Introduction: Vitamin C and Scurvy

Humans need to obtain vitamin C from dietary sources, and regular supplies are required. Vitamin C is present in a wide range of fruits and vegetables, and smaller amounts are found in milk, meat and fish. Storage, preparation and cooking practices affect the vitamin C content.

Foods containing vitamin C are present at all latitudes, but will be more plentiful and less seasonally dependent at lower latitudes. A wide range of social and cultural factors influence the types of foods eaten, and their vitamin content.

Individual vitamin C requirements vary depending on age, and factors such as pregnancy. Symptoms of scurvy frequently occur when no vitamin C has been ingested for 90 days, but once obtained recovery is rapid; significant improvements have been noted clinically after 48 hours.

Skeletal Changes

Haemorrhagic manifestations due to impaired collagen formation are the primary bone change. Scurvy causes depressed osteoblastic activity and a virtual cessation of bone formation; formation occurs rapidly once vitamin C is obtained. The full range of changes is discussed by Brickley and Ives (2008). Examples of skeletal changes associated with scurvy are shown in Figures 1 and 2.

Introduction: Vitamin D and Rickets

Vitamin D deficiency is primarily caused by a prolonged lack of exposure to sunlight and/or dietary deficiency of foodstuffs containing vitamin D. Sunlight exposure varies between geographic latitudes (Holick & Adams, 1998).

Levels of vitamin D deficiency can provide an important indicator of socio-economic, cultural, environmental and nutritional conditions in the past.

Skeletal Changes

Vitamin D is required during the mineralization of osteoid and, during deficiency, areas of unmineralised osteoid will develop throughout the skeleton. Examples of changes associated with rickets are shown in Figures 3 and 4.

Methods

During recording if any pathological changes linked to scurvy were present the individual was recorded as having scurvy. Both rickets (term used where unfused growth plates present) and residual changes associated with rickets (see Brickley et al., in press), were recorded. If either of these changes were present the individual was coded as having rickets. For this analysis, individuals aged 20+ were considered to have ‘healed’ rickets and younger individuals ‘active’ rickets, providing a good overall indication of numbers who survived periods of deficiency.

Results and Discussion

• Lesions suggestive of scurvy were identified in 1.37% of the individuals analyzed.

• Lesions suggestive of rickets (active and healed) were identified in 1.40% of the burials analyzed (see Fig. 5). For most periods the prevalence of those rickets is lower for adults than those aged <20 years.

Spatial Relationship of Cases of Rickets and Scurvy

A relationship was found between latitude and vitamin D deficiency (Fig. 7). Although the general pattern observed demonstrated cases of rickets increase markedly above 45° degrees, some sites did not follow this trend e.g. Xironomi, Greece (26%) and Çatalhöyük, Turkey (8%), both located at 38°. Here a range of social and cultural practices that impacted on vitamin D were present. GIS data show that levels of rickets are higher in environments where large urban settlements are likely to be found.

Future Directions/Research

Data analysis is on-going, particularly for later periods. Once complete it will be possible to examine the temporal relationship between rickets and scurvy, and the link to latitude and urban settlements, as well as links between these conditions and other stress indicators.

Conclusions

Results are preliminary, but a broad link between complex urban communities and deficiency diseases is suggested.
Contextual Dimensions of European Health and Lifestyle: The Archaeological and Historical Record

AAPA Symposium
Reconstructing Health and Disease in Europe: The Early Middle Ages through the Industrial Period

I would like to write about the history of those tribes, but I am held back by the thought that they did not have any history, and if I would do so I would be guilty for imposing my own mindset on their descendants who were greedily grasping for any kind of mythology. Czeslaw Milosz. Piekas przydrozny, 1997

Introduction
Skeletal evidence from archaeological sites is interesting from biological and historical points of view. Concerning biomedical aspects, the possibilities of hypothesis testing under extreme physiological conditions in contemporary medicine are severely limited. However, as the history of humanity in Europe had already created such conditions that cannot be reproduced in any experiment, skeletal remains can be of value for biomedicine, for example by exploring human adaptation and the development of pathological changes without the impact of modern treatments. Concerning history, the study of human remains from archaeological sites facilitates the understanding and interpretation of the quality of past lives. By themselves, skeletal remains tell us little about the history of human health and its determinants; although they can show signs of disease, methodological difficulties complicate the interpretations. Contextual information about the natural and sociocultural environments people inhabited is necessary to draw meaningful conclusions about how these impacted health. The aim of this presentation is to introduce the scope and the design of this large ongoing study.

Material and Methods
Global History of Health Project members have selected skeletons representing 83 European sites dating from Antiquity/Prehistory (<500 BC) to the early Modern period (after 1501 AD) (Table 1 and Fig. 2) for analysis in order to maximize the quality of both the skeletal and available contextual information; the total number of skeletons included for this analysis is 10,969. The sample will inevitably increase as the Project progresses.

