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Maxillary Sinusitis in Medieval Scania

Prevalence of sinusitis in three osteological materials.



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Abstract

The objective of this thesis was to contribute to the limited research that has been carried out concerning maxillary sinusitis in medieval Scania. The aspiration was to do an inclusive comparative osteological analysis of three skeletal materials and investigate whether there is a difference in prevalence among rural and urban individuals as well as between sex, age and if an aetiology was visible. The materials chosen for this study consists of one from S:t Jörgen, encompassing 107 individuals, which represents the urban material while the rural consists of two different skeletal materials. One from Löddeköpinge composed of 76 individuals along with 31 individuals from Norra Åsum.

The results revealed that there was no significant difference between the rural and urban materials. The females were slightly more affected by maxillary sinusitis than males in both rural and urban materials. The older individuals in all three materials were more affected by maxillary sinusitis. There was, however an indication that the younger individuals in the urban material were more susceptible to maxillary sinusitis than the younger individuals in the rural. The aetiology could not be clearly defined due to several reasons, one of them is most certainly that it is multifactorial as well as that the sample size was small. Nevertheless, this study needs to be seen as a pilot study and it shows great potential to contribute to the pathological knowledge and understanding of the medieval period.

Keywords: Osteology, Maxillary sinusitis, Medieval, Scania

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1. Introduction

The medieval period in Sweden was a time full of change, going from a more rural society to an urban one. The cityscape we see today in Sweden was established during this time (Andrén 1985, p.3). The early medieval period was to a certain extent formed by the turbulent and unruly social and political situation happening in the country, at the time when Norway attacked Scania and Jylland. This combined with an uprising among the farmers demonstrating the payment to the bishops that had been decreed at this time. There was also a shift in the social structure, where an upper-class had started to form in the rural regions in Scania. The Danish crown and the church had also gotten a stronger hold on the region during the early medieval time (Schmidt-Sabo 2005, p.12-f).

All these factors could have the agency to influence the general health of both a rural as well as an urban population. The structures, urban or rural are not something static, but rather something fluent that is not only shaped by the people but also something that shapes them (Schmidt-Sabo 2005, p.45). One of the significant differences between the rural and urban environments was that the urban one was not self-sufficient, it relied on help from the countryside for provisions. It was also a considerably limited area with quite a large population, which could have a detrimental effect on the general health. Not only due to the cramped living conditions but also due to the amount of refuse and provisions (Arcini 1999, p.13). The high population density is a contributing factor to the survival and spread of infectious diseases. The relation between population size and the spread of infectious diseases has been called the threshold effect, which means that when the population reach a large enough size it results in a more favorable environment for the disease combined with an accelerated spread (Cohen 1989, p.48).

The purpose of this thesis is to gain a deeper understanding of the differences between a rural and urban population in medieval Sweden from an osteological approach. The focal point is the health, more specifically if the living conditions in a town were detrimental to the health in the sense that it affected the general health of the maxillary sinuses. The possible differences between the rural and urban population could create a pattern where the sinuses are unequally or equally affected by sinusitis between the sexes as well as the age groups. The studies that have been carried out concerning sinusitis among rural and urban populations during the medieval period, have provided quite varied results. Even though the disease is well-known there are still many questions that remain unanswered, especially in the

archaeological material. Not solely concerning its aetiology but also which groups in the society that might be more susceptible to the disease. If the analysis shows a pattern between the prevalence of sinusitis and different age or/and sex groups there might be social circumstances such as certain work tasks that exposed that significant group more than others.

1.2 Aims and research questions

Maxillary sinusitis is a common health problem, not only at the present but also historically. However, there are still many questions that are left unanswered. Not solely concerning why the sinuses exist, but also questions regarding the aetiology and pathogenesis of the disease. There are several hypotheses that link the disease to environmental conditions, which would mean that the prevalence would vary depending on if you lived in an urban or a rural area. It would also be of interest to see whether there is a difference in the severity of sinusitis between rural and urban individuals as well as age and sex, which could give an insight into the general quality of life at this point in time.

However, there is still limited paleopathological work done on this subject especially in Sweden, which is why I have chosen to investigate it further. I focus on the chronic cases of sinusitis since this is generally what leaves marks on the skeleton. I have opted to do an inclusive study, which means that all ages will be included. The aim is to do a comparative study of the prevalence of maxillary sinusitis in three different osteological materials from medieval Scania. Approximately two hundred individuals have been studied, half is comprised of the urban material which is from S:t Jörgen in Malmö and the rural material consists of osteological material from Norra Åsum and Löddeköpinge.

To gain a deeper understanding of sinusitis in medieval Scania I have chosen to investigate the following research questions:

- Is there a difference between the urban and rural populations?
- Are there any differences between males and females?
- Are there visual differences between old and young individuals?
- Is an aetiology distinguishable for the disease?

2. Background

The aim of this chapter is to give a framework for the following chapters, with a comprehensive presentation of what is known about the aetiology and pathogenesis of sinusitis along with a discussion regarding rural and urban life. The chapter concludes with a discourse concerning the osteological material used for this study and the previous archaeological work conducted on the subject.

2.1 Sinusitis

Sinusitis is an inflammation in the paranasal sinuses, and even though it is a common affliction there are still many unanswered questions concerning the aetiology and pathogenesis (Boocock et al. 1995a, p.483). It is a common affliction all over the world, the WHO also known as World Health Organization includes this within Chronic obstructive pulmonary disease (COPD) which is an umbrella term for several diseases. An estimation was made in 2004 that over 64 million people around the world suffer from COPD and is believed to be the third leading cause of death by 2030 (World Health Organization). Research carried out by Örebro University Hospital states that approximately 10% of the European population suffers from chronic sinusitis which has a detrimental effect on quality of life for these individuals (Hugosson et.al 2018).

There are four symmetrical sinuses (maxillary, ethmoid, frontal and sphenoid) in the human body. The growth process of the sinuses is a gradual one, from childhood until they reach adult size in adolescence. However, it is only the maxillary and ethmoid sinuses that exist from birth. The sinuses are air-filled cavities that are interconnected through the sinus ostia, which are small openings that drains to the nasal cavity. The maxillary sinuses drain into the middle meatus which is a nasal passage of the nasal cavity, located next to the maxillary sinus. The ethmoid, frontal and maxillary sinuses merge and drains in the ostiomeatal complex, a channel that links them together (Fig.1). The development of viral or bacterial sinusitis is due to a blockage or inflammation in the ostiomeatal complex since it disturbs the effectiveness of mucociliary clearance (Brook 2009, p.126).

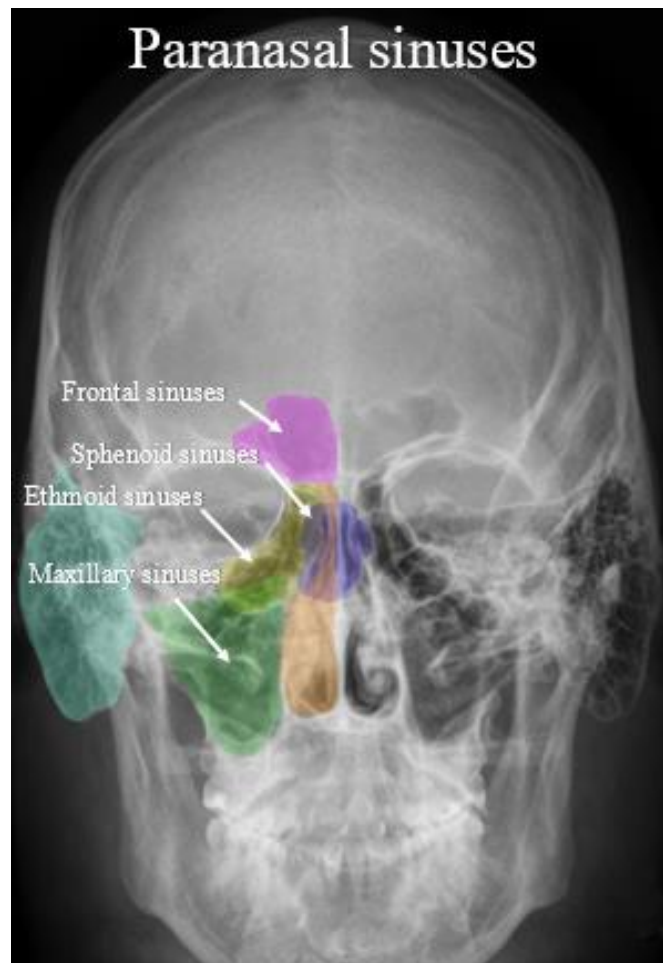


Fig.1 Image illustrating the paranasal sinuses.

Photo from: Wikimedia Commons

The sinuses serve several functions, one of them is as a physical and chemical defense against particulate matter and pathogens that are inhaled (Roberts 2007, p. 794). However, there are still gaps in our knowledge concerning their function and what governs their shape. These questions have been debated relentlessly for decades and have to this day not been agreed upon. Although, there are several technical advances made in computed tomography (CT), magnetic resonance (MR) or positron emission tomography (PET) scanning allowing for a better understanding of variation in development as well as diseases (Laitman 2008, p.1347-1349). On this much debated subject Márquez (2008, p.1351) wrote a much-needed simplification on why the sinuses exist... “The various putative reasons for the existence of the sinuses can be grouped into three categories: architectural; physiological; and nonfunctional.”

One of the prerequisites for a healthy sinus is a maintained ventilation of the sinus. The oxygen that is consumed by the mucosa of the maxillary sinus consists for the most part of antral air. A person that is affected by recurrent sinusitis will have a reduction of oxygen

tension in the antral air compared to a healthy person. This reduced ventilation of the medium has proven to be a more favorable environment for bacterial growth. The bacteria were also able to maintain these low oxygen tension even after ventilation was restored. Another key fact to a healthy sinus is the drainage. If the secretion, which consists of mucus, inflammatory exudate, bacteria as well as inflammatory cells is not discharged, there is a higher risk of inflammation (Lundberg & Engquist 1983, p. 53-55). Sinusitis among children is quite rare, however if it develops it tends to be when the child is between four and ten years of age. The main cause for its development at such a young age is the climatic conditions (Ballenger 1985, p.215).

Sinusitis can be quite easily omitted when looking for pathologies since the sinuses are air-filled cavities inside the skull. In most of the severe cases of sinusitis it is more likely to be chronic which will affect the general health of the person. If the affliction is left unresolved it could possibly lead to bronchitis as well as pneumonia (Wells 1964, p. 80).

Most of the symptoms associated with acute sinusitis are postnasal drip, nausea, facial pain, fever and cough. These symptoms are similar for chronic sinusitis, which will be the focal point for this thesis (Evans 1994, p.1415-1416). Chronic sinusitis is the type that is visible for osteologists due to the fact that it takes weeks for a bone reaction to happen. A healthy sinus has an atrium that is smooth and regular in appearance, with some minor channels that in life contained blood vessels and nerves. Whereas a sinus afflicted with sinusitis have pitting, white pitted bone and/or spicules. The aetiology of maxillary sinusitis is numerous but can broadly be put into three separate categories; systematic susceptibility, congenital predisposition and/or environmental conditions (Lewis et.al. 1995, p.498-502). The environmental conditions could be harsh climate, from cold and wet to hot and dry with dust-laden air. It might also develop due to close living conditions, ill ventilated houses with open fires (Wells 1964, p.81). Apart from the environmental factors there is also the risk of an apical infection if a tooth root perforates the floor of the sinus leading to an infection. The risk is heightened if the tooth is removed and leaving a portion of the root behind or if a fistula forms inside the maxillary sinus (Ballenger 1985, p.205) Chronic sinusitis as mentioned earlier, is a multifactorial disorder which arise if an acute inflammation is continuous or acute or subacute sinusitis reoccurs. Though, there are also some physical abnormalities such as a smaller opening to the sinus, or a reoccurring episode of a cold or allergy that could facilitate the risk of sinusitis (Cardesa et.al. 2006, p.41). The restoration of the sinus to its normal milieu is always the priority in the treatment of maxillary sinusitis, usually by antral puncture or lavage. Penicillin is the antibiotic of choice when dealing with sinusitis, due to its

effectiveness (Ekedahl 1983, p.56). However, even if today's treatment is antibiotics it is not unproblematic since the resistance has grown substantially over time. Another option is surgical drainage as previously mentioned. Drainage has been a treatment in prehistoric times as well (Brook 2009, p.133-134). Trephination is believed to have been used as a way to treat headaches which were caused by several afflictions such as sinusitis. This has been seen in several cases such as the skull from Tarkhan in Egypt as well as an American case where a skull had its frontal sinus opened as a way to relieve the pain from what could be chronic sinusitis. Another case from Collombey-Muruz, Switzerland had a trephination through its eye-socket and the medial floor and wall were cut, opening up both the frontal and maxillary sinus (Wells 1964, p.143-144).

2.2 Urban and rural

The urbanization of Scania unfolds during the medieval period which needs to be understood through a Danish and south Scandinavian context. This time in Denmark can be put in three distinct periods; the early medieval period (990-1150), the high medieval period (1150-1350) and the late medieval period (1350-1550). The earliest cities functioned as royal regional centers where the political, financial and administrative functions were gathered. Some of the cities date back to the Viking age, like Lund, Helsingborg and Lomma. Due to the changes in the high medieval period, the cities began to move away from being important places for the royal and political power to gain a more commercial importance. The cities reach their peak of independence as well as evolving into a central place for trade in the late medieval period (Carelli 2007, p.88-90).

Even though, the urbanization did not fully commence until the medieval period, it was established in the early iron age. The iron age was the time where the preconditions and foundations were created for what would become the actual cities. It is not until the late medieval times that the concept of a city person, special institutions in the city as well as fortifications such as city walls were formed. Anglert & Larsson (2008) assert the changing perception of the rural landscape from viewing it as something passive and unproblematic. To the present understanding, which is quite contradictory, the view is that the country side is looked at as something active and nonlinear. It would be a mistake to simplify something that is clearly problematic. Not only are there several factors that play a significant role in the development of the urban and rural landscape, and there are also clear differences on a local

and regional level. The changes that are visible in the landscape have happened at different rates and are bound and formed their individual prerequisites. The landscape that surrounds Malmö has during both prehistory as well as historically been characterized by numerous settlements that were in close proximity to each other (Anglert & Larsson 2008, p.303-306). It is important however to understand that there might be a need to have a distinction between the early and the later medieval urban environments since the general health might not have been too affected in the early stage of urbanization (Arcini 1999, p.13). Although, this is not something that should have affected the urban material in this thesis since it is from the latter half of the medieval period.

