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Signs of sinusitis in times of urbanization in Viking Age-Early Medieval Sweden

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ABSTRACT

The influence and possible negative impact on sinus health of living conditions in rural and urban environments in Viking Age (AD 800–1050) and Early Medieval Sweden (AD 1050–1200) is investigated. Skeletal samples from 32 rural settlements in the Mälaren Valley (AD 750–1200) and burials in the nearby proto-urban port of trade Birka (AD 750–960) are examined. Based on the diagnostic criteria for maxillary sinusitis used in earlier studies, the results show that there is no significant difference in the prevalence of signs of sinusitis between the two materials (i.e. the Mälaren Valley versus Birka). Consequently, this provides no evidence that living in a proto-urban environment had a negative impact on sinus health. However, when compared with previously studied samples from the early medieval town Sigtuna, dated to AD 970–1100, the populations of the Mälaren Valley and Birka show significantly lower frequencies of bone changes interpreted as chronic maxillary sinusitis (95%, 70% and 82% respectively). This implies that the urban environment of Sigtuna could have led to impaired sinus health. There is also a significant difference between males and females in the Birka material, in which more females (100%) than males (68%) were affected. A gender based differentiation in work tasks is suggested by this, or exposure to environmental risk factors that affect sinus health. No difference between males and females could be detected in the samples from the Mälaren Valley and Sigtuna.

1. Introduction

1.1. Sinusitis and the pathophysiology of maxillary sinusitis

Sinusitis, an inflammation of the mucous membrane of the paranasal sinuses, is a common health problem (Brook, 2009; Slavin et al., 2005). Bioarchaeological studies suggest that this was also the case in many populations in prehistoric and historical times. Sinusitis often starts with rhinitis, but clinical research has shown that dental disease could also be a reason for maxillary sinusitis (Brock, 2006). The early phase of an acute sinus infection is often viral, in some cases followed by a bacterial infection. In chronic sinusitis, bacteria are believed to play a major role in most cases, with pathogens such as *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Haemophilus influenza* and *Moraxella catarrhalis*. Even though bacterial and viral infections are the most common cause (Lundberg and Engquist, 1983), other factors which lead to swelling of the sinuses such as allergies, poor air quality or fungi can also be involved in chronic sinusitis (Brook, 2009; Slavin et al., 2005).

The mucosa of the maxillary sinuses and the nasal cavity is contiguous with a small opening, the ostium, connecting the sinus cavity with the middle meatus. Since gravity cannot drain the sinus through the ostium, cilia transport mucus toward the ostial opening. Drainage of the sinus might be prevented by damage to the cilia or blockage of the ostium, which could be caused by inflammation of the mucosal membrane in an upper respiratory infection or allergy, a foreign body in the nose, or a fracture of the nose. In maxillary sinusitis of a dental origin, the ostium can remain open (Brook, 2009; Slavin et al., 2005). Typical symptoms of acute sinus inflammation include nasal congestion, purulent rhinorrhea, facial-dental pain, postnasal drainage, headache and coughing. Fever and malaise are less frequent. Usually an inflammation only lasts up to ten days, but when the symptoms last for eight weeks or more, sinusitis is classified as a chronic disease (Brook, 2009; Slavin et al., 2005). The symptoms of chronic sinusitis are similar to those of acute sinusitis, but can be more subtle. Chronic sinusitis can prevail for years, and a primary infection can spread and cause further complications such as subdural abscesses, meningitis, sepsis or even death (Slavin et al., 2005).

The mucous membranes of the sinuses are bonded to the periosteum, and a chronic inflammation can lead to bone changes.

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However, the relationship between inflammation of the mucous membrane and bone changes is not fully understood. Clinical studies show that bones can be affected in chronic sinusitis, but the changes are usually too small to register in radiography (for example Jang et al., 2002; Tsakiropoulou et al., 2011). In a study where CT scans were performed on patients with a history of chronic sinusitis, only 47% demonstrated positive signs of sinusitis in the CT scan. There was no difference in the severity of the symptoms between patients with positive CT scans and those with negative scans (Stankiewicz and Chow, 2002). This shows that the clinical symptoms only have a weak correlation with the changes visible in a CT scan, and underlines the problem of interpreting the experience of disease and quality of life based on skeletal changes.

1.2. Bioarchaeology

Due to preservation problems, few studies in bioarchaeology have documented bone changes in the sinuses. Among the several sinuses in the cranium, the most studied is the maxillary sinus, due to ease of access. Signs of chronic inflammatory disease in this skeletal region have mainly been documented in medieval skeletal populations from northern Europe (Boocock et al., 1995; Lewis et al., 1995; Panhuysen et al., 1997; Roumelis, 2007; Sundman and Kjellström, 2011; Wells, 1964, 1977). Nevertheless, surveys based on groups dated to the Bronze- and Iron Age have also been made (Liebe-Harkort, 2012; Wells, 1964, 1977) in addition to studies based on non-European populations dating from the period AD 750–1700 (Merrett and Pfeiffer, 2000; Roberts, 2007). Standards for registration were developed by Boocock et al. (1995) but criteria for preservation and the method of using an endoscope differ between studies. The investigations use the signs of upper respiratory diseases in relation to contextual factors, to discuss trends and variety in health among the studied samples (for a review see Roberts, 2007). (Although not further mentioned in this study, ribs can also develop new bone formation as a result of inflammation due to pathogens and poor air quality).

