age group**	**FML (mm)**	**DJD**	**SD**	**EH**	**DA**	**AMTL**	**CO**	**T**
CG54	?	M	50+								
CG55	?	M	30-50	444		X				X	X
CG56	?	M	30-50							X	
CG57	?	A	12-18							X	
CG58	?	M	18-30	511			X				
CG59	?	A	12-18				X			X	
CG60	?	M	18-30	470							
CG61	?	F	50+	418	X	X			X		
CG62	?	F	30-50	408					X		
CG63	?	A	0-1								
CG64	?	M	50+	437		X			X		
CG65	?	M	18-30	437							
CG66	?	A	12-18								
CG67	?	M	30-50	469		X					
CG68	?	M	18-30								
CG69	?	M	18-30								
CG70	?	F	18-30	424							
CG71	?	M	30-50	490	X	X				X	
CG72	?	F	50+	435	X	X					
CG73	?	F	50+	420		X		X			
CG74	?	F	50+	447		X					X
CG75	?	F	12-18	417							
CG76	?	M	20+								
CG77	?	F	30-50	388							
CG79	?	A	0-1								
CG80	?	F	30-50	409							
CG81	?	M	30-50	516							
CG82	?	M	18-30	488						X	
CG83	?	M	30-50	463							
CG84	?	A	8-12							X	
CG85	?	M	30-50			X					
CG86	?	M	18-30								X
CG87	?	M?	12-18								
CG88	?	M	20+		X						
CG89	?	M	18-30	475			X				
CG90	?	M	18-30								
CG91	?	A	12-18								
CG92	?	A	8-12								
CG93	?	M	18-30	461							
CG94	?	M	12-18							X	
CG95	?	F	18-30	426							
CG96	?	M	18-30	470							
CG97	?	M	30-50	500	X	X					X
CG98	?	A	1-4								
CG99	?	A	8-12								
CG100	?	M	30-50		X						
CG102	?	F	18-30	431							
CG103	?	A	0-1								
CG104	?	F	18-30	433							
CG105	?	M	50+		X	X			X		
CG106	?	A	0-1								
CG107	?	M	30-50	461	X						

Skeleton ID	Time period	Sex	Age group	FML (mm)	DJD	SD	EH	DA	AMTL	CO	T
CG108	?	A	12-18								
CG110	?	M	30-50	461	X					X	X
CG111	?	A	20+								
CG112	?	M	30-50	485							
CG113	?	M	30-50	477							
CG114	?	A	20+								
CG115	?	M	50+	431	X	X			X		
CG116	?	A	12-18								
CG117	?	A	4-8								
CG118	?	M?	20+								
CG119	?	A	1-4								
CG120	?	A	12-18								
CG121	?	M	30-50	477	X						
CG122	?	F	30-50			X		X			
CG123	?	A	8-12								
CG124	?	A	18-30								
CG125	?	M	30-50								
CG126	?	M	30-50			X					
CG127	?	A	12-18								
CG128	?	A	18-30								
CG129	?	M	50+	490		X					X
CG130	?	M	18-30	456							
CG131	?	M	30-50			X					
CG132	?	A	30-50								
CG134	?	A	20+								
CG135	?	A	12-18								
CG136	?	A	4-8							X	
CG137	?	M	18-30	476		X					
CG138	?	M	18-30	515							
CG139	?	A	4-8							X	
CG140	?	M	30-50			X		X			
CG141	?	A	4-8							X	
CG142	?	A	20+								
CG143	?	F	50+			X					X
CG144	?	A	8-12								
CG145	?	A	12-18								
CG146	?	F?	18-30								
CG147	?	F	50+	429	X	X			X		X
CG148	?	M	30-50								
CG149	?	F	50+	415	X	X			X		
CG150	?	M	18-30	449	X						
DG1	1250-1350	M	18-30	484							
DG2	1250-1350	A	1-4								
DG4	1250-1350	A	20+								
DG5	1250-1350	M?	20+								
DG6	1250-1350	M?	18-30								
DG8	1250-1350	A	20+								
DG9	1250-1350	M	30-50								
DG10	1250-1350	M	50+	426	X	X					
DG11	1250-1350	A	20+								
DG12	1250-1350	M	18-30	479							
DG13	<1250	M	30-50	492							