There are cases where a dependency on immigration from the country side, developed to maintain the population due to a high mortality rate among young individuals. Boldsen (1990) compared the data from several osteological materials from medieval Denmark, relating height variation to social and regional differences by the measurement of the thighbone. The osteological material from Löddeköpinge, which partly comprises the rural material for this study was part of the study of Boldsen. Along with an osteological material from S:t Stefan in Lund showed that the materials from Scania was shorter than that of Jutland. There was also a difference in height in the material from Löddeköpinge where the more well-off people were 3 cm taller than the poor. These differences in height could be contributed as the effects of regional, structural and social differences (Boldsen 1990, p.181-183). Another deviation between the countryside and the town is the work structure. There are different restrictions and possibilities, where the towns relied on specialization and collective distribution of tasks. While the countryside depended on self-sufficiency compared to the importance of the collective (Carelli 2007, p.94).

There was a shift in the cultural landscape between the 13th and 14th century due to an increase in the population along with social tension among the farmers and the nobility. However, there was also a dependency between the urban and rural communities that had not existed before. There was still a clear need for agricultural production, simultaneously as a need for prestige-products. This co-dependency created not only restrictions but also new possibilities of lifestyle and living (Thomasson 2008, p.296-f).

Archaeological investigations of several constructions along Västergatan and Östergatan in Malmö have been related to the preparation of fish. Connecting the place to a well-known medieval market known as Skånemarknaden. Malmö would have an even more prominent role in the commerce of herring in the latter half of the 13th century (Billgren 2002, p.8).

S:t Jörgen is the name of the patron saint of leprosy in the 14th century, since this is the

name of the cemetery it is thought that the earliest purpose for the location was a hospital dedicated to patients with leprosy. However, this has not been confirmed by any archaeological features at this point in time. The osteological material does not verify this as the purpose of the cemetery either since the material is not affected by leprosy to any larger extent than any other cemetery (Einarsen 2002a, p.13f).

2.3 Archaeological background

This portion of the background is intended to give an overview of the archeological sites where the osteological material comes from in this study. The first part is focusing on the urban site of S:t Jörgen and the latter part is about the rural sites; Norra Åsum and Löddeköpinge.

2.3.1 S:t Jörgen

The quarter of S:t Jörgen is situated in the city center of Malmö. It is surrounded by Baltzarsgatan in the north, Södergatan towards the west and Kalendegatan in the east. The chapel of S:t Jörgen was first mentioned in written sources 1461 (Sarnäs 2012, p.5). It was located where Baltzarsgatan 34 is today. The chapel was in all probability demolished around 1549, even though the name is referred at a later date (Rosborn 1984, p.20). The topography of Malmö is quite varied, and the city sits on a sandy type of soil that is fine-grained. Some of less advantageous preservation conditions were observed around the quarter of S:t Jörgen (Gardelin 2005, p.41).

The first encounter with the archaeological remains of S:t Jörgen was during the building of Butterickshuset in 1912. Both graves and remnants from the surrounding wall were discovered however, several skeletons were discarded without properly documenting it first. It was not until 1989 that the first archaeological excavation was initiated by Malmö museum which finished in 1993. Archaeologist uncovered the remnants of the medieval chapel of S:t Jörgen, as well as the cemetery with over 1500 graves. The majority of the graves were quite well-preserved, however, there were some graves that were damaged and affected by poor soil conditions, water or dug through during the excavation (Einarsen 1989, p.1-2). If all the loose bones from disturbed graves would be included the number of interred individuals would be twofold. The majority of the individuals were uncovered south of the chapel, in some cases there were as many as six layers of graves on top of each other (Einarsen 2002b, p.22).

The osteological material was examined and recorded by the Department of Anthropology (ADBOU), Institute of Forensic Medicine, University of Southern Denmark- Odense for the article *Epidemiological Approach to the Paleopathological Diagnosis of Leprosy* by J. L.

Boldsen in 2001. The material was also examined by Svenja Weise in 2009 for her Ph.D. thesis *The Medieval Cemetery of S:t Jörgen in Malmö, A Paleodemographic Analysis*.

In the figure below all three geographical areas are presented to illustrate the distribution the materials used in this thesis.



Fig.2 Map of Scania depicting Löddeköpinge (diamond), Norra Åsum (triangle) and S:t Jörgen (circle).

Photo from: Wikimedia Commons

2.3.2 Norra Åsum

In 1983 an archaeological investigation of 71 graves was initiated due to a road construction on Fredskogsvägen in Norra Åsum. Of the 71 graves there were 68 preserved skeletons mostly towards the north, due to more beneficial environment for preservation. There was finer sand towards the north while the south had a more courser sand-quality which is unfavorable. The graves at the cemetery were first uncovered in 1959 when they were digging for cable in the area. Resulting in an exhumation of ten graves by the county custodian of antiquities, the graves were dated to the mid-19th century during a cholera epidemic. While construction of housing was conducted in the area in 1979, leading to more extensive excavations could be undertaken which unearthed 40 archaeological features. This excavation uncovered archaeological artefacts that aided in the dating of the cemetery.

A preliminary investigation of the area was conducted in 2010 by Sydsvensk Arkeologi. The investigation covered an area of 1750 m² and affected the cemetery and graves that this analysis encompasses. However, the disturbance to this area was minimal, only some human bones were uncovered but no intact graves due to earlier unauthorized trenching (Kockum

2010, p. 7-13).

The skeletons uncovered in 1983 were oriented in an east-western direction. There were nine individuals that were buried in caskets and 59 individuals that were buried without (Beijer 1983, p. 3-9). The osteological material was also used in the thesis *Barnen i spegeln - en studie av barn och ungdomars hälsa i de tidigmedeltida Tygelsjö och Norra Åsum* by Bratt et.al (1997). This material was deemed as more representational to its time than Tygelsjö since it was better preserved and had a higher frequency of infants as well as a seemingly fair representation between males and females. Their study encompassed 52 individuals between the ages 0-20 years, out of 107 in total. The children suffered from various conditions, such as linear enamel hypoplasia (LEH) and cribra orbitalia (CO). The thesis also focused on the timespan for the individuals in relation to the afflictions as well as mortality, which varied quite a bit between the ages (Bratt et.al 1997, p.133-135).

More graves have been found since the report by Beijer (1983), culminating in 117 graves. However, some of the graves did not have any preserved skeletons while others housed several individuals. During the excavation there was problems identifying the graves due to the soil quality which made it difficult to distinguish the outline of the graves. Additional challenges such as previous work in the area, from house construction and digging for cable complicated the excavation (Kockum 2010, p.8).

2.3.3 Löddeköpinge

The osteological material from Löddeköpinge comes from the medieval cemetery that was excavated by the Department of Archaeology at Lund University between 1975 and 1980. The excavation was led by Tom Ohlsson and the osteological analysis was performed by Ove and Evy Persson, whilst the data processing and statistics of both the osteology and demography was executed by Jesper Boldsen. An area of 2700 m² and 1700 graves were examined. The entire cemetery is assessed to cover an area of ca 5000 m², with approximately 2500 graves.

The positioning of the skeletons, with the heads towards west as well as the lack of grave goods attest to a Christian burial. The data also suggest that the graves are from the early medieval period around the 11th century, on account of the positioning of the skeletons and the sherds of ceramics found in the graves (Cinthio 1988, p.121-125). There was an area in the central part of the cemetery that was without graves which have been interpreted as the location where the former church stood. The eastern part of the cemetery is understood to be the oldest part of the cemetery dating back to the 11th century. The cemetery was later in the

11th century extended towards the west and was discontinued in the latter half of the 12th century.

Since the cemetery is used during a rather short period of time and retained numerous individuals in such a small-scale area, it suggests that the individuals could come from a greater region than earlier interpretations presumed. However, there is some debate regarding the dating that the cemetery was used at a later date. Jacob Kieffer-Olsen and Peter Carelli, postulate that the cemetery was used for a longer period of time and that the dating should be closer to 12th century – 14th century (Jonsson 2009, p. 43f). The osteological material from Löddeköpinge has also been part of theses by Svensson (2007), Wiberg (2007 & 2008), Hagefalk et al. (2009) Hagefalk (2011), Nattwind (2011) and Stråhlén (2014).

2.4 Research history

This chapter contains the relevant archaeological research done on sinusitis in prehistory, mostly focusing on studies with a focal point in northern Europe. Some attention will be brought to the current research on sinusitis to give an insight into the medical outlook on the affliction today.

2.4.1 Maxillary sinusitis

Some of the first mentioning's of the sinuses goes as far back as Hippocrates in 400 BC, who described the nasal function as the drainage of the mucus of the brain and then 600 years later the Greek anatomist Galen mentioned them (Márquez 2008, p. 1351). However, it was not until Leonardo da Vinci that the maxillary sinuses were drawn and described in 1489 after he dissected a human head obtained after a probable execution (O'Malley & Saunders 1983, p.27,44). It is also worth mentioning the scholars that further the research on the human sinuses to where it is today by giving an anatomical description, such as Mouret (1898), Sieur and Jacob (1901) and Grünwald (1925).

There are several studies on sinusitis among archaeological material, however, even though the condition is common there are several questions that remain unanswered regarding differences in prevalence depending on age, sex and environment. One of the first comparative studies on a rural and urban medieval population in Britain was done in 1995.

The study asserted a higher prevalence of maxillary sinusitis in the urban population (55 %) than the rural (39%). There was also an indication that there could be a correlation between

the affliction and the occupation as well as industrial air pollution in the city of York which lead to a higher rate of sinusitis in the urban population (Lewis et.al.1995, p.497). Boocock, Roberts and Manchester (1995) investigated a relation between leprosy and sinusitis in their study of 133 individuals from the medieval times in England. In the material 54.9 % presented bone changes in their sinuses. The results also showed that there was little difference in frequency between nonleprosy and individuals affected by leprosy. However, they did see the environmental factor as a possible explanation of the prevalence of sinusitis. There are many things that increase the risk of infection, such as malnutrition, poor housing and environmental pollutants like smoke particles, underventilation or even overcrowding (Boocock et al. 1995b, p.265-267). A study conducted by Panhuysen et al. (1998) focused on maxillary sinusitis in medieval materials from Maastricht in the Netherlands. It concluded that there were no visible differences among the rural and urban materials. It also revealed that odontogenic sinusitis was the most common among all the individuals which made it hard to see if there were any associations to environmental factors (Panhuysen et.al 1998, p.610-611).

A study was conducted of 207 individuals from the Southern Ontario Iroquoian sample dated to ca AD 1440 by Merrett et al. (2000). The results showed that almost half of the individuals suffered from chronic maxillary sinusitis, and that it increases with age. The males and females in the study were exposed to similar predisposing factors leading to the development of sinusitis (Merrett et al. 2000, p. 300-316).

The environmental factor has also been the focal point in a study by Roberts (2007), where she investigated whether poor air causality could be a leading cause for maxillary sinusitis. The study consisted of seven skeleton samples, from North America, Nubia and England. The places were chosen to show environmental and subsistence economic diversity. The results were then compared to previously studied data. The presence of sinusitis varied from 17.2 % to 51.5 % between the seven different skeletal samples. The results indicated also that different portions of the population were affected by sinusitis. There were a clear sex differences among the 15 sites, were 11 out of 15 sites showed that females were more affected. Both rural and urban sites were affected, the most apparent differences were seen regionally. Which means that the urban and rural aspect might not be essential for predisposition rather that the overall geographical place was influential from an environmental and climatic perspective. There were differences among hunter-gatherers and agricultural people, the results revealed that rural agricultural sites were more consistently affected (Roberts 2007, p.792-799).

The skeleton samples from North America, which was prominently rural settlements

showed that females were more affected. This result could be an indication of a relation between occupation and the prevalence of sinusitis. It could mean that the females had more indoor activities than their male-counterparts who had more tasks outdoor. Another site at Indian Knoll with a population that were foragers with a semi-nomadic lifestyle, showed less difference between the sexes, suggesting that they spent a more equal time outdoors. There were also sites with archaeological material indicating towards that there had been several smoke-producing industries, like metalworking and pottery production which could have predisposed the people to sinusitis (Roberts 2007, p.800-f). Beyond the environmental factor there is also the potential to detect occupational patterns which was one of the focal points in the study by Roumelis (2007). The osteological sample suitable for the study of maxillary sinusitis was quite limited, only comprising 86 adults and 27 subadults. The skeletal sample was from the rural medieval town of Kirchberg. Almost all the individuals exhibited signs of maxillary sinusitis to some degree, more so the males. Among the adults 98 % had some form of visible abnormalities while 77.8 % among the subadults were affected. Both sides of the sinuses seemed to be equally affected among the males, females and subadults (Roumelis 2007, p.48-f).

In an additional study concerning the relation between environmental factors and health by Liebe- Harkort (2012), had the aim to study the presence and distribution of cribra orbitalia, enamel hypoplasia and maxillary and frontal sinusitis in an osteological material from Smörkullen, a Roman Iron Age burial ground. The results of the study suggested that the environmental factors and malnutrition affected the immune system which lead to fairly high representation of cranial lesions. The study included subadults, nine out of twenty individuals suffered from maxillary sinusitis. Several individuals suffered from multiple afflictions, such as cribra orbitalia and sinusitis. Among the adults (69 individuals) 88.4 % were affected by maxillary sinusitis. However, there was little difference between the males and females of the study (Liebe-Harkort 2012, p.387-397).

Two other studies were conducted between rural and urban populations by Sundman and Kjellström (2013). In one study they analyzed the influences and negative impact on sinus health in rural and urban populations in Viking age and early medieval Sweden. They did a comparative study between 32 rural settlements in the Mälaren Valley and a proto-urban material from Birka. The results showed no clear difference regarding the prevalence of sinusitis.

Nevertheless, when they compared the results with the results from their previous study that focused on the urban medieval population of Sigtuna they saw a that there were more

individuals affected in the material from Sigtuna, which could imply that the urban environment had a detrimental effect on sinus health. Another significant difference that could be discerned was in the material from Birka which showed that more women than men were affected by sinusitis. This result indicates that the work tasks might be gender based or that environmental factors made women more susceptible to infections (Sundman & Kjellström 2013b, p.4457-4458).

Children are some of the most vulnerable members of society and should therefore be more susceptible to sinusitis, especially in urban sites compared to the rural. This is the hypothesis established by Krenz-Niedbała and Łukasik (2016) in their study of maxillary sinusitis among 100 subadults in medieval urban and rural sites in Poland. The results showed a non-significant difference between the rural and urban material. There was however a rather low number of affected individuals compared to previous studies. All cases of sinusitis were believed to be of respiratory origin, which was not unexpected since dental sinusitis is more likely to arise in older individuals. The underlying cause of the disease was believed to be poor air-quality, bad hygiene, low quality of housing and that the water was contaminated by human respiratory adenoviruses (Krenz-Niedbała et.al 2016, p.103-110).

