



Comparison of mercury and lead levels in the bones of rural and urban populations in Southern Denmark and Northern Germany during the Middle Ages



Kaare Lund Rasmussen ^{a,*}, Lilian Skytte ^a, Anne Juul Jensen ^a, Jesper Lier Boldsen ^b

^a Department of Physics, Chemistry and Pharmacy, University of Southern Denmark, Campusvej 55, DK-5230 Odense M, Denmark

^b Department of Anthropology (ADBOU), Institute of Forensic Medicine, University of Southern Denmark, Lucernemarken 20, 5260 Odense S, Denmark

ARTICLE INFO

Article history:

Received 6 April 2015

Received in revised form 14 June 2015

Accepted 14 June 2015

Available online 3 July 2015

Keywords:

Human bones

Lead

Mercury

Pb

Hg

Medieval

Denmark

Germany

ABSTRACT

Mercury and lead were present in European medieval society in very different ways. Mercury was rare and occurred only as point sources such as medicine, the colour pigment cinnabar and in the process of gilding. Lead was ubiquitous in the urban societies and present even in the rural ones; the main source was lead glazed kitchenware. We have investigated the distribution of both elements in the bones of rural and urban populations in Northern Germany and Southern Denmark. 283 individuals from six different medieval cemeteries have been studied. The individuals have been examined anthropologically to determine sex and age at death, while samples of the cortical and trabecular bone tissues from the femur have been analysed chemically. Prior to chemical analyses the samples were thoroughly decontaminated. The samples were measured for mercury, lead and calcium. From the data of the rural populations we have established limits for the background exposure levels: 80 and 300 ng g⁻¹ for mercury and 5 and 7 µg g⁻¹ for lead in cortical and trabecular bone tissue respectively. On average 21% of the population was exposed to Hg above background, but the frequency of high Hg exposure varied from cemetery to cemetery. Lead exposure reached even out into the rural communities where ca. 35% of the population was exposed above background. No correlation was seen between Hg and the proposed social status indicator Pb. Based on measurements of calcium we propose for the first time a criterion for rejecting the analysis of a skeletal sample due to contamination.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

Six different medieval populations in Northern Germany and Southern Denmark have been sampled and analysed for Hg, Pb and Ca (plus a suite of other elements not reported here). The aim of this investigation was to compare the degree of Hg and Pb exposure of humans residing in rural environs with people living in urban communities. The anthropogenic impacts are thought to be larger and more diverse in the urban communities, but some anthropogenic sources are likely to have been present at both places, e.g. lead glazed ceramics. The degrees of Hg and Pb exposures are determined by two factors, firstly the degree of isolation of the community, a factor which is relevant for both Hg and Pb, and secondly by the frequency of single individuals which have been exposed to point sources of Hg at some instance in their lives. These single individuals would include those who received medical treatment with Hg, the herbalists and/or therapists that prepared and administered such medicine, and individuals handling the red ink in scriptoria which will generally be limited to monks or novices in monastic institutions.

In medieval Western Europe mercury was predominately used for three very different purposes: as an ingredient in medicine, as the colour pigment cinnabar in red ink, and in the process of gilding metallic objects. Only limited and distinct groups of the population were exposed to Hg through participating in these rather specialized processes, but those individuals that were exposed did indeed incorporate Hg in their bone tissue (Steinbock, 1976; Charlier, 2006; Rasmussen et al., 2008; Fornaciari et al., 2011; Rasmussen et al., 2013a). Mercury has been identified in excess in some special cases such as noble, royal or very famous people, e.g. Ferdinand II of Aragon and King of Naples (Fornaciari et al., 2011); in several of the noble inhabitants of medieval Moscow (Alexandrovskaya and Panova, 2003; Alexandrovskaya and Alexandrovskiy, 2005); and in Agnes of Sorel from France (Charlier, 2006). But excessive levels of Hg has also been found in individuals of the ordinary population in Russia (Alexandrovskaya and Panova, 2003; Alexandrovskaya and Alexandrovskiy, 2005) and in Denmark (Rasmussen et al., 2008; Rasmussen et al., 2013a).

The advantage of Hg in terms of interpreting medieval bone chemistry is that it has a “large dynamic range”, meaning that the environmental background is extremely low whereas the exposed individuals occasionally exhibit soaring concentrations. One potential caveat in interpreting Hg-exposures in medieval man is that Hg were in rare

* Corresponding author.

E-mail address: klr@sdu.dk (K.L. Rasmussen).

cases used for embalming purposes. This is mainly an issue for the rich or famous, but in these cases it is crucial to be able to distinguish whether the Hg exposure occurred prior to death or after. In the case of S. Francesco Caracciolo, interred in S. Gennaro's chapel in the Cathedral of Naples, a sample of soft tissue from inside the cranium showed a highly elevated Hg concentration which could indicate the use of Hg for embalming purposes, but at the same time a sample of cortical bone tissue from the tibia also showed an elevated Hg concentration, thus leaving no doubt that S. Francesco Caracciolo was exposed to Hg earlier in his life probably from receiving medicine containing Hg (Rasmussen et al., 2012). However, this was not the case with world renowned astronomer Tycho Brahe, where only the textiles in the grave were found to be high in Hg (Rasmussen et al., 2013c).

As it can be seen from the above, a crucial question pertinent to these discussions is what constitutes an elevated Hg concentration and what is just at the background. Seemingly this is different for cortical and trabecular tissue (Rasmussen et al., 2013a). Based on measurements of ca. 100 individuals Rasmussen et al. (2008) suggested an Hg background level of between 10 and 100 ng g⁻¹. In the present paper we address this problem and attempt to establish more accurate limits for the background levels of Hg in cortical and trabecular tissues in the ordinary medieval population in Northern Germany and Southern Denmark.