Skeleton ID	**Time period**	**Sex**	**Age group**	**FML (mm)**	**DJD**	**SD**	**EH**	**DA**	**AMTL**	**CO**	**T**
DG15	<1250	M	12-18								
DG16	1250-1350	M?	20+								
DG17	1250-1350	A	20+								
DG18	<1250	F	50+	408	X						
DG20	1250-1350	F	50+	444							
DG21	1250-1350	A	18-30								
DG22	1250-1350	M	30-50	477	X						
DG24	1250-1350	A	12-18								
DG25	1250-1350	A	20+								
DG26	1250-1350	M	30-50								
EG1	1250-1350	F	50+	425	X	X			X		
EG3	1250-1350	F	30-50	416		X				X	
EG8	1250-1350	M	18-30			X					
EG9	1250-1350	M	30-50								
EG12	1250-1350	M?	30-50	420	X	X					X
EG17	1250-1350	F	30-50			X					
EG19	1250-1350	A	20+								
EG23	1250-1350	A	12-18								
EG25	1250-1350	A	20+								
EG28	1250-1350	F	30-50	454		X					
EG31	1250-1350	M	20+								
EG32	1250-1350	M	30-50	436	X	X			X		
EG35	<1250	F	30-50	403	X	X		X		X	X
EG40	<1350	M	30-50	435							X
EG45	1250-1350	M	18-30	476							X
EG47	<1350	F	30-50	428				X			
EG49	1250-1350	A	18-30								
EG50	1250-1350	M	12-18								
EG52	1250-1350	F	50+	428	X	X			X		X
EG53	1250-1350	M	30-50	463							
EG54	1250-1350	M	30-50	402	X	X		X			
EG63	1250-1350	M	18-30	449							X
EG66	Appr. 1350	M	30-50	471							
EG67	<1350	M	30-50								X
EG68	<1350	A	18-30								
EG72	1250-1350	F	30-50	399	X						
EG73	Appr. 1350	M	30-50	449		X		X	X		
EG76	1250-1350	M	50+	492	X	X		X			X
EG77	1250-1350	A	20+								
EG81	Appr. 1350	M	18-30	461							
EG83	1250-1350	A	1-4								
EG84	1250-1350	F	18-30	404							
EG86	1250-1350	M	30-50	470	X						
EG90	<1350	M	30-50	478		X		X			
EG93	<1450	M	18-30							X	
HG13	<1250	A	1-4								
HG101	<1350	M	30-50								
HG103	<1350	M	50+	496	X	X		X			X
HG107	<1300	M	30-50	451							
HG108	<1300	A	12-18							X	
HG109	<1300	M	18-30	457							
HG111	<1350	M	50+	498	X						

Skeleton ID	Time period	Sex	Age group	FML (mm)	DJD	SD	EH	DA	AMTL	CO	T
HG113	<1350	M	30-50	481							
HG114	?	A	12-18								
HG119	<1350	M	18-30	482						X	X
HG120	<1350	M	30-50	473							X
HG121	<1350	M	30-50								
HG126	<1350	A	20+								
HG34A	<1250	A	8-12								
HG48	<1300	A	12-18								
HG49	<1250	A	8-12								
HG57	1300-1350	A	4-8								
HG58	1300-1350	M	18-30								
HG59	1300-1350	A	18-30								
HG63	<1300	M	18-30	438							
HG69	<1300	A	18-30								
HG70	<1350	M	18-30								
HG75	<1250	M	30-50		X	X					X
HG93	Appr. 1350	A	4-8				X				
HG94	Appr. 1350	A	4-8								
MG1	<1350	M?	50+			X			X		X

FML=femur maximum length, DJD=degenerative joint disease, SD=spinal degeneration, EH=enamel hypoplasia, DA=dental abscess, AMTL=ante-mortem tooth loss, CO=cribra orbitlia, T=trauma