The problems concerning sinusitis are still to this day an issue, since the condition is quite often overlooked as well as misunderstood. There are cases where it has been mistaken for a common cold in adult and is easily omitted among children. Misdiagnosis along with wrongful treatment can lead to chronic sinusitis and other serious conditions. There are, however, several misconceptions that have been clarified due to more advanced techniques such as endoscopy and other surgical techniques which have been essential both for the anatomy of the sinuses but also postoperative care (Josephson et.al 1994, p.2). The current discourse in the medical community tend to center around how to improve the diagnostic process, as well as the treatment process.

Dr. Wyler and Dr. Mallon wrote an article concerning the current clinical problems facing the medical community today. Their article advocated that the complexity concerning sinusitis needed to be more acknowledge due to the present mistreatment. There are several instances where unnecessary antibiotics are prescribed when the cause is viral pathogens, which cannot be treated by antibiotics. This could however easily be rectified by a stricter criterion for clinical diagnosis. There are also the perpetual questions concerning the expenditures, not only the medical cost of the medicine but also loss of work that needs to be considered when treating sinusitis today (Wyler and Mallon 2019, p.41). The cause and treatment of sinusitis is also the focal point in a study by Whyte and Boeddinghaus (2019).

Odontogenic cause for maxillary sinusitis is believed to be as high as 25 to 40 % of all current cases however, odontogenic infection is still not thoroughly explored by radiologist. Which is problematic since imagery is key to make the distinction between odontogenetic and rhinological as the underlying cause (Whyte and Boeddinghaus 2019)

3.Theory

The theoretical chapter will discuss what biocultural theory can contribute to the osteoarcheological field and other areas in archeology as well as how it is implemented in a study. The latter part of the chapter will focus on the osteological paradox, what it is and why it is an important factor to bear in mind in any osteological analysis.

3.1 Biocultural issues and prospects

Viewing osteoarchaeology as purely atheoretical and technical would be a misrepresentation of the field. It is important to realize that there is no need for technical expertise for successfully to construct methodological strategies (Sofaer 2006, p.33-f). Patterns of biological variation can be seen in several different areas on the human body, both in the soft tissue as well as the skeletal elements (Zakrzewski 2011, p.189).

The aspiration to distinguish which external forces that change, and shape people of the past is a true predicament. While, we can clearly see cultural and social change in society it is much harder to clarify how these changes impacted the population. When it comes to the aspiration to understand the fundamental questions regarding diseases, of how, when, why and where there are several issues that needs to be considered (Stinson et.al 2012, p.12-f).The biocultural approach can be seen as a consolidation of two separate theories, cultural ecology and the evolutionary theory (Bush and Zvelebil 1991, p.5).

The biocultural perspective entails that to truly understand human biology we need to understand that humans are cultural beings. Therefore, it is imperative to approach it from a cultural point of view, as an influence on the environment but also how we as humans relate to the surrounding environment. One cultural aspect that has a crucial impact on human biology is poverty. Poverty is multifaceted and needs to be viewed from multiple dimensions. However, it is as we know a contributing factor for a worse general health and a higher susceptibility to different diseases. In a modern study done by Crooks (1995) on children living in poverty in America and the relation of poverty with health, growth and school

achievement showed that the environmental factors are very important.

Poverty, in relation to location such as rural and urban as well as ethnicity can affect the persons growth leading to low stature and weight, as well as a predisposition for chronic illness. All these aspects can consequently have a detrimental effect on a person's behavior, cognitive development, motivation etc. Even though this was a study concerning children in modern America it is still applicable since it all concerns human beings and shows the many ways a factor such as poverty affects human biology (Stinson et.al 2012, p.3-15). This is simply one of the many contributing factors that affect human biology. There are also various challenges with the biocultural approach when it comes to implementation, most likely due to that we are unaccustomed to measure the cultural. Some of the difficulties are also to prescribe substantiated definitions of poverty, socioeconomic status as well as urban and rural. Along with being able to measure the many different key variables and make sure it is replicable as well as define the multiple pathways (Dufour 2006, p.1-5). Needless to say, the skeletal body has been used to underpin ideas as well as interpretations for quite a long time. Sofaer (2006) contend that there is however an absence of seeing the body as the source and focal point for generating the interpretations. The osteological determinations of sex and gender are many times used for interpretation however, there is a disassociation between osteoarchaeology and archaeological thought (Sofaer 2006, p.2-3).

There is no clear consensus in the discourse concerning the role the human skeletal body should play in paleopathological research, even among the scholars specialized in the issue. Bush and Zvelebil (1991) remark that there is need for caution regarding trying to draw to broad conclusions from a single disease about a past society's health. Not meaning that there is no place for it, but rather that it is essential to tread carefully and not make too grand of claims (Bush and Zvelebil 1991, p.4). Goodman (1991) views are more favorable, seeing the potentials of using the pattern of individual indications of health and disease to see its relation to sociability, reproduction, work capacity and learning. However, this does not mean that the issue is unproblematic. There are challenges that should be acknowledge such as being able to distinguish patterns among individuals and the implications they have on a larger scale, for whole societies (Goodman 1991, p.31-f).

Another instance where the biocultural approach was used was in a study carried out by Eisenberg (1991). The aim was to examine the community health among the people from the cultural period known as the Mississippian. In the area where the city of Nashville resides today in Tennessee, America. The study ventured to use disease within the population, as a way to gain a deeper insight into different aspects of culture in a no longer existing society.

The paleopathological study included 888 individuals from A.D. 1275- 1450. The results of the study revealed how people's lives had been affected by illness and stresses at different point in their lives. The population had quite a few health problems, the younger individuals were affected by nutritional deficiencies, infection as well as bacterial, viral and parasitic problems. The general life expectancy was quite low compared to other contemporary sites. The mortality profile could be explained by different scenarios, from epidemic episodes of catastrophic events that recurred, to chronic diseases. This in relation to the social burdens on the society both political and economical which could have restricted the access to resources. The use of health as a focal point in the study by Eisenberg (1991) has led to a more profound understanding of the complexity and relation between health and culture (Eisenberg 1991, p.115-119).

3.2 Osteological paradox

Some issues need to be considered in the archaeological quest for a greater understanding of past societies health by using skeletal samples as the main source. One of the significant contributions to the discourse relating to the osteological paradox is the article by Wood et al. (1992). Which argues that the interpretations derived from paleopathological and paleodemographical data can not be seen as something straightforward but should rather be regarded as something complex. The authors states that three theoretical issues need to be addressed..." demographic nonstationarity, selective mortality, and hidden heterogeneity in risks..."

The osteological paradox is in a simplified manner of speaking the three issues accentuated by Woods et al. (1992). The demographic nonstationarity concerns the populations which are sensitive to small variations in fertility consequently affecting the age-at-death distributions while the mortality has little effect on the distribution leading to the assumption that it is fertility that should be studied instead of mortality.

The second issue is selective mortality which entails the inescapable fact that the skeletal samples we work with are consisting of dead people. This is problematic since this means we only have a portion of the population that were at risk of disease or death, consequently the people who died. Resulting in the age-group that is analyzed is the people that died at that age not the living, which means that they are not truly representative of that age-group. Therefore, an overestimation of the frequency of a pathological condition is likely to happen.

Lastly, we have the hidden heterogeneity in risks which refers to the issue of the

composition of the skeletal sample that is analyzed. This is on account of the fact that the susceptibility and/or frailty to illness and death of the individuals is an unknown combination among the individuals as well as it is undistinguishable (Wood et al. 1992, p.343-345).

In the article by Bennike et al. (2005) they express the paradoxicality in the attempt to reconstruct health in previous societies. The research centers around preadults from two skeletal materials from medieval Denmark, one from a leprosarium in Næstved and a more privileged group from Æbelholt. To base a study on preadults can be beneficial in the sense that it is not as enigmatic as materials on adults due to the methodological flaws of aging adults.

However, the material in the study cannot be regarded as entirely unproblematic since the individuals from Næstved were at the leprosarium for a reason. Hence their representativity of how the health was in the past society is not only questionable but doubtful. This can be said to all similar studies, in the sense that the people failed to adapt to the environmental and cultural factors which altered the community one way or another. The study highlighted the importance to never forget the economical, historical and cultural contexts of people in the past as well as the problem of only study one age group in a osteological material (Bennike et al. 2005, p. 734-744).

4. Material

The material chapter will encompass three parts; firstly, a presentation of the material used for the study, describing the general preservation as well as limitations and difficulties in each individual material. Secondly a brief discussion on the different dating methods used, and lastly a review of taphonomy as an imperative factor.

4.1 Osteological material

The material used in this study is intended to represent the rural and urban individuals that lived during the medieval time in Scania. The urban consists of 107 individuals from the cemetery of S:t Jörgen in Malmö curated by Malmö Museer, while the rural population is composed of two different materials encompassing 107 individuals. One of the osteological materials consists of 31 individuals from Norra Åsum near Kristianstad and the other material of 76 individuals comes from Löddeköpinge. Both rural materials are stored at the repository of Historiska museet in Lund.

The dating of the materials span from the early medieval times to the end of the period. In

ideal circumstances the timeline would be narrower between the materials. However, this is not possible due to the focal point of the study: sinusitis, since it requires well preserved specimens. This means that the material needs to be of sufficient size since many skeletons are too well preserved consequently leading to exclusion along with the need for a fair representation between sex and age. There are also time restrictions that needs to be considered.

The state of preservation and fragmentation level was good in all materials. The rural materials were slightly poorer, nevertheless this did not affect the analysis in any substantial way. Even though the sinuses are susceptible to damage due to its composition and placement they were generally well-preserved.

Furthermore, there is also a need to acknowledge the fact that there are several factors such as genetics and non-skeletal diseases or injuries that could affect the general health of a person. Thus, leading to a susceptibility to maxillary sinusitis or other diseases, that can not be attributed to either environmental, age or sex related factors. However, the complexity of human health is far too extensive to include in its entirety in this thesis.

There are several factors that determine whether an individual was chosen for the study, the most essential was preservation. However, since the materials from S:t Jörgen as well as Löddeköpinge were quite extensive not all individuals with sinuses could be included which meant that I had to apply a randomized method of choosing. The only essential criterion that needed to be met was that the person had at least one sinus floor preserved. I aimed to have a fair representation of sex and age as well, which indivertibly affects the method of choosing. I had the possibility with the material from S:t Jörgen to look at the previous osteological analysis which gave some indication of the preservation status of each grave. However, this was helpful to a certain degree, regrettably this did not assure that the state of preservation of the sinuses was acceptable. The osteological material from Norra Åsum was a less extensive material which meant that I did not need to exclude any suitable individuals. I had the intent of getting a well-rounded distribution among the individuals from Löddeköpinge by choosing graves as evenly as possible, in respect to sex and age.

However, unfortunately no consideration could be taken to the placement of the graves, due to the boundaries created by the necessity of the preservation of certain skeletal elements. The placement of the graves, in relation to the church could give an insight into the status of the interred individuals. Nevertheless, this factor could not be prioritized in this study, yet should be noted since it affects most grave material.

4.2 Dating and taphonomy

The osteological material from S:t Jörgen was dated to the 14th century to the middle of the 16th century. The cemetery and chapel are mentioned in several sources, simplifying the dating. The arm positions were used for a more precise dating (Einarsen 2002, p.22). Redin (1976) was one of the first to develop the use of the arm position as a method for a more exact dating however, with some apprehensions regarding external factors that could affect the positions. Not only the chosen form of internment, depending on if the individual was buried in a casket or without. Consequently, creating restrictions as well as possibilities of movement. However, also secondary deformations could have an equal affect on the ultimate positioning (Redin 1976, p.31). Whether the remains are articulated or not, varies depending on the joints. Some joints known as persistent joints, are held in place by major ligament and tendinous attachment. These joints will stay articulated longer than others during the decomposition process. The humero-ulnar component, referring to the elbow is one of these joints (Knüsel and Robb 2016, p.658). The use of arm positions for dating is also a criticized method in medieval material due to the Reformation in 1536. After this point in time arm positions that were used in earlier centuries was brought back into use which makes the method redundant (Boldsen et.al 2006, p.346). The osteological material of Norra Åsum was dated to the early medieval period based on an iron ax and a comb made of bone that were found on the site from a previous excavation in 1979 (Beijer 1983, p.3). Even though, there is more of a debate regarding the dating of the graves in Löddeköpinge it leans towards the early medieval period as well. The positioning of the arms in association with the coins found on the site suggests that the cemetery was in use between the 11th century and 12th century. However, both Kieffer-Olsen (1992) and Carelli (2001) states that it might be closer to the 12th century to 14th century, based on recalibrated C¹⁴ samples.

Taphonomy is an important factor that needs to be considered in all osteological studies. It entails all postmortem processes that can affect the skeletal remains, both biological and physical. The preservation of the remains depends on the archaeological context it was deposited in. Although, it also consists of the human factor, meaning all modifications left on the bone intended or unintended by a human since time of death (White 2011, p.459). All these factors can alter the representation of gender, age and elements of bone that are preserved as well as degree of preservation of the bones. The study of taphonomy is imperative not only to gain a better understanding of the processes that affect the decomposition of the skeleton but also give indications of how the person was buried

(Magnell 2008, p.121).

The materials used in this study was as mentioned earlier quite well-preserved and only had very limited taphonomic modifications. The material from Löddeköpinge had a few more variations among the individuals due to the geographical spread of the graves and the different soil condition, which had a detrimental effect on the preservation. The material from S:t Jörgen was also unevenly affected by taphonomic factors due to the condition of the soil. However, there were less modifications in the urban material. The skeletons from Norra Åsum were in general well-preserved. The graves that had been excavated in the southern part of the cemetery were less preserved due to a coarser gravel type while the northern part contained a finer sand type more favorable for preservation (Beijer 1984, p.5-6). All materials had to some extent been damaged during the excavation process, nonetheless this did make a significant difference in the analytical process.

5. Method

The fifth chapter entails a brief discussion on the age and sex estimations that were performed on the three osteological materials. The final part of the chapter will discuss the different pathological criterions for the study and how sinusitis was categorized depending on its severity.

5.1 Age and sex estimations

The individuals in the study were categorized into four age groups; infans, subadult, adult and matur. The categories are based on Buikstra and Ubelaker (1994) however, their seven categories have been reduced to four with a larger age span. The intention was to give a broader idea of potential pathological shifts with age. The reasoning behind this choice was that the material itself was quite limited and would benefit from fewer categories.