1.3. Maxillary sinusitis in relation to environmental factors

Human health is affected by poor air quality; according to WHO, air pollution, indoors and outdoors in both developed and developing countries, causes millions of deaths every year (WHO, 2006). Inhalation of particles from dust or smoke in the air triggers the negative effect, (densely populated and poorly ventilated houses can further aggravate the effects by transmission of droplet infection). However, there are no worldwide standards for *air quality*; due to a variety of economic, political and social factors, this is determined independently by each country. A wide range of health problems are associated with poor air quality but the most well-known are respiratory diseases, followed by cardiovascular diseases and lung cancer. Etiologic factors (except for viruses and bacteria) are air pollutants; for example, sulphur and nitrogen oxides (WHO, 2006). The particles come primarily from combustion of fossil fuel. Each etiologic agent may cause an inflammatory response, which if it becomes chronic can lead to bone changes in the sinuses (upper-respiratory-tract infection) or on the visceral surface of the ribs (lower-respiratory-tract infection). The consequences of air pollution depends on exposure, age and general health status, but even concentrations of airborne particles that are slightly over the background level can cause negative health effects (Romieu et al., 2002).

Modern epidemiological research demonstrates several differences in health between people in urban and rural environments. The concept of "rural" can be defined differently depending on population density, geographic location or social organization. Regardless of definition, people in an urban context tend to have a somewhat poorer health due to environmental and socio-cultural factors (Verheij et al., 1998). The urban centres include a greater number of people who may become exposed in general, and higher concentrations of people in the physically weakest groups. In a Swedish historical perspective, little is known about the variations in health between early towns and their surroundings during the first period of urbanization. In a bioarchaeological study of different general health parameters from early medieval Lund, the results indicated small differences between the townspeople and rural dwellers (Arcini, 1999). Internationally, the health of medieval rural and urban populations has been compared in several studies (cf. Roberts and Cox, 2003). Urban settlements are considered to have been unhealthy environments, where diseases spread more easily due to higher population density, poor sanitation and hygiene, polluted water and a constant inflow of new people that might be infected (McGarth, 1992; Storey, 1992). An increased specialization in crafts could make areas into industrialized zones. These activities might lead to toxic fumes or contamination of water supplies and secondarily to health problems. A decline in health during the process of urbanization has been demonstrated in skeletal assemblages from a variety of contexts; the applied indicators of stress vary from stature to pathologically induced bone changes (Manchester, 1992; Roberts and Cox, 2003; Steckel and Rose, 2002). Infectious diseases that spread by droplet infection particularly benefit from a dense population like in a medieval town (Manchester, 1992). These environments facilitate the transmission of microorganisms such as viruses and bacteria, subsequently leading to epidemics. In the early proto-towns, the housing of the urban dwellers was similar to that of rural groups, but people and animals were more closely crowded in the town. In a rural settlement, on the other hand, there was a greater exposure to irritants in soil and close contact with a larger number of animals, which could also increase the risk of developing maxillary sinusitis (Lewis, 2002). Thus, the same risk factors exist for both groups, although in different degrees. In Swedish towns, a state administrative system of sanitary preventive measures was not introduced until the 16th century (Dundin and Willner, 2007). Nevertheless, the crowdedness and poor environment in the centres continued to be a health problem. Moreover, although it is seldom mentioned in the historical records, it is likely that the small dwellings with central hearths also caused indoor air pollution (Brimblecombe, 1999). It was only in the mid-1800s that one of the first Swedish reports of problems with poor air quality was presented, this was an inspection of factory-workers' conditions (Dundin and Willner, 2007). In both urban and rural environments, with some exceptions, women took care of the household duties of the farms (Christensen-Nugues, 2004; Myrdal and Bäärnhielm, 1994; Rui, 1996; Sawyer, 1992; Virtanen, 1964: 565). This indicates that their activities were more closely related to the home and indoor life than the men, who were generally more mobile, suggesting the existence of differences in health between men and women.

The earlier bioarchaeological surveys have shown that populations in urban settlements often have a higher prevalence of signs of chronic maxillary sinusitis than populations in rural settlements (Lewis et al., 1995; Roberts, 2000, 2007; Roberts et al., 1998). One study of Medieval Britain demonstrates that while there was a higher prevalence of maxillary sinusitis in urban populations, probably caused by air pollution, the rural populations more often suffered from sinusitis caused by dental disease (Roberts et al., 1998). In the same study, a hypothesis was presented concerning a sex-based distribution of maxillaris sinusitis, which may have been caused by the division of work mentioned above. However, no statistically significant difference in the frequency of maxillary sinusitis between men and women was found. In a study of sinus health in the