The St. Peter's church

Skeleton ID	Time period	Sex	Age group	FML (mm)	DJD	SD	EH	DA	AMTL	CO	T
HS1	M12thC-1536	M	30-50	433							
HS2	M12thC-1536	A	0-1								
HS3	M12thC-1536	F	20+								
HS4	M12thC-1536	F	20+		X	X					
HS5	M12thC-1536	M	20+								
HS6	11thC-1536	M	30-50			X					
HS9	M12thC-1536	M	20+	453		X					
HS10	M12thC-1536	F	18-30			X					
HS11	M12thC-1536	F	18-30								
HS12	M12thC-1536	A	12-18								
HS13	M12thC-1536	F	20+			X					
HS14	M12thC-1536	M	12-18								
HS15	M12thC-1536	F	20+								
HS16	M12thC-1536	A	12-18				X				
HS17	M12thC-1536	M	20+								
HS19	M12thC-1536	A	0-1								
HS22	M12thC-1536	F	20+								
HS26	M12thC-1536	A	12-18								
HS30	M12thC-1536	A	20+								
HS31	M12thC-1536	F	30-50			X			X		
HS32	M12thC-1536	F	20+	419	X	X					
HS34	M12thC-1536	M	30-50	433		X					
HS38	M12thC-1536	F	30-50								
HS42	M12thC-1536	A	0-1								
HS43	M12thC-1536	A	0-1								
HS44	M12thC-1536	A	0-1								
HS45	M12thC-1536	A	4-8								
HS46	M12thC-1536	A	4-8								
HS47	M12thC-1536	F	30-50			X		X			
HS61	M12thC-1536	A	0-1								
HS62	M12thC-1536	F	20+								
HS72	Pre stone church	F	20+								
HS82	M12thC-1536	F	20+								
HS85	M12thC-1536	M?	30-50	451		X			X		
HS93	M12thC-1536	M	30-50	506	X	X					
HS99	M12thC-1536	A	12-18								
HS108	M12thC-1536	F	30-50	418							
HS110	M12thC-1536	A	1-4								
HS111	M12thC-1536	F	30-50								
HS113	M12thC-1536	M	50+		X	X					
HS114	M12thC-1536	M	30-50		X	X					
HS121	M12thC-1536	A	20+			X					
HS122	M12thC-1536	A	4-8								
HS123	M12thC-1536	F	18-30								
HS124	M12thC-1536	F	18-30	441							
HS125	M12thC-1536	M	20+								
HS131	M12thC-1536	F	30-50	414	X						
HS132	M12thC-1536	F	20+	455							

Skeleton ID	Time period	Sex	Age group	FML (mm)	DJD	SD	EH	DA	AMTL	CO	T
HS133	M12thC-1536	F	18-30	422							
HS141	M12thC-1536	F	30-50	453		X					
HS143	M12thC-1536	F	20+	422							
HS144	M12thC-1536	F	18-30								
HS145	M12thC-1536	A	4-8								
HS146	M12thC-1536	F	18-30	423							
HS147	M12thC-1536	F	30-50					X	X		
HS148	M12thC-1536	M	30-50	458	X						
HS149	M12thC-1536	A	0-1								
HS151	M12thC-1536	F	18-30								
HS155	M12thC-1536	F	20+								
HS160	11thC-1536	A	1-4								
HS161	M12thC-1536	A	0-1							X	X
HS163	M12thC-1536	A	0-1								
HS164	M12thC-1536	A	0-1								
HS162	M12thC-1536	F	50+					X	X		
HS165	M12thC-1536	F	20+								
HS176	M12thC-1536	M	18-30	474							
HS177	M12thC-1536	A	18-30			X					
HS179	M12thC-1536	A	0-1								
HS186	M12thC-1536	A	0-1								
HS187	M12thC-1536	A	0-1								
HS188	M12thC-1536	A	0-1								
HS189	M12thC-1536	A	0-1								
HS190	M12thC-1536	M	20+	457							
HS191	M12thC-1536	M?	18-30								
HS197	M12thC-1536	A									
HS199	M12thC-1536	F	30-50	445		X					
HS202	M12thC-1536	A	0-1								
HS203	M12thC-1536	A	20+								
HS204	M12thC-1536	A	0-1								
HS205	M12thC-1536	F	30-50	400				X			
HS206	11thC-1536	M	30-50	478							X
HS207	11thC-1536	M	30-50								
HS210	M12thC-1536	M	30-50			X					
HS211	M12thC-1536	F	20+								
HS212	M12thC-1536	F	18-30			X					
HS213	M12thC-1536	F	20+								
HS214	M12thC-1536	F	30-50			X					
HS215	M12thC-1536	M	30-50								
HS216	M12thC-1536	F	30-50	420		X					
HS218	M12thC-1536	M	20+								
HS219	M12thC-1536	F	20+								
HS220	M12thC-1536	F	20+								
HS221	M12thC-1536	M	30-50	413		X					
HS222	M12thC-1536	F	30-50							X	
HS223	M12thC-1536	F	50+	390	X	X			X		X
HS224	M12thC-1536	F	30-50	447		X		X			
HS231	11thC-1536	M	30-50	477					X		X
HS232	M12thC-1536	M	30-50								
HS233	11thC-1536	F	20+	410							
HS238	11thC-1536	A	20+								