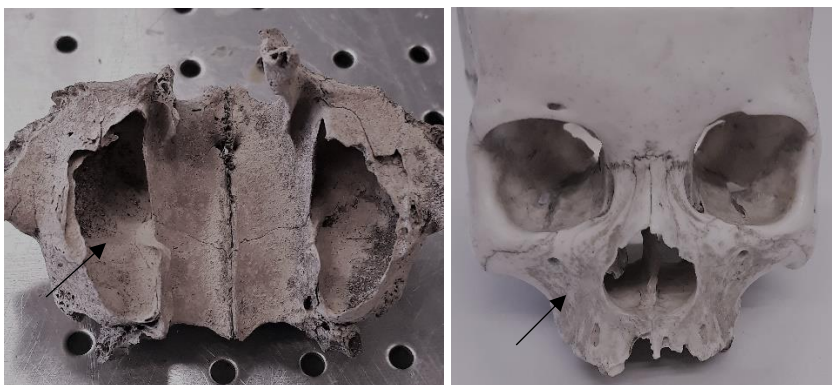
These age-categories are quite comprehensive and entail a generous age span. Infans include all children to the age of six years, and the subadult category is all children from approximately 6-18 years of age. The older category is divided into adult consisting of individuals from 18 to 40 years of age, while matur are individuals who are 40 years or older. The age-categories are quite broad however, there was no need for exact age in this particular study. The primary methods used for age estimations are focused on the pelvic bones due to age-related changes. Guidelines from Lovejoy and colleagues (1985) was used to examine the

auricular surface of the pelvic bones. The pubic symphysis was also examined using Suchey/Brooks (1990) scoring system accessible in White (2011). The youngest individuals were aged by measuring the long bones, Johnston (1962) without including the epiphyses, the femur was often chosen as a result of the better preservation.

The term; sex refers in this thesis to the biological differences between male and female, while gender is used as a more cultural term focusing on the individuals identification. The sex estimations in the analysis were done using both primary and secondary characteristics, the primary are based on the sexual dimorphism of the pelvic bones. Both using the Phenice technique (1969) as well as Walker in Buikstra and Ubelaker's Standards (1994). The secondary characteristics are sexually dimorphic cranial features also from Walker in Buikstra and Ubelaker's Standards.

5.2 Pathologies

This thesis only includes the chronic cases of sinusitis, seeing that it is the chronic cases that tend to leave traces on the skeleton. The sinuses are bilateral air-filled spaces that are situated in the maxillary bone, on both sides of the nose (Fig.3). The roof of the sinus forms the floor of the orbit, while the medial wall of the sinus is made up in part by the superior maxilla and ethmoid with its air sinuses. The lateral wall of the sinus forms the inner boundary to the pterygoid fossa while the posterior wall bounds to the pterygo maxillary fossa. Below the floor of the sinus is the alveolus of the maxilla which holds the teeth (Negus 1958, p.341).



*Fig. 3 Pictures of the maxillary sinuses (G1035) to the left and to the right a cranium depicting their placement.
Photo by: Cecilia Eriksson*

A healthy sinus has a smooth and quite regular surface while an inflamed sinus has either pitting, remodeled bone in the form of spicules, lobules or a net-like structure, or a combination of them. There might also be a slight discoloration (Fig.4).

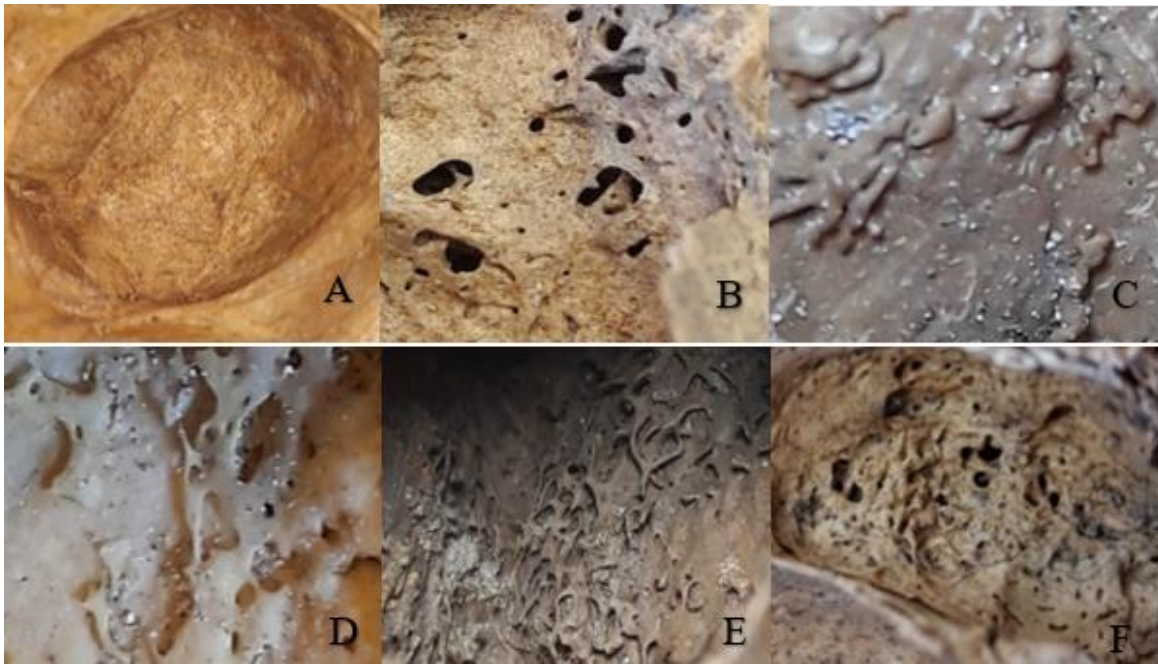


Fig. 4 A) Non pathological B) Pitting C) Lobules D) Net-like spicules E) Remodeling- spicules F) Combination Photos by: Cecilia Eriksson

It is imperative that in advance of any pathological analysis to fully understand the limitations and constraints inherent in the material in question. Without this understanding, no useful nor reliable data will be discernable.

Before any pathological determination was made, it was essential to make sure the cavity was as clean as possible for proper visualization. This was achieved by the use of small brushes, bone tools made of plastic, not to damage the surface and/or a pipette to blow the area clean.

The sinusitis was categorized into a scoring system from Sundman and Kjellström's analysis on the osteological material from Sigtuna (2013). The scoring system is based on the stages of severity, if there were a limited change to an area no bigger than 1,5cm² it was assigned score 1. While if an area between 1,5 and 2,5 cm² was affected by moderate changes the score 2 would be assigned. Score 3 was ascribed when more than half of either the floor, walls of the roof were altered. There are some slight variations in my system of scoring the stages of severity due to several factors. One of these was that this study includes children which deviated from the study done by Sundman and Kjellström (2013). By choosing to include younger individuals in the study, adjustments needed to be made to the size in the different scores. It is imperative when choosing to include children to be aware not to confuse developmental changes with pathological. During the developmental stages of the sinuses there is a possibility that small holes might appear due to the developmental stages of the

teeth, which could be mistaken for pathological pitting (Sundman & Kjellström 2013a, p.449). Since I used endoscopy as a method to visualize inside the sinuses, I could also include relatively intact cranium. This meant however, that it was more challenging to get a precise estimate of how large area was affected by sinusitis. The endoscopy camera for this study had a resolution of 1280x720 pixels and a potential 60° rotation and was equipped with a 6 high-intensity LED lamp.

Endoscopy has been used as a method in other studies centered around the maxillary sinuses. Two of these are Boocock et al. (1995a) and DiGangi and Sirianni (2017) who used endoscopy although, by firstly drilling a whole to gain access inside the cranium. To drill into the cranium is intrusive and a destructive method which can be perceived as less optimal. Even though, more individuals can be examined and included a study. In the study by Boocock et al (1995a) it was considered an invaluable method. However, to drill into the cranium was not an option in this study.

6. Analysis

This chapter is comprised of the results from the osteological analysis that was performed on the urban material from S:t Jörgen and the rural material from Löddeköpinge and Norra Åsum. The analysis of the osteological material was carried out under a two-month period. The first part will highlight the general composition of the various materials such as age, sex distribution and then delve into the distribution of the individuals affected by sinusitis. The final part of the chapter will examine the dispersion of the different degrees of severity of sinusitis among the individuals.

6.1 S:t Jörgen

The general preservation among the individuals from S:t Jörgen was good. This was reflected in the high representation of young individuals. In the diagram below (Fig.5) there is visible difference among the representation of sex as well as age. However, there are only slight differences among the males and females. The most apparent contrast is between the mature and the younger individuals (subadult and infans). The material consisted of 58 adult/mature and 49 subadult/infans.

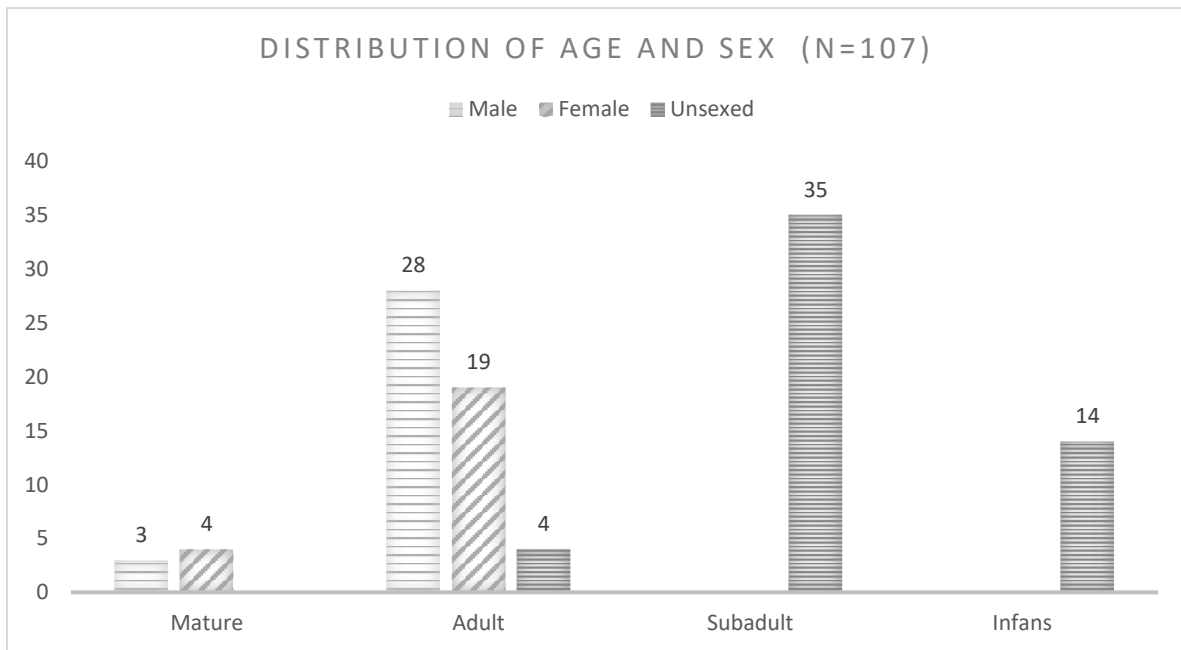


Fig. 5 Diagram illustrating the distribution of age and sex among $n=107$ individuals from S:t Jörgen.

When it comes to representation of sex there is a slightly higher account of males, 32 compared to 25 females however, this was not surprising since earlier studies showed a higher prevalence of that sex among the individuals. None of the subadults nor the infants, have been sexed due to its uncertainty. The aim was to have a material that was a fair representation of age and sex at that time. Nevertheless, the analysis is controlled by the existent of well-preserved sinuses which will in the end be the essential stage whether an individual was chosen or not.

6.2 Norra Åsum & Löddeköpinge

The rural material consists of 107 individuals from two different archaeological sites. One of the sites is Norra Åsum which is comprised of all applicable individuals. This concluded to 31 individuals, this material was then combined with 76 individuals from Löddeköpinge to represent the rural material for this analysis. Some differences should be mentioned between the rural materials. Norra Åsum had a higher representation of children, encompassing close to 50 % of the individuals. Compared to a mere 30 % in the osteological material from Löddeköpinge, which is the norm in most osteological materials from cemeteries. However, both materials had quite an equal representation in either sex.

Since the material from Löddeköpinge is a rather sizable material compared to Norra Åsum, not all individuals could be included even though the preservation was good and countless individuals had a well-preserved cranium. This is not merely due to preference of equal distribution among the rural as well as the urban materials. It is also due to the necessity

of limitation on account of time restrictions. The representation in each age-category varies between the rural and urban materials.

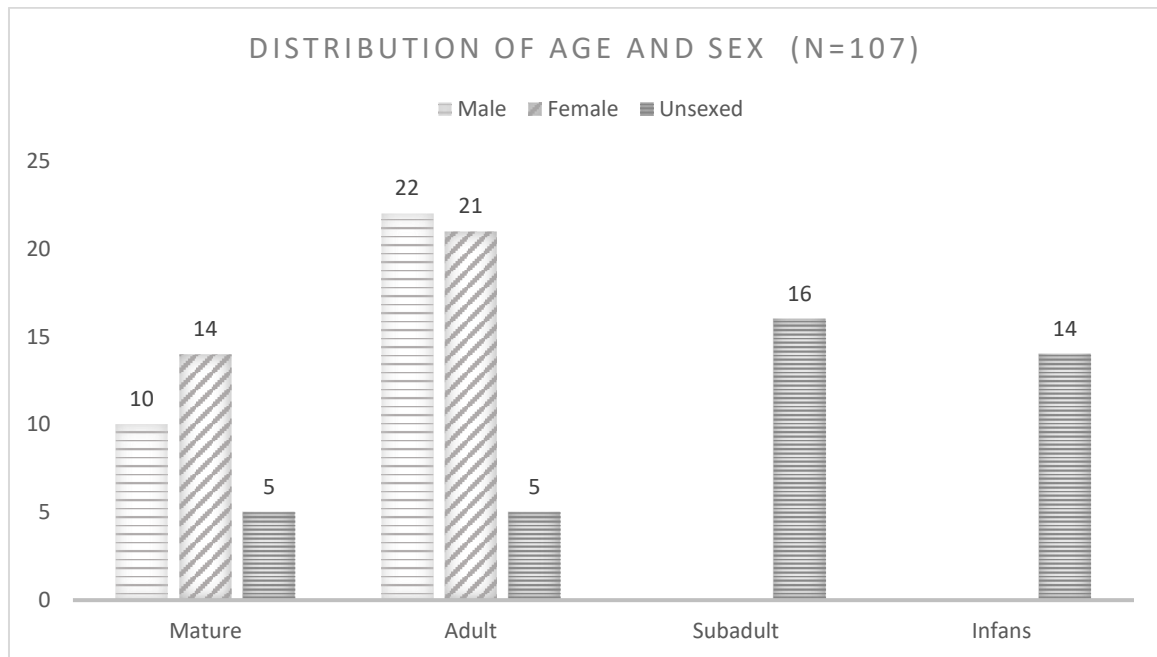


Fig. 6 Distribution of age and sex in rural material. N=107 (Norra Åsum & Löddeköpinge).