No natural deposits of Hg-containing minerals exist in Northern Germany or Southern Denmark, and the supply of Hg must therefore have been brought to Northern Europe via a network of trade routes, probably originating from the cinnabar mines near Almadén in central Spain although other mines did exist within the medieval world. For this reason it is to be expected that Hg would primarily reach people in the urban communities and they are therefore expected to be exposed more often and more severely than contemporary rural populations, which remained rather isolated throughout the medieval period. The *ad hoc* expectation is therefore to find relatively high Hg concentration in a few individuals, primarily in the urban populations, and below background Hg-concentrations in the majority of the populations and almost exclusively so in the rural ones.

Lead was widespread in medieval Northern Europe – in contrast to Hg there were several common-place sources for Pb. The sources for Pb in the medieval societies encompassed lead glazed ceramics which were in close and daily contact with foodstuff; lead containing coins; stained glass windows; lead tiled roofs which were in some instances in contact with the drinking water. Although some of these sources for human Pb-exposure were present in all medieval communities in Northern Europe, there is every reason to suspect they were much more ubiquitous in urban than in rural communities. It is therefore an intuitive hypothesis that one should find higher concentrations of Pb in urban communities than in rural ones.

2. Sample material

It is not an easy task to identify the graves of monks with certainty even in the cloister walks of monasteries. In the Dominican Friary in Schleswig, for instance, women and children are also found amongst individuals interred in the cloister walk. So, the rationale behind the selection of cemeteries in the present work has been to select urban communities in harbour towns with a high degree of commercial activity implying that the inhabitants were highly mobile and that a fair fraction of the population was rich and advanced. The urban cemeteries selected were Rathaus Markt in Schleswig in Northern Germany situated in the former Duchies, and Ole Worms Gade in Horsens in Central Jutland some 50 km north of the border to the Duchies. These two populations are expected to have been highly exposed to Hg and Pb. To counterpoise this, four rural cemeteries have been selected. Two immediately outside the selected urban societies: St. Clements just outside the city limits of Schleswig and Tirup 1.3 km outside of Horsens city limits. The other two more remote rural cemeteries

selected were Nybøl in central South Jutland in the former Duchies, and Skt. Alberts Kapel on the island of Ærø also in the former Duchies.

The location of the six selected sites north and south of the present day Danish–German border, but in medieval time belonging to or close to the Duchies, can be seen in Fig. 1 and short descriptions are listed in Table 1. Even though the cemeteries are all medieval there are wide differences in the time intervals in which they were active – a fact that has some bearings on the interpretations of the data present below. The skeletons are selected randomly in the cemeteries, except that children are not normally included in the selection and with the exception that the skeletons from St. Clements are selected to have approximate ages between 20 and 30 at the time of death.

2.1. Rathaus Markt

The Rathaus Markt cemetery was situated some 80 m east of the Cathedral in Schleswig, but most likely belonged to a no longer existing church called St. Trinity (Boldsen et al., 2013). Oak coffins in 25 graves were dendrochronologically dated to between AD 1060 and 1205 (Lüdtke, 1997). The church and the cemetery appear to have been abandoned between 1200 and 1250, perhaps due to the establishment of the market square called Rathaus Markt (Radtke, 1985). The entire sample of skeletons from the Rathaus Markt excavation have been analysed and published by Grupe (1997) and 223 skeletons were examined for signs of leprosy by Boldsen et al. (2013).

2.2. St. Clements Kirche

St. Clement's Church is situated northeast of the medieval city centre of Schleswig outside the northern city gate. The parish of St. Clement was mentioned for the first and last time in AD 1196. It appears that the church and cemetery are older than the city gate (built around 1200), as graves have been found under the street leading through the gate (Lafrenz and Carius, 1985, pp. 10 and 66). St. Clements has previously been viewed as a city cemetery as it is situated within the modern day city limits of Schleswig. However, our analyses show that the interred individuals were indeed much similar to a rural population. The skeletons are described in a yet unpublished manuscript from 2005 (Gerhardt, personal communication). 108 skeletons out of the 206 available were investigated and scored for leprosy by Boldsen et al. 2013. The skeletons selected in this study from this cemetery includes solely individuals from ca. 20 to ca. 30 years of age.

2.3. Ole Worms Gade

The cemetery in Ole Worms Gade was a town parish cemetery for Horsens from the early middle ages to 1480. The Church of Our Lady was given to the monastic order of the Knights Hospitaller by King Valdemar Atterdag in 1351, but it continued to function as the main burial place for the inhabitants of Horsens until 1480, and burials even continued to be made on the cemetery until the reformation in 1536 (Knudsen and Schjørring, 1992; Klemensen, 2009, 2011). The site was an intensely utilized urban cemetery where only the later burials – mainly from the 15th century – were preserved as *in situ* skeletons. This is reflected in the fact that more than half of the individuals identified were loose-findings, *i.e.* individuals were the bones were not found *in situ* (Pedersen and Boldsen, 2010).

2.4. Tirup

Tirup was a small village situated 1.3 km outside of the medieval town of Horsens. The Tirup cemetery is the only totally excavated rural medieval cemetery in Denmark. The usage of the cemetery has been dated to the period AD 1150–1350 based on archaeological and documentary sources (Boldsen et al., 1985, Kieffer-Olsen et al., 1986). The fact the all burials from a small rural community over a 200 year

Download English Version:

<https://daneshyari.com/en/article/7446518>

Download Persian Version:

<https://daneshyari.com/article/7446518>

[Daneshyari.com](https://daneshyari.com)