Skeleton ID	Time period	Sex	Age group	FML (mm)	DJD	SD	EH	DA	AMTL	CO	T
HS242	M12thC-1536	F?	20+			X					
HS243	M12thC-1536	A	1-4								
HS244	M12thC-1536	A	0-1								
HS245	M12thC-1536	A	0-1								
HS247	M12thC-1536	M	30-50	463		X			X		
HS249	M12thC-1536	F	18-30	397							
HS250	M12thC-1536	M	18-30	481							
HS251	11thC-1536	M	30-50	471		X					X
HS252	11thC-1536	A	1-4							X	
HS253	11thC-1536	M	30-50			X			X		X
HS254	M12thC-1536	F	50+		X	X					
HS255	M12thC-1536	A	0-1								
HS256	M12thC-1536	A	0-1								
HS257	M12thC-1536	F	30-50			X	X	X			
HS259	M12thC-1536	A	20+								
HS260	M12thC-1536	F	20+								
HS261	11thC-1536	M	30-50			X					
HS262	M12thC-1536	F	20+								
HS263	Pre stone church	A	1-4								
HS264	M12thC-1536	A	20+								
HS265	M12thC-1536	F	20+								
HS266	11thC-1536	A	0-1								
HS277	11thC-1536	A	8-12							X	
HS278	11thC-1536	A	8-12								
HS279	11thC-1536	A	4-8							X	
HS281	M12thC-1536	M	20+								
HS282	M12thC-1536	F	30-50								
HS283	M12thC-1536	F	20+								
HS284	M12thC-1536	F	18-30						X		
HS285	M12thC-1536	F	30-50								
HS286	M12thC-1536	A	20+								
HS290	M12thC-1536	A	1-4								
HS291	M12thC-1536	F	20+		X						
HS294	Pre stone church	F	30-50								
HS295	M12thC-1536	F	20+								
HS302	M12thC-1536	A	0-1								
HS303	11thC-1536	F	18-30	410							
HS306	11thC-1536	A	8-12								
HS308	M12thC-1536	M	20+								
HS309	M12thC-1536	M	30-50	496							
HS310	M12thC-1536	M	30-50			X					
HS311	M12thC-1536	M	30-50		X	X				X	
HS313	11thC-1536	M	30-50	488							
HS315	M12thC-1536	F	20+								
HS319	11thC-1536	M	30-50			X					
HS320	11thC-1536	M	50+								X
HS321	11thC-1536	A	1-4								
HS325	M12thC-1536	A	0-1								
HS326	M12thC-1536	F	30-50	448	X	X					
HS329	M12thC-1536	A	0-1								