The diagram (Fig. 6) illustrates the age and sex distribution in the rural material. The age categories have a more even representation in relation to the urban material. Not solely among the older individuals, but also among the younger. The diagram also demonstrates a marginally higher representation females than males. There are 35 females and 32 males in the material, this does not necessarily mean that there were more females in the complete osteological material of either site, merely that the individuals chosen were more preserved. Furthermore, since the material from Löddeköpinge was too extensive to be all-inclusive, the analysis then required a more randomized method of choosing. There are also quite visible changes among age and sex between the rural and urban materials. The rural material has a more equal representation, while the urban has a higher frequency of younger individuals.

6.3 Sinusitis in rural and urban population

The existing variations between the rural and urban populations were minor. The urban population being marginally more affected by sinusitis than the rural individuals (Fig.7). Among the individuals from S:t Jörgen there were 36,4 % that suffered from sinusitis while 35,5% of the people of Norra Åsum and Löddeköpinge were affected. To examine possible dissimilarities in the prevalence of maxillary sinusitis among the rural and urban material a

significance test for proportions was carried out by using the statistical computing program R, version 3.5.3. The hypothesis test was carried out to establish if there were any significant differences among the materials.

A p-value less than 0.05 was considered significant. The statistical test revealed a p-value of 0.5, indicating no significance. A significance test was also undertaken to analyze the prevalence of sinusitis among males and females in the rural and urban populations. Among the females, of the rural and urban material the p-value was 0.5, establishing no significance. The p-value among the males, of the rural and urban populations was 0.369, proclaiming no significance in either group.

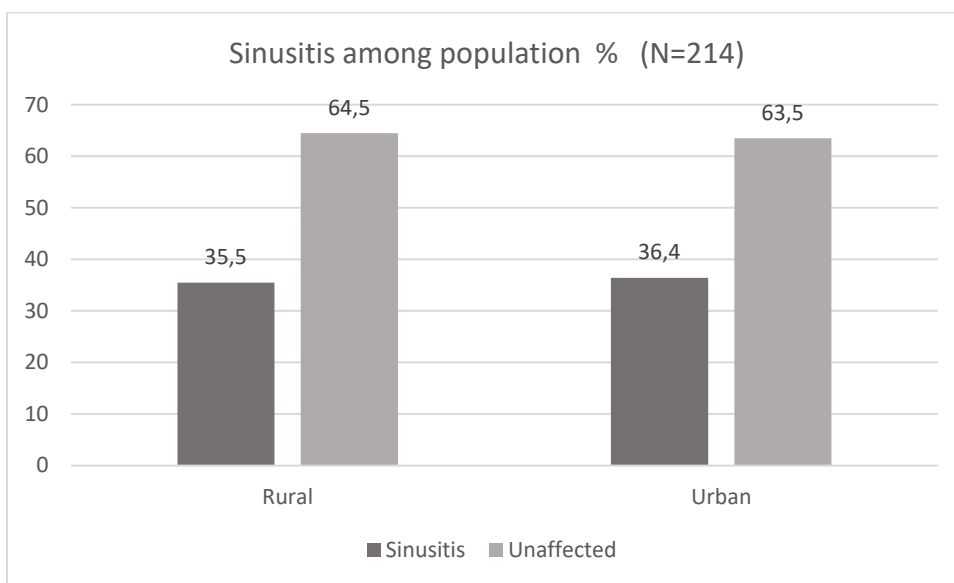


Fig. 7 Distribution of sinusitis in percent among rural and urban population.

There is a slightly higher prevalence of sinusitis on the right maxillary sinus than the left in the urban material whilst the rural material shows that the left is more affected than the right. The individuals with unilateral sinusitis are almost equally affected in the rural and urban materials (Fig. 8).

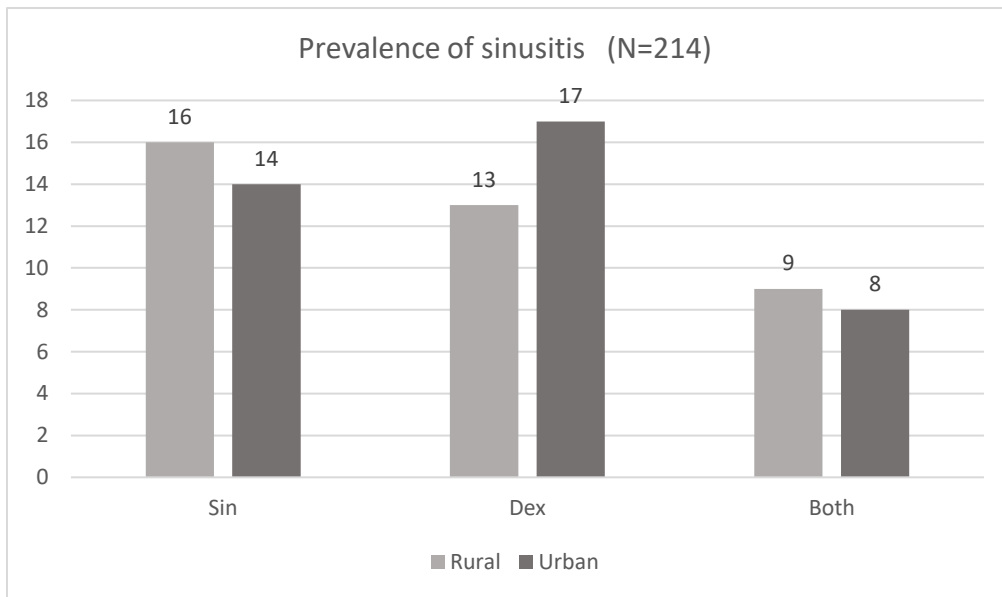


Fig. 8 Prevalence of sinusitis between the left (sin) and right (dex) maxillary sinuses.

The maxillary sinusitis was documented using a scoring system that classified the sinusitis in stages of severity. There is a discernable difference between the three stages. The results are depicted by using percentile, however it is essential to bear in mind that it will in some cases show over 100 % due to the fact that one individual could have more than one stage of severity since there are two sinuses.

The analysis revealed that stage I was the most common among the male and females in the rural material. There were 17 women that were affected by sinusitis, while there were only 10 males that had the affliction. Even though, score I was the most common among the females as well, there was a more equal distribution among the degrees of severity compared to the other groups. The most palpable difference among the individuals is that there are substantially fewer among the individuals that have had a severe form of sinusitis (Fig. 9).

A significance test was also carried out to see if there were any differences in the rural and urban materials between the sex that were afflicted by score II. The rural displayed a p-value of 0.5 which means that there is No significant difference between the females and males. The urban p-value was 0.7385 concluding that there was no significance in that group either.

| Score | Female | Male | Unknown |
|-------|----------------|----------------|----------------|
| | M.s presence % | M.s presence % | M.s presence % |
| I | 76 | 80 | 81.8 |
| II | 23.5 | 20 | 27.2 |
| III | 11 | 0 | 0 |

Fig. 9 The percentile of rural individuals affected by sinusitis, scored 1-3.

The urban material did not differentiate much from the rural except that it was more even among sexes as well as the different scores. There were 11 females and 8 males with maxillary sinusitis. It is, however, important to bear in mind that there are variations between the rural and urban materials that affects the results.

Even though, the aspiration is to have materials with equal representation between the sex as well as age there will be differences. The rural material has more females than males contrary to the urban material. There are also more matur individuals among the rural material which could explain the higher prevalence of score III and score II since it takes time to develop chronic sinusitis (Fig.9). This will be more easily visualized in the two figures below showing the relation between age and severity of sinusitis (Fig.11 & 12).

| Score | Female | Male | Unknown |
|-------|----------------|----------------|----------------|
| | M.s presence % | M.s presence % | M.s presence % |
| I | 72.7 | 75 | 80 |
| II | 36.3 | 12.5 | 15.5 |
| III | 18.1 | 12.5 | 5 |

Fig. 10 The percentile of urban individuals affected by sinusitis, scored 1-3.

The similarities as well as the dissimilarities among the materials have become quite evident. Even though, the urban and rural materials are almost equally affected by sinusitis, there are however differences among the individuals themselves. In the figure below one contrast is easily identified, namely the apparent difference of distribution of severity among the individuals (Fig.10).

Again the age distribution among the materials is an essential factor for what is noticeable between the different scores. The urban material consisting of 39 individuals has a lower median age and was not as affected by the more severe sinusitis (Fig. 11). However, there are

other factors that are consequential for the diffusion of severity. One is preservation, both of the material in general but also the cavity itself. By this I mean that if the floor is the only part of the sinus preserved the severity could possibly be more severe than what is visual.

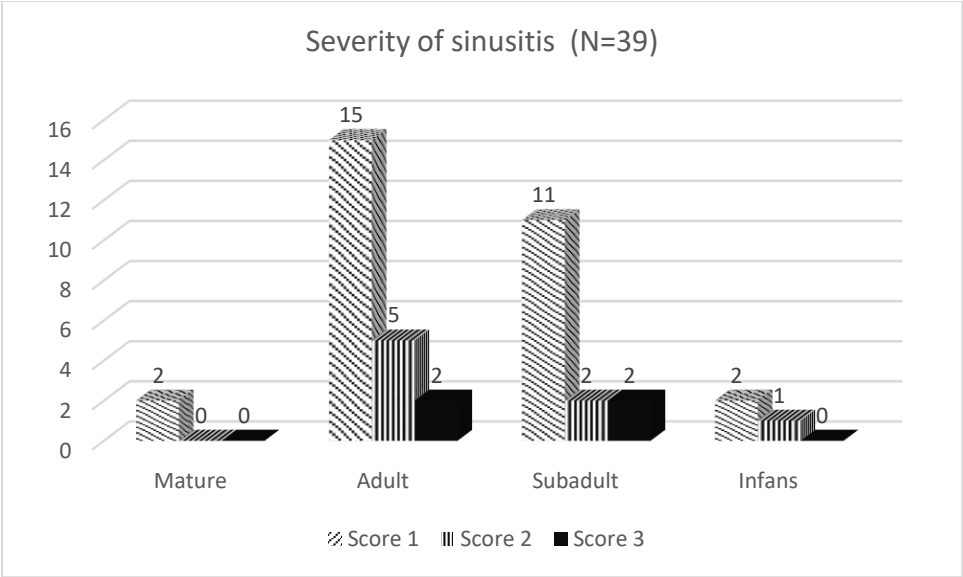


Fig. 11 Diagram depicting the distribution of severity of sinusitis among the urban material.

In the diagram below depicting the rural material, we see that there is a higher representation of individuals with a higher median age affected by sinusitis than in the urban. The higher representation of older individuals could be contributed to both the factor of preservation discussed previously, as well as different living conditions among the age groups in the rural and urban populations (Fig.12).

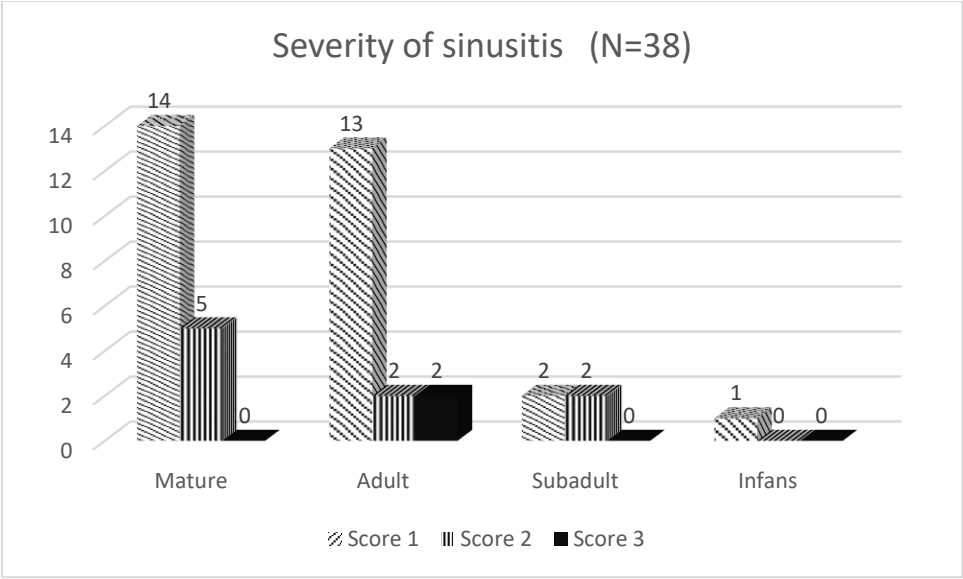


Fig. 12 Diagram depicting the distribution of severity of sinusitis among the rural material.

7. Discussion

The intent and ambition for this master thesis was to delve deeper into the aetiology and pathogenesis of maxillary sinusitis. More specifically, with the aim to do a comparative study of the prevalence of maxillary sinusitis in three osteological materials from the medieval period in Scania. To accomplish this, I chose to investigate four questions, firstly if there was a difference between the urban and rural material and then if there was any visible difference in sex as well as age and ultimately if an aetiology was distinguishable.

In regard to the primary question of potential differences between the rural and urban population the answer is that there was no significant difference in these materials. However, more evident differences were visible between age as well as sex. The analysis indicate that the older individuals were more susceptible to maxillary sinusitis than the young, with some variations among the rural and urban materials. The females in this study also seem to be more prone to sinusitis than the males, however this will be more thoroughly discussed later in the chapter. The aetiology is rather hard to define and is most certainly multifactorial.

The material is essential in any paleopathological study, not only the general preservation of the material but also size and that it is a fairly equal representation of sex and age in the material. The purpose of the thesis was to do an inclusive material study, which refers to that no age groups nor any sex were excluded. The urban material was consisted of 107 individuals from S:t Jörgen cemetery and the rural which also consisted of 107 individuals was comprised of two materials, from Norra Åsum and Löddeköpinge. Even though, the osteological material for this study can be seen as small-scale sample it is still possible to discern patterns as well as tendencies and potentials within the analysis, which could be beneficial for further studies. However, as for this study the time limitations created the boundaries and possibilities for each part of the thesis. The initial obstacle within the study was that I had never studied sinusitis before, which meant that I needed to familiarize myself with the different stages of severity and the multifarious side of sinusitis. This was not an actual issue and was essential for the success of the study though it is something that needs to be reflected upon, concerning the time limitations. A study such as this which do not use any destructive methods also require the right material. By the right material I refer to the fact that the skull needs to be well preserved, however not too well preserved hindering the access to the maxillary sinuses.