Skeleton ID	Time period	Sex	Age group	FML (mm)	DJD	SD	EH	DA	AMTL	CO	T
HS330	Pre stone church	A	1-4								
HS331	Pre stone church	A	1-4							X	
HS332	Pre stone church	A	1-4								
HS335	M12thC-1536	A	12-18								
HS339	M12thC-1536	A	30-50			X					
HS342	Pre stone church	F	18-30								
HS343	M12thC-1536	F	20+								
HS344	M12thC-1536	F	20+	416							
HS347	M12thC-1536	A	0-1								
HS348	M12thC-1536	A	12-18								
HS349	M12thC-1536	A	0-1								
HS351	M12thC-1536	F	30-50		X	X					X
HS353	M12thC-1536	M	50+	495	X	X		X			
HS354	M12thC-1536	A	20+								
HS356	Pre stone church	A	0-1								
HS357	M12thC-1536	F	30-50	421							
HS358	M12thC-1536	A	0-1								
HS359	M12thC-1536	F	20+								
HS360	M12thC-1536	A	0-1								
HS363	M12thC-1536	F	30-50	418		X			X		
HS364	M12thC-1536	M	30-50			X					
HS371	M12thC-1536	M	18-30								
HS372	M12thC-1536	F	30-50								
HS373	M12thC-1536	M	50+	451	X	X					
HS374	M12thC-1536	A	0-1								
HS376	M12thC-1536	M?	20+								
HS385	M12thC-1536	M?	30-50	463							X
HS398	M12thC-1536	A	0-1								
HS400	Pre stone church	M	18-30	499	X						
HS411	Pre stone church	F	18-30								
HS416	Pre stone church	F	30-50								
HS425	M12thC-1536	F	30-50	448	X						
HS426	M12thC-1536	F	30-50			X					
HS427	M12thC-1536	A	1-4								
HS429	M12thC-1536	M	30-50								
HS433	M12thC-1536	M	18-30								
HS434	M12thC-1536	A	20+			X					
HS436	M12thC-1536	F	30-50			X					
HS437	M12thC-1536	F	30-50		X						
HS438	M12thC-1536	M	30-50								
HS439	M12thC-1536	M	50+								
HS440	M12thC-1536	M	20+								X
HS441	M12thC-1536	F	30-50		X	X			X		
HS442	M12thC-1536	A	12-18								

Skeleton ID	Time period	Sex	Age group	FML (mm)	DJD	SD	EH	DA	AMTL	CO	T
HS443	M12thC-1536	F	18-30								
HS444	M12thC-1536	F	20+								
HS446	M12thC-1536	M	18-30	466							
HS447	M12thC-1536	F	18-30								
HS448	M12thC-1536	F	30-50			X					
HS449	M12thC-1536	A	12-18								
HS453	M12thC-1536	M	50+			X					
HS454	M12thC-1536	A	30-50								
HS455	M12thC-1536	F	18-30								
HS456	M12thC-1536	M	20+								
HS457	M12thC-1536	A	20+								
HS458	M12thC-1536	F	20+								
HS459	M12thC-1536	M	20+								
HS460	M12thC-1536	F	18-30				X				
HS461	M12thC-1536	A	20+		X						
HS462	M12thC-1536	A	12-18								
HS463	M12thC-1536	M	20+								
HS466	M12thC-1536	A	0-1								
HS467	M12thC-1536	F	20+	412							
HS469	M12thC-1536	F	18-30	441							
HS470	M12thC-1536	M	30-50	463		X					
HS471	M12thC-1536	F	30-50								
HS472	M12thC-1536	A	0-1								
HS473	M12thC-1536	A	0-1								
HS476	M12thC-1536	M	50+		X						
HS478	M12thC-1536	A	20+								
HS479	M12thC-1536	F	20+			X					
HS481	M12thC-1536	A	20+								
HS482	M12thC-1536	F	18-30				X				

FML=femur maximum length, DJD=degenerative joint disease, SD=spinal degeneration, EH=enamel hypoplasia, DA=dental abscess, AMTL=ante-mortem tooth loss, CO=cribra orbitlia, T=trauma