The overall prevalence of sinusitis in the populations was quite considerable. In the urban material 36.4 % were affected, compared to 35.5 % in the rural material. The representation of sinusitis should be considered as a minimum since no invasive methods were used in the study which inadvertently excludes individuals possibly affected by sinusitis.

The results in this study correlates to some previous studies which also had a high number of afflicted individuals. Lewis et al. (1995) osteological analysis presented a high percentile of affected individuals in both the rural (39 %) and the urban (55 %) material. Merrett et al. (2000) had around 50 % of affected individuals in their analysis, the same goes for Boocock et al. (1995a) who also presented a substantial number of affected individuals 55 %. Another study by Liebe-Harkort (2012) had an even higher representation of maxillary sinusitis (88.4 %), even though no invasive methods were used. Nonetheless, there are also studies that have presented much lower frequencies of maxillary sinusitis. In the seven skeletal samples analyzed by Roberts (2007) the frequency of maxillary sinusitis varied quite a bit from 17.2 % in some to 51.5 %. Some caution should be taken when comparing data since different age and scoring systems might have been applied. There was a difference tough between the rural population which was slightly less affected (45 %) and the urban with a higher frequency of sinusitis (48.5 %). However, the fact that there is generally a high prevalence of sinusitis in archaeological material is of interest. Several of the studies link the high number of affected individuals to environmental factors, which will be discussed later in the chapter.

Focusing on the primary question concerning the rural and urban material, we can detect some differences in the prevalence of sinusitis. The urban material has a slightly higher prevalence of sinusitis however there is not a statistically significant difference between the urban and the rural materials. The fact that the two categories are quite similar does not necessarily mean that the environmental factor is redundant when it comes to the aetiology of sinusitis. There are numerous reasons why they are so similar, such as the limited size of the materials or the representational differences between them. However, the majority of the rural material was comprised of Löddeköpinge which is known as a *köpingeort*. This essentially means that it had a higher prevalence of mobility and trade than other rural sites. The fact that the site had a higher mobility and trade should be considered in this thesis since it might share both rural and urban traits making the differences between the samples smaller. Although, there has been lengthy discussion on this subject, concerning its intrinsic meaning and developmental process (Söderberg 2000, p.261). Regardless the exact meaning and the overall uncertainty it is still something that should be considered when comparing the data.

The outcome in studies concerning maxillary sinusitis between rural and urban sites have

been thoroughly diverse. In some cases, there have been clear differences like in the medieval population in the study by Lewis et al. (1995), while in others like Panhuysen et al. (1998) presented no significant difference (fig.13).

| Prevalence of maxillary sinusitis | | | |
|-----------------------------------|----------|-------|---------------|
| | Rural | Urban | No difference |
| This Study | 35.5% | 36.4% | |
| Lewis et.al (1995) | 39% | 55% | |
| Panhuysen et.al (1998) | | | X |
| Roberts (2007) | 45% | 48.5% | |
| Roumelis (2007) | | | |
| Sundman & Kjellström (2013a) | 70 & 82% | 94% | |
| Sundman & Kjellström (2013b) | | | X |
| Krenz-Niedbala et.al (2016) | | | X |

Fig.13 Chart comparing the prevalence of sinusitis between previous studies and this.

A more discernable difference could be detected between the sex, in both the rural and urban materials. The females appear to be more affected than the males, both in the rural as well as in the urban materials. This coincides with earlier studies, Roberts (2007) had 15 sites in her study and 11 out of 15 presented a higher frequency of sinusitis among females, however only two of the sites had significant differences. It is suggested in the study that this could be attributed to miscellaneous work tasks between the males and females. The opposite results were however presented by Sundman & Kjellström (2013a) and Roumelis (2007) where males were more frequently affected. One of the palpable issues when trying to discern differences between the sex is that there is often a bias towards either males or females, which can be problematic when trying to discern patterns in the materials. Both the rural and urban samples had more males, implying that since females are more affected by the condition there is a higher probability that there was an underlying cause for it. The cause could be due to environmental factors, which was suggested by Roberts (2007), Merrett et al. (2000) as well as Brimblecombe (1999) who studied the relation between poor air quality and respiratory health. Merrett et al. (2000) mentions the possibility of microenvironments that might facilitate the development of upper respiratory inflammation, such as inhaling wood smoke from hearths (Merrett et al. 2000 p.316). There is merit to the idea, however they also press on the difficulty to pinpoint the main reason for the development of maxillary sinusitis. Viewing the environmental cause as a contributing factor for the development of infections is logical, though some caution is needed before drawing any conclusion since it can as easily be another factor or multifactorial contributing to the development. There have been studies on the relation between air pollution and indoor huts. One of them was done in Sweden on

reconstructed Dark Age huts by Edgren and Herschend (1982), which showed high levels of air pollution. However, this also depends on if the cooking is done indoor or not, which is not always the case. Roumelis (2007) reflects in his study of medieval Kirchberg about the potential dangers of having permanent burning hearths indoor, which would fill the room with soot-particles and endanger the health of the residents. There are also the seasonal differences which would have had its own impact since windows and doors would have been closed during the colder months of the year entrapping even more smoke (Roumelis 2007, p.17).

Another example is a medieval study by Lewis et al. (1995) which presented distinct differences among the urban population who had been more exposed to industrial air pollutants than the rural population. This would be a more reasonable comparison to my skeletal samples, however contrary to their study there were no significant differences between the rural and urban samples. This might not simple be due to that the environmental difference between rural and urban was minimal, more so that the samples in this study was significantly smaller than Lewis et al. (1995) as well as the fact that the problem with industrial air-pollutants might not be the same in Malmö at this time.

The technical developmental process regarding food preparation as well as heat sources is another key factor to bear in mind. Brimblecombe (1999) discusses the importance of technological change concerning air pollution and health such as the expansion in use of chimneys which must have made an immense difference in most households (Brimblecombe 1999, p.10-f).

The risk factors would have varied between urban sites, even though the industrialization of Malmö might not be comparable to other British medieval towns, it would still have meant a more crowded environment than for the rural population. It was only a small portion of the population that lived in towns, in 15th century Stockholm only had approximately 5 000 citizens. The concept of “public health” was also unknown at this point in time, it was not until the 16th century that any preventive measures concerning sanitary was implemented (Sundin et al. 2007, p.44-46). The medical knowledge as limited as it was, could more or less be attributed to the knowledge within the convents. Which also meant that the medical advice was closely related to religion. However, there are very few scriptures preserved limiting our knowledge on the area (Uddenberg 2015, p.113). The discernable difference between males and females could also be due to that the females in this osteological material had a greater longevity than the males. This might be due to a general high prevalence of violence in the society or other stressors leading to a shorter life expectancy. There were more matur females than males in both the rural and urban material which could also explain why there were more

women with maxillary sinusitis, since it takes time for the infection to leave marks on the bone.

Beyond the general difference in sex there was also an evident contrast between the age categories in the rural and urban material in this study. The younger individuals were clearly more affected by maxillary sinusitis in the urban material than the rural (Fig. 11 and 12). This is problematic to compare to other studies since several chooses to exclude subadults. The results in this study highlights the importance to do an inclusive study, otherwise risk missing crucial distributional differences among the populations. There are however difficulties in the determination process of sinusitis in children due to developmental pitting, nonetheless this those not mean they should be excluded.

There are studies suggesting an increase of sinusitis with age (Panhuysen et al. 1997 and Merrett et al. 2000) however, there are also data negating this statement. The aetiology might also vary between the age groups, which was suggested in the study by Merrett et al. (2000), were the juveniles and adolescents were more affected by respiratory related maxillary sinusitis. However, the study includes individuals with the combination of sinusitis and dental infections, this problematize a straightforward comparison since it is almost impossible to distinguish whether the maxillary sinus bone-remodeling is the primary cause or secondary due to the dental infection (Merrett et al.2000, p. 312-f).

Maxillary sinusitis- aberrations in frequency between age and sex

| | Female | Male | Child | Adult |
|------------------------------|---------------------------|-------------|--------------|--------------|
| This Study | Higher | Lower | Lower | Higher |
| Roberts (2007) | Higher | Lower | | |
| Sundman & Kjellström (2013a) | Lower | Higher | | |
| Merrett et.al (2000) | No significant difference | | Lower | Higher |
| Panhuysen et.al (1998) | | | Lower | Higher |

Fig.14 Aberrations in frequency of maxillary sinusitis in this study as well as previous research

Roumelis (2007) also made an insightful observation concerning the relation between age and sinusitis. He commented that if sinusitis is present in all age groups it would indicate that the inflammation was present throughout the lives of the population. There is merit to the notion, and it is fairly logical that it was an ever-present burden. The urban material in this study had quite an even distribution between the ages and suggests that the inflammation in the urban site was more persistent and harder to cure due to environmental factors or the hosts immunity. The question concerning the immune system is interesting and relevant factor. In the osteological material from Kirchberg there were several individuals suffering from

malnutrition and scurvy which could predispose the individual to other diseases, especially children who are more vulnerable (Roumelis 2007, p.136). The importance of the environmental factor when it comes to the aetiology of the disease is a given, however a person's immune system is as important, and the factors are closely related.

The analysis of maxillary sinusitis also revealed dissimilarities between the scores of severities. Score one, which was the less severe score was the most common among all the materials. This was as I anticipated however, there were subtle differences in the age and sex categories. The most prominent aberration was the high frequency of affected subadults in the urban material. It is of interest since children tend to be more susceptible to disease, hence it might give an inclination to what impact maxillary sinusitis had on the society at large. The premise that children are the most vulnerable members in society is also shared by Krenz-Niedbała et.al (2016) whose study centered on children in medieval Poland. Their premise was also that the children in the urban area should be more affected by sinusitis than the rural, however the results revealed that there was statistically non-significant tendency towards the premise.

The score of severity is also important since it provides information of how badly the population were affected. The urban material has a higher percentile on score III than the rural material which could be an indication of more favorable conditions for the growth and longevity of the inflammation.

The females are also more affected by the more severe score of sinusitis. This does not necessarily have to mean something, nonetheless it does propose the possibility that they might have been more regularly exposed to the infection due to environmental circumstances such as inhaling smoke from hearths or some gender-specific work task. However, the most noticeable difference among the rural and urban skeletal samples in terms of the severity of sinusitis is that a substantial number of subadults were notably affected by the disease.

The theoretical chapter in the thesis will only briefly be discussed, however it should be mentioned since it correlates to the results in the analysis, especially the osteological paradox. Because even though there are notable tendencies in the skeletal samples, such as the relatively young age of the affected individuals in the urban material there are other factors that needs to be taken into consideration. The skeletons that exhibit symptoms of maxillary sinusitis should be considered as the healthier part of the population since they lived long enough for the infection to leave marks on the bone. While the individuals with a low health status wouldn't have survived long enough for this to happen. The underrepresentation might also be a result of that no destructive methods were used in the analysis which means that

some individuals could not be included. Then there is the inherent complexity concerning the biocultural approach which focuses on the interconnected relationships between humans and humans and the surrounding environment. This is very important to include however it is hard in my opinion to distinguish what factor caused the infection, since it probably is multifactorial in many cases. The numerous factors and the complexity surrounding them are also mentioned in the article by Schell (1992), not simply the biological such as age, sex and race but also the social ones like occupation and socio-economic status (Schell 1992, p.136). The connection between environment and health have been linked in numerous studies such as the modern study by Crooks (1995). That particular study focuses on children in today's society which makes it much easier to detect the potential environmental factors that could have caused the infection. However, paleopathological studies have a clear disadvantage in the sense that the environmental factors are in most cases no longer a part of the existing society. There is no real possibility to see the actual impact of the general filth in the city or houses, as well as the lack of hygiene or the cramped living conditions, and its significance on the health of the population. In many cases there are just well-thought out scenarios, which might be the closest we can get to the truth.

On the other hand, modern studies can also be of help especially when you are studying something as common, even in modern times as maxillary sinusitis. The better we get at dissecting the aspects of the disease, with the use of modern technology as well as getting closer to understanding the complexity of it, the easier it will be for paleopathological studies to make more plausible scenarios concerning its aetiology and pathogenesis. For example, Wyler and Mallon (2019) discuss the impact sinusitis has had on the job market, and the amount of loss of work that it has caused. This is perchance hard to connect in a factual manner to archaeological material however, it gives archaeologist the potential to see the limitations and impediments it causes to people in general. Another area which is quite unknown when it comes to the maxillary sinuses are the potential variations within populations.

There are still several questions remaining concerning the actual anatomy of the sinuses and their variations. Which means that the progress we are making in research regarding maxillary sinusitis is potentially trivial if we do not understand the skeletal element fully. However, there are advances made in several areas and one of these is the usage of 3D methods. The potential of using 3D methods to gain a deeper knowledge of the anatomy of the maxillary sinus and the nasal cavity and its variability is discussed at great length in the article by Butaric et al. (2010). One of the main topics in the article centers around what

parameters govern the form of the atrium. To be able to establish which factors are influencing the shape they propose to use volumetric data from 39 human crania using computed tomography scans. The ecogeographical provenience is known for all individuals enabling the assessment of its relation to the size and shape of the atrium. The study was a pilot study and focused on quite a small sample however, the results suggested that the nasal cavity correlates with the facial shape, nevertheless the architecture of the maxillary sinus is still unknown. What could be determined is that their existence is not simply to fill up the remaining space of the nasal cavity. More environmental variables as well as a larger sample size is needed to get a more comprehensive idea of the underlying factors to answer these questions (Butaric et al.2010, p.426-436).

This relates to my thesis in the sense that there are always problems when using small sample sizes, however this does not discard the importance of pilot studies. The initial step of any study tends to be flawed in one way or another. Nonetheless, this can also be seen as a vantage point to see if improvements need to be made or if the questions, we try to answer might be wrong. In this thesis there are notable tendencies such as the difference in age as well as sex, which have the potential to become even more evident within a larger skeletal sample. The fact that the differences between rural and urban material are miniscule can also be attributed to the skeletal samples chosen for this study, since it is quite hard to find a suitable sample due to the fact that the availability is limited of rural material which is large enough, in addition to being well-preserved enough from this time period.

A possible solution to this is to include more skeletal samples to comprise the rural material in future studies and simply factor in the geographical differences. The small samples become an issue since only crania with at least one maxillary sinus preserved could be included in the study. If more invasive methods had been applied such as drilling holes for better visualization, more individuals and smaller samples could have been included. Naturally, this needs to be taken into relation to the importance of preservation of archaeological material. Destruction of any archaeological material is not something done without just cause, even if it is done in the name of science all the consequences needs to be thoroughly examined. There might also be future technological advances making destructive methods redundant.

Beyond the methodological improvements that could be made there would be clear advantages to do a more comprehensive paleopathological study. By including more osteological data concerning health, which would have been possible within a larger time frame which would have allowed for a deeper understanding of populations general health. If a more extensive pathological study was conducted there would also have been possible to

detect the role of the persons immune system in relation to sinusitis. An individual that is afflicted by another disease will have a weakened immune system and might be more prone to maxillary sinusitis. Also, societies at large that lived and worked during a time of uncertainty, not only political but by disease and food shortage must have been affected physically as well. To have a closer look at nutrient-related diseases and its relation to maxillary sinusitis would be important to include in future studies as well. This study did not include maxillary sinusitis that was considered to be caused by dental pathologies. This was decided due to time limitations however, it would give a deeper understanding of the different facets of the disease and would be an additional factor to include in future studies. I think when a study such as this is conducted it is essential to have as large a skeletal sample as possible to be able to detect patterns. It would also be beneficial to look beyond the osteological data and include more aspects such as demography and other archaeological data from the excavations.

Another issue is regarding the chronological phases of the three materials since they span from the early to the late medieval times which was necessary due to surrounding circumstances such as limited time but also general preservation however, this was unavoidable for this study. Nevertheless, if the objective in future studies is to expand geographically and include more provinces in Sweden it would open up for the possibility to narrow down the chronological differences between the materials. By comparing materials that are closer in time to each other is more advantageous since it would provide a fairer representation of the urban and rural population in medieval Sweden.

This study has however provided an insight into the conceivable differences and similarities in the urban and rural material. It has also shown the potential in focusing on maxillary sinusitis as a way to study general health in a population since it is a comparatively common affliction.

8. Conclusion

The study did not relay conclusive evidence to neither a higher prevalence of sinusitis among the urban nor the rural population however, it did give indications of differences in other areas. The reason for the inconclusive results between the samples are most likely numerous, one could of course be that there are none, nevertheless the relatively low quantity of individuals in the study might also be an underlining cause for such a similar result between

the two. There is also the possibility that if more areas from this period in Scania were included within a larger time frame the results could have provided more nuanced data. Both samples consisted of 107 individuals each, in the rural material 35.5 % were affected by sinusitis while the urban had a slightly higher prevalence of 36.4 %.

There were clearer distinctions in other areas such as age and sex. The severity of sinusitis was different among the males and females in both the rural and urban material. Score I was the most common in both groups however, the females seem to be more prone to be affected by the more severe degrees of sinusitis than the males. The reason for this is hard to conclude and pin-point to a specific one, it might very well be multifactorial.

Another variation in the materials could be detected between the age groups, especially in the distribution of severity. The urban material had a lower median age than the rural and displayed a higher frequency of subadults affected by sinusitis while the rural had more mature individuals affected by the disorder. This might be due to a slightly skewed representation among the age groups or it could be a true indication that the younger population in urban areas were more susceptible.

The question concerning the causality of maxillary sinusitis could not be entirely answered however, the study did favor a multifactorial explanation for its cause. The environmental factor is probably a contributor which is affirmed by comparing with previous studies where the majority of them states that the environmental factor is most likely a dominant factor nonetheless, not exclusive. The underlying cause is presumably more problematic and interrelated with other such as an individual's age, sex, general health, social factors and even genetics causing a higher susceptibility for developing maxillary sinusitis.

I view the future possibilities for further studies of maxillary sinusitis to have excellent potential to not only broaden our knowledge of the health in medieval Scania but also in our society at the present.

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List of diagrams, figures and tables

(Picture on front page)

Drawing by Leonardo da Vinci from the late 13th century. Depicting the skull, anterior view with frontal and maxillary sinuses exposed.
From the webpage Wikimedia Commons.

Search word: Leonardo da Vinci skull

https://commons.wikimedia.org/wiki/File:Leonardo_Skull.jpg (2019-04-04)

Fig.1

Image illustrating the paranasal sinuses.

Photo from the webpage: Wikimedia Commons

Search word: Human skull sinuses

https://commons.wikimedia.org/w/index.php?title=Special:Search&limit=20&offset=20&ns0=1&ns6=1&ns12=1&ns14=1&ns100=1&ns106=1&search=human+skull+sinuses&advancedSearch-current={ }#/media/File:NNH_im_Roentgen_frontal_Annotation.png (2019-05-22)

Fig.2

Map of Scania, depicting the geographical areas where each of the osteological material comes from.

From the webpage Wikimedia Commons.

Search word: Skåne.

<https://commons.wikimedia.org/wiki/Sk%C3%A5ne> (2019-04-01)

Fig.3

The photo to the left depicts the maxillary sinuses, while the other show their placement.

Photo by Cecilia Eriksson

Fig.4

Photo (a) illustrates a healthy sinus, while the remaining photos depict the morphological changes to the sinuses due to sinusitis.

Photo by Cecilia Eriksson

Fig. 5

Diagram of the distribution of age and sex in the skeletal sample from S:t Jörgen (n=107).

Fig. 6

Diagram of the distribution of age and sex among the skeletal sample from Norra Åsum & Löddeköpinge (n=107)

Fig. 7

Diagram of distribution of sinusitis among rural and urban skeletal samples (%).

Fig. 8

Distribution of sinusitis between the left (sin) and right (dex) maxillary sinus.

Fig. 9

The distribution among rural individuals, female, male and unknown affected by sinusitis in percent, scored from 1 (least severe) to score 3 (most severe).

Fig. 10

The distribution of urban individuals, female, male and unknown affected by sinusitis in percentile, scored from 1 (least severe) to score 3 (most severe).

Fig. 11

Diagram depicting the distribution of severity of sinusitis among the urban material.

Fig. 12

Diagram illustrating the distribution of severity of sinusitis among the rural material.

Fig. 13

This study and previous research on the prevalence of maxillary sinusitis in rural and urban sites depicted in a table.

Fig. 14

An overview of previous research and this study regarding the distribution of maxillary sinusitis between sex and age.

Appendix

Maxillary sinusitis

| ID | Provenance | Grave | Sex | Age | Sinusitis (dex) | Sinusitis (sin) | Notes | Photo |
|----|------------|-------|---------|----------|-----------------|-----------------|---|---------|
| 1 | St Jörgen | 40 | Unsexed | Subadult | x | x | Both sinuses are well preserved. | |
| 2 | St Jörgen | 28 | Male? | Adult | x | 1 | "Fishnet" bone | |
| 3 | St Jörgen | 31 | Female | Matur | - | x | | |
| 4 | St Jörgen | 56 | Male | Adult | x | - | | |
| 5 | St Jörgen | 33 | Unsexed | Subadult | x | x | | |
| 6 | St Jörgen | 42 | Male? | Adult | x | x | Perforations on the floor | |
| 7 | St Jörgen | 97 | Female | Adult | x | x | | |
| 8 | St Jörgen | 1016 | Female? | Adult | x | x | | |
| 9 | St Jörgen | 958 | Female? | Adult | x | 1 | Pitting and white pitted bone | EB |
| 10 | St Jörgen | 946 | Male? | Adult | x | x | | EB |
| 11 | St Jörgen | 820 | Male | Adult | x | x | Badly preservd | |
| 12 | St Jörgen | 107 | Unsexed | Subadult | x | x | Well preserved | |
| 13 | St Jörgen | 1099 | Unsexed | Subadult | 3 | x | Whole floor covered with pitting and spicules | EB & MB |
| 14 | St Jörgen | 333 | Male | Adult | x | x | | EB |
| 15 | St Jörgen | 965 | Female? | Subadult | x | x | | EB |
| 16 | St Jörgen | 866 | Female | Matur | x | x | Badly preserved | EB |
| 17 | St Jörgen | 1082 | Unsexed | Subadult | 1 | x | Spicules on the wall as well as pitting | EB & MB |
| 18 | St Jörgen | 1023 | Unsexed | Adult | 1 | 1 | Spicules (fishnet) on both floors | EB & MB |
| 19 | St Jörgen | 275 | Unsexed | Subadult | x | x | | |
| 20 | St Jörgen | 722 | Male | Adult | x | x | Only floors preserved | MB |
| 21 | St Jörgen | 249 | Male | Matur | x | x | Both sinuses preserved | |
| 22 | St Jörgen | 1393 | Female | Adult | x | x | Both well preserved | MB |
| 23 | St Jörgen | 1425 | Female | Adult | 1 | x | Spicules on the wall | MB |
| 24 | St Jörgen | 1302 | Unsexed | Subadult | x | 1 | | MB |
| 25 | St Jörgen | 1323 | Female? | Adult | x | x | Badly preserved | MB |
| 26 | St Jörgen | 601 | Female | Adult | 1 | 2 | Quite bad sinusitis | MB |
| 27 | St Jörgen | 1116 | Female? | Adult | 3 | 1 | Sinusitis in both sinuses | EB & MB |
| 28 | St Jörgen | 1121 | Male? | Adult | x | x | | |
| 29 | St Jörgen | 1354 | Female? | Adult | x | x | Visible roots | |
| 30 | St Jörgen | 376 | Unsexed | Subadult | 2 | x | Bone spicules and pitting | MB |
| 31 | St Jörgen | 260 | Male | Adult | x | 1 | Bone spicules | MB |

| | | | | | | | | |
|----|-----------|------|---------|----------|---|-----|---|---------|
| 32 | St Jörgen | 1080 | Male | Adult | x | x | | |
| 33 | St Jörgen | 1027 | Female? | Adult | | 1 x | Pitting and bone spicules | MB |
| 34 | St Jörgen | 1446 | Male? | Subadult | x | x | | MB |
| 35 | St Jörgen | 1321 | Male? | Adult | | 1 x | Pitting and spicules | MB |
| 36 | St Jörgen | 1503 | Male | Adult | | 2 x | Pitting and spicules | MB |
| 37 | St Jörgen | 1298 | Male | Adult | x | x | Well preserved sinuses | MB |
| 38 | St Jörgen | 1085 | Female? | Matur | x | x | | MB |
| 39 | St Jörgen | 683 | Male? | Adult | x | | 1 Bone spicules | MB |
| 40 | St Jörgen | 1365 | Female | Subadult | | 3 | 3 Severe sinusitis. Bone spicules, pitting and lobules. | EB & MB |
| 41 | St Jörgen | 1144 | Male | Adult | x | x | | MB |
| 42 | St Jörgen | 880 | Male | Adult | x | x | | |
| 43 | St Jörgen | 326 | Female | Adult | x | x | Not well preserved | |
| 44 | St Jörgen | 377 | Male | Matur | x | | 1 Spicules of bone. | MB |
| 45 | St Jörgen | 1020 | Female | Adult | | 2 x | Fishnet bone and lobules | MB |
| 46 | St Jörgen | 742 | Male | Adult | | 3 - | Sinusitis due to infec? | MB |
| 47 | St Jörgen | 252 | Unsexed | Subadult | x | x | | EB |
| 48 | St Jörgen | 220 | Unsexed | Subadult | x | x | | MB |
| 49 | St Jörgen | 265 | Unsexed | Subadult | | 1 | 1 Pitting and spicules of bone on the floors. | MB |
| 50 | St Jörgen | 434 | Unsexed | Subadult | x | x | | |
| 51 | St Jörgen | 433 | Unsexed | Subadult | | 1 x | Pitting and spicules | MB |
| 52 | St Jörgen | 1444 | Unsexed | Subadult | x | x | | |
| 53 | St Jörgen | 1455 | Unsexed | Adult | | 1 x | Spicules of new bone | MB |
| 54 | St Jörgen | 1416 | Unsexed | Subadult | | 1 x | Pitting and spicules. | MB |
| 55 | St Jörgen | 263 | Male | Adult | x | x | | MB |
| 56 | St Jörgen | 901 | Unsexed | Subadult | x | x | | MB |
| 57 | St Jörgen | 1115 | Male? | Adult | x | x | | MB |
| 58 | St Jörgen | 841 | Unsexed | Subadult | - | x | | |
| 59 | St Jörgen | 410 | Unsexed | Subadult | x | | 1 Pitting and spicules | MB |
| 60 | St Jörgen | 363 | Male? | Adult | x | x | | |

| | | | | | | | | | |
|----|-----------|------|---------|----------|---|---|---|--|----|
| 61 | St Jörgen | 790 | Unsexed | Subadult | | 1 | 1 | Pitting and spicules | MB |
| 62 | St Jörgen | 62 | Unsexed | Subadult | x | | x | Some pitting visible but nothing pathological. | MB |
| 63 | St Jörgen | 184 | Unsexed | Adult | x | | 1 | Pitting and spicules | MB |
| 64 | St Jörgen | 262 | Male | Adult | x | - | | | MB |
| 65 | St Jörgen | 219 | Unsexed | Subadult | x | | 1 | Pitting | MB |
| 66 | St Jörgen | 270 | Unsexed | Subadult | | 1 | - | Pitting | MB |
| 67 | St Jörgen | 231 | Unsexed | Subadult | x | | x | | MB |
| 68 | St Jörgen | 201 | Unsexed | Subadult | - | | 2 | Pitting and spicules | MB |
| 69 | St Jörgen | 116 | Unsexed | Infans | | 1 | x | Pitting and white bone and spicules | MB |
| 70 | St Jörgen | 79 | Unsexed | Infans | x | | x | | MB |
| 71 | St Jörgen | 72 | Unsexed | Infans | | 2 | 2 | Pitting and spicules. Badly preserved. | MB |
| 72 | St Jörgen | 47 | Unsexed | Infans | x | | x | | MB |
| 73 | St Jörgen | 1210 | Unsexed | Infans | - | | x | | MB |
| 74 | St Jörgen | 1169 | Unsexed | Infans | | 1 | - | Pitting and spicules. | MB |
| 75 | St Jörgen | 647 | Unsexed | Infans | x | | x | | MB |
| 76 | St Jörgen | 340 | Unsexed | Infans | - | | x | | |
| 77 | St Jörgen | 562 | Unsexed | Infans | x | | x | | |
| 78 | St Jörgen | 839 | Male? | Adult | x | | x | | |
| 79 | St Jörgen | 890 | Unsexed | Infans | x | | x | | |
| 80 | St Jörgen | 911 | Unsexed | Infans | x | | x | Some pitting is visible | MB |
| 81 | St Jörgen | 183 | Unsexed | Infans | x | | x | | MB |
| 82 | St Jörgen | 51 | Unsexed | Infans | x | | x | | |
| 83 | St Jörgen | 53 | Unsexed | Subadult | - | | 1 | Pitting | MB |
| 84 | St Jörgen | 25 | Unsexed | Subadult | - | | x | | |
| 85 | St Jörgen | 44 | Unsexed | Subadult | x | | x | | |
| 86 | St Jörgen | 1039 | Unsexed | Adult | x | | x | | |
| 87 | St Jörgen | 826 | Unsexed | Infans | x | | x | Quite well preserved. | MB |
| 88 | St Jörgen | 527 | Unsexed | Subadult | x | | x | | |
| 89 | St Jörgen | 14 | Unsexed | Subadult | - | | x | | |
| 90 | St Jörgen | 34 | Unsexed | Subadult | x | | x | Small perforations | MB |

| | | | | | | | | | |
|-----|------------|------|---------|----------|---|---|---|--|---------|
| 91 | St Jörgen | 759 | Female | Adult | | 1 | 2 | Pitting and spicules | MB |
| 92 | St Jörgen | 94 | Unsexed | Subadult | | 1 | x | Pitting in atrium | |
| 93 | St Jörgen | 516 | Female | Adult | x | | x | Dental caries causing infection in the sinus. | MB |
| 94 | St Jörgen | 497 | Female? | Adult | x | | x | | |
| 95 | St Jörgen | 540 | Unsexed | Subadult | x | | x | | |
| 96 | St Jörgen | 456 | Male? | Adult | x | | x | | |
| 97 | St Jörgen | 307 | Female | Adult | x | | x | | |
| 98 | St Jörgen | 1425 | Female | Adult | | 1 | x | Bone spicule | MB |
| 99 | St Jörgen | 782 | Male? | Adult | - | | x | | |
| 100 | St Jörgen | 1498 | Male | Adult | x | | x | | |
| 101 | St Jörgen | 1147 | Female | Matur | x | | x | | |
| 102 | St Jörgen | 1481 | Male? | Adult | x | | - | | |
| 103 | St Jörgen | 121 | Male | Matur | x | | 1 | Bone spicules | MB |
| 104 | St Jörgen | 407 | Female | Adult | x | | 2 | Lobules of bone and spicules of new bone. | MB |
| 105 | St Jörgen | 386 | Male | Adult | x | | x | | |
| 106 | St Jörgen | 784 | Female | Adult | x | | 1 | Bone spicules | MB |
| 107 | St Jörgen | 860 | Male | Adult | x | | x | | |
| 108 | Norra Åsum | 15 | Male | Adult | | 1 | x | Some form bone formation. Active. | MB |
| 109 | Norra Åsum | 25 | Male | Adult | x | | x | Well preserved. No clear pathologies. | |
| 110 | Norra Åsum | 14c | Male | Adult | - | | x | Visible penetration of root in the antral floor. | MB |
| 111 | Norra Åsum | 14b | Male? | Adult | x | | x | | |
| 112 | Norra Åsum | 21 | Male | Adult | x | | x | | |
| 113 | Norra Åsum | 18 | Female? | Adult | x | | - | Well preseved cranium. Hard to get good visualisation. | |
| 114 | Norra Åsum | 34 | Unsexed | Subadult | | 2 | 1 | New bone formation, spicules and pitting. | EB & MB |
| 115 | Norra Åsum | 41 | Unsexed | Subadult | - | | x | Som pitting but nothing pathological. | |
| 116 | Norra Åsum | 43 | Female | Adult | x | | x | | |
| 117 | Norra Åsum | 36 | Unsexed | Subadult | x | | 1 | Bone spicules and pitting | MB |
| 118 | Norra Åsum | 35 | Female | Adult | x | | x | Visible roots penetrating the atrium. | MB |
| 119 | Norra Åsum | 38 | Unsexed | Subadult | - | | x | | |

| | | | | | | | | | |
|-----|--------------|------|---------|----------|---|---|---|---|---------|
| 120 | Norra Åsum | 58 | Female | Adult | x | | 1 | Possible sinusitis due to lobules however close to perforation. | MB |
| 121 | Norra Åsum | 51 | Unsexed | Infans | x | - | | | |
| 122 | Norra Åsum | 53 | Unsexed | Infans | x | x | | Small perforations on the floor. | |
| 123 | Norra Åsum | 48 | Female | Matur | | 2 | 1 | Spicules, lobules and pitting. | EB & MB |
| 124 | Norra Åsum | 44 | Female | Adult | x | x | | Very well preserved sinuses. | |
| 125 | Norra Åsum | 57 | Unsexed | Subadult | x | x | | Both sinuses, no pathologies. | |
| 126 | Norra Åsum | 62 | Female | Adult | | 3 | 2 | Both sinuses are affected. | MB |
| 127 | Norra Åsum | 66 | Unsexed | Subadult | x | x | | Roots penetrating the atrium. | |
| 128 | Norra Åsum | 71 | Unsexed | Infans | x | x | | No pathologies. | |
| 129 | Norra Åsum | 60 | Unsexed | Subadult | x | x | | No pathologies. | |
| 130 | Norra Åsum | 64 | Male | Adult | x | x | | Buried with child. | |
| 131 | Norra Åsum | 59 | Unsexed | Infans | x | | 1 | Small perforations and spicules of new bone | |
| 132 | Norra Åsum | 27 | Unsexed | Infans | x | x | | Intact sinuses, but very porous. | MB |
| 133 | Norra Åsum | 6 | Unsexed | Adult | x | - | | | |
| 134 | Norra Åsum | 49 | Female | Adult | x | x | | Extremely well-preserved sinuses. | MB |
| 135 | Norra Åsum | 4 | Unsexed | Adult | x | x | | Partly preserved. | |
| 136 | Norra Åsum | 73 | Male | Matur | | 1 | x | Small spicules on the wall of the sinus. | MB |
| 137 | Norra Åsum | 63 | Female? | Adult | - | | 1 | Spicules on the wall. | |
| 138 | Norra Åsum | 68 | Unsexed | Subadult | - | x | | | |
| 139 | Löddeköpinge | 1298 | Male | Adult | x | x | | | |
| 140 | Löddeköpinge | 1266 | Male | Matur | | 1 | x | Spicules of new bone. | MB |
| 141 | Löddeköpinge | 1267 | Male? | Adult | x | x | | Both sinuses intact. | |
| 142 | Löddeköpinge | 1307 | Male? | Adult | x | x | | Both sinuses quite well intact. | |
| 143 | Löddeköpinge | 1169 | Female | Adult | | 1 | 1 | Small spicule on both sinuses. | |
| 144 | Löddeköpinge | 1286 | Male | Matur | x | x | | | MB |
| 145 | Löddeköpinge | 1288 | Male | Matur | x | x | | Very little preserved. | |
| 146 | Löddeköpinge | 1287 | Female? | Adult? | x | x | | Bad preservation of remains. No clear pathologies. | |

| | | | | | | | | |
|-----|--------------|-------|---------|----------|---|-----|---|----|
| 147 | Löddeköpinge | 1280 | Unsexed | Subadult | x | x | Dex better preserved | |
| 148 | Löddeköpinge | 1230A | Male | Adult | x | x | Sinus (sin) hole due to infec? | MB |
| 149 | Löddeköpinge | 1198 | Male | Adult | | 2 - | Spicules on the floor of the atrium. | MB |
| 150 | Löddeköpinge | 1152 | Female | Matur | x | | 1 Spicules of bone. | MB |
| 151 | Löddeköpinge | 1227 | Male? | Adult | x | x | | |
| 152 | Löddeköpinge | 1225 | Male | Adult | x | | 1 Spicules on the wall. | MB |
| 153 | Löddeköpinge | 1229 | Female | Adult | | 1 x | Remodelling spicule. | MB |
| 154 | Löddeköpinge | 1237 | Male? | Adult | x | x | | |
| 155 | Löddeköpinge | 1155 | Male? | Adult | x | x | | |
| 156 | Löddeköpinge | 1156 | Male? | Matur | x | x | | |
| 157 | Löddeköpinge | 1164 | Unsexed | Infans | x | - | Well-preserved, no abnormalities. | |
| 158 | Löddeköpinge | 1171 | Unsexed | Subadult | x | - | Cribr. orb. | |
| 159 | Löddeköpinge | 1157 | Female | Adult | x | - | | |
| 160 | Löddeköpinge | 1115 | Female | Matur | | 2 - | Spicules of bone (woven). | MB |
| 161 | Löddeköpinge | 1119 | Male? | Adult | x | x | Only floors left | |
| 162 | Löddeköpinge | 1120 | Female? | Matur | x | x | | |
| 163 | Löddeköpinge | 687 | Unsexed | Subadult | x | x | Only floors left. | |
| 164 | Löddeköpinge | 1026 | Unsexed | Adult | x | x | Both floors intact no abnormalities. | |
| 165 | Löddeköpinge | 791 | Female | Adult | x | - | Hole in the atrium (path?) | EB |
| 166 | Löddeköpinge | 814 | Female? | Adult | | 1 | 1 Spicules and minor pitting | MB |
| 167 | Löddeköpinge | 854 | Male? | Matur | x | x | Very well-preserved but no abnormalities. | |
| 168 | Löddeköpinge | 633 | Unsexed | Matur | x | | 1 Spicules very small. Holes from root visible. | |
| 169 | Löddeköpinge | 615 | Unsexed | Infans | x | x | Pitting on the floor (developmental pitting?) | |
| 170 | Löddeköpinge | 616 | Unsexed | Infans | x | x | Pitting, developmental. | |
| 171 | Löddeköpinge | 613 | Unsexed | Infans | - | x | Very well-preserved skull. | |
| 172 | Löddeköpinge | 400 | Male? | Adult | - | | 1 Spicules (wax-like) | MB |
| 173 | Löddeköpinge | 542 | Male? | Matur | x | x | | |
| 174 | Löddeköpinge | 581 | Male? | Matur | x | x | Both floors are quite well-preserved. | |
| 175 | Löddeköpinge | 280 | Female | Adult | x | x | Inatct skull, endoscope. | |
| 176 | Löddeköpinge | 377 | Female? | Adult | | 1 - | Pitting on floor and roof | |

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| 177 | Löddeköpinge | 453 | Male? | Adult | x | x | Some pitting but nothing pathological | |
| 178 | Löddeköpinge | 290 | Unsexed | Matur | x | 2 | Some form of infec on wall. Porous and pitting visible. | MB |
| 179 | Löddeköpinge | 495 | Male? | Matur | 2 | x | Spicules on the wall of the atrium. | |
| 180 | Löddeköpinge | 480 | Unsexed | Subadult | x | x | Some minor pitting. | |
| 181 | Löddeköpinge | 299 | Unsexed | Adult | 1 | 1 | Spicules of bone | MB |
| 182 | Löddeköpinge | 258 | Female? | Matur | 1 | x | Small spicule | MB |
| 183 | Löddeköpinge | 208 | Female | Adult | x | x | Semi-intact | |
| 184 | Löddeköpinge | 236 | Unsexed | Matur | 1 | x | The atrium i parted in two sections. | |
| 185 | Löddeköpinge | 196 | Female | Matur? | x | x | Pitting visible more likely due to roots. | |
| 186 | Löddeköpinge | 232A | Female? | Adult | x | x | Minor pitting on sinus (dex) not sinusitis. | |
| 187 | Löddeköpinge | 149 | Female? | Adult | x | x | No abnormalities visible. Cribra (sin) | |
| 188 | Löddeköpinge | 166 | Female? | Matur | x | x | Only floors preserved. | |
| 189 | Löddeköpinge | 161 | Unsexed | Subadult | x | x | Small perforations probably due to growth. | |
| 190 | Löddeköpinge | 119 | Unsexed | Adult | x | 1 | Pitting on the floor. Very bad preservation of individual. | MB |
| 191 | Löddeköpinge | 192 | Female? | Matur | x | 1 | Spicules on wall. Severe arthritis on shoulder. | MB |
| 192 | Löddeköpinge | 153 | Female | Adult | x | x | Sinus (dex) was best preserved. No abnormalities visible. | |
| 193 | Löddeköpinge | 125 | Female? | Matur | x | x | Poor outer preservation of skull. | |
| 194 | Löddeköpinge | 34 | Unsexed | Matur | - | 1 | New bone spicules on the wall of atrium. | MB |
| 195 | Löddeköpinge | 111 | Unsexed | Matur | 1 | 1 | Spicules of new bone. | MB |
| 196 | Löddeköpinge | 64 | Female | Matur | - | x | No pathologies. | |
| 197 | Löddeköpinge | 44 | Female | Matur | 1 | 1 | Spicules on the walls of the atrium. Some minor pitting. | MB |
| 198 | Löddeköpinge | 93 | Unsexed | Infans | x | x | Pitting but does no look pathological. | |
| 199 | Löddeköpinge | 83 | Male? | Adult | x | x | Poorly preserved sinuses. Some of the walls and roof intact. | |
| 200 | Löddeköpinge | 77F | Unsexed | Infans | x | - | No pathology visible. | |
| 201 | Löddeköpinge | 5B | Unsexed | Infans | x | x | Some minor perforations, non path. Cribra orb. | |
| 202 | Löddeköpinge | 29 | Unsexed | Infans | x | x | Well-preserved no path. Cribra orb. | |

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|-----|--------------|-----|---------|----------|---|---|--|----|
| 203 | Löddeköpinge | 27 | Unsexed | Subadult | 2 | - | Spicules (net-like). | MB |
| 204 | Löddeköpinge | 4 | Unsexed | Infans | x | x | Some minor pitting on sinus (dex) non path. | |
| 205 | Löddeköpinge | 1 | Unsexed | Subadult | x | x | No pathologies visible. | |
| 206 | Löddeköpinge | 23 | Unsexed | Subadult | x | x | Very ill-preserved sinuses, no path. | |
| 207 | Löddeköpinge | 805 | Female? | Adult | 3 | - | Spicules on both walls and floors of the sinus | MB |
| 208 | Löddeköpinge | 862 | Female | Matur | 2 | 2 | Spicules and pitting | MB |
| 209 | Löddeköpinge | 842 | Female? | Matur | x | 1 | Spicule on the ant-wall | MB |
| 210 | Löddeköpinge | 575 | Female? | Matur | x | 1 | Spicules | MB |
| 211 | Löddeköpinge | 759 | Male? | Adult | x | x | | |
| 212 | Löddeköpinge | 551 | Male? | Matur | - | 1 | Spicule on wall | MB |
| 213 | Löddeköpinge | 649 | Male | Adult | - | 1 | Pitting on floor of sinus | MB |
| 214 | Löddeköpinge | 523 | Male | Adult | 1 | x | Pitting on the roof of sinus | |