Table 1: Chronological subdivisions used in the poster analyses

<table>
<thead>
<tr>
<th>Period</th>
<th>Dates (B.C./A.D.)</th>
<th>Dates (B.P.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antiquity/Prehistory</td>
<td>1500 B.C. – 500 B.C.</td>
<td>250 – 0</td>
</tr>
<tr>
<td>Classical Antiquity</td>
<td>500 B.C. – 250 B.C.</td>
<td>250 – 500</td>
</tr>
<tr>
<td>Early Middle Ages</td>
<td>500 A.D. – 1000 A.D.</td>
<td>1000 – 500</td>
</tr>
<tr>
<td>High Middle Ages</td>
<td>1001 A.D. – 1500 A.D.</td>
<td>1500 – 1001</td>
</tr>
<tr>
<td>Late Middle Ages</td>
<td>1501 A.D. – 1700 A.D.</td>
<td>1700 – 1501</td>
</tr>
<tr>
<td>Modern</td>
<td>1701 A.D. – 1900 A.D.</td>
<td>1900 – 1701</td>
</tr>
</tbody>
</table>

Recording of Skeletons
All project members coded skeletal variables according to a uniform system (available from the project website http://global.sbs.ohio-state.edu/). Sex and age determination was established according to the criteria listed in the database. Health indicators selected are easily recorded and do not require sophisticated diagnostic equipment. These include skeletal measurements to estimate stature and robusticity, dental traits such as linear enamel hypoplasia, dental caries and antemortem tooth loss; cribriform orbitalia and porotic hyperostosis, signs of scurvy and rickets, specific (TB, leprosy, treponematoses), and non-specific infectious diseases, or perioseal reactions, trauma, and degenerative joint disease. A pilot analysis (on-line personal diagnostic quiz for participants) revealed no significant inter-observer biases. The total sample recorded by country is illustrated in Figure 3.

Contextual variables for each site include latitude and longitude, altitude, soil types, vegetation zone, precipitation, and length of growing period. Extensive use of Geographic Information Systems databases from a variety of sources are being used to reconstruct the ecosystems inhabited by the people whose remains are being studied. These databases contain information pertaining to climatic variation and key variables of socio-economic importance such as growing season length, patterns of annual precipitation, water availability, local topographical relief, etc. Figure 2: Site locations and names using latitude and longitude imported into google earth

Figure 3: Distribution by country of the total sample recorded.

Preliminary Results and Prospects for the Future
Studies of these European data in the following posters provide a unique opportunity to explore correlations between health, geographic, environmental and socio-cultural contexts. We also plan to refine the chronological framework for analysis through the selective use of radiocarbon dating. For example, we have found that a considerable proportion (48%) of the variance in estimated adult height (a parameter that has been shown to be an excellent summary of quality of life index) can be explained by a simple multiple regression model that incorporates such local ecological variables (see, the Body Size and Femoral length poster). However, our goal is not to use such environmental data to create deterministic models. Instead, we are using deviations from the predictions they produce to identify the socio-cultural factors that are the key determinants of the health history of the European population.


Acknowledgements: Supported by the U.S. National Science Foundation (BCS-0527658, SES-0138129, BCS-0117958). Special thanks to Kimberly Williams for her assistance in the development of this research, and Ohio State University for continued institutional and facilities support.
History of Degenerative Joint Disease in Europe: Inferences about Lifestyle and Activity

AAPA Symposium
Reconstructing Health and Disease in Europe: The Early Middle Ages through the Industrial Period

Background

Anthropologists and other social scientists have long had an interest in quality of life as it relates to workload, lifestyle, and activity. An important tool for addressing this general topic is degenerative joint disease, articular joint modifications largely owing to wear-and-tear over the course of life.

In addition to differences by joint, variation in age and sex is highly informative about the behavioral and life experiences of a population as it relates to workload and activity. This project documents and interprets temporal and other patterns derived from the Global History of Health Project in order to characterize the history of activity in a broad sense for Europe.

Objectives

• Draw inferences about activity in relation to key shifts in settlement, technology, and other factors that influence lifestyle in the last 10,000 years of human evolution.
• Test the hypothesis that technological innovation occasioned a decline in workload and activity.

Methods

• All major upper and lower limb articular joints or joint groups were assessed: shoulder, elbow, hip, knee, wrist/hand, ankle/foot for both right and left sides. All available elements of a joint were assessed, but only one element had to display degenerative changes in order to indicate presence of DJD. Each joint was scored: no evidence of DJD (score=0); slight marginal lipping (score=1); severe marginal lipping, commonly with porosity and/or eburnation on joint surface (score=2); complete or near complete destruction of joint surface, often accompanied by ankylosis (score=4); joint fusion (score=5). Summary joint scores were calculated: (right side score + left side score)/2.
• All cervical, thoracic, and lumbar vertebrae were scored separately with focus exclusive to the vertebral body surface and margin: no DJD (score=0); slight to moderate marginal lipping on at least one body (score=2); extensive marginal lipping, with or without intervertebral body surface degeneration (e.g., Schmorl's nodes) (score=3).

Age and Sex Variation

Consistent with progressive age-associated DJD, there is a clear increase in prevalence with age for all sites and individuals combined. The age effect is especially pronounced for proximal joints (shoulder and hip), intermediate for knee, elbow, and wrist/hand, and least for the ankle/foot (Fig. 1).

Males have significantly more DJD than females (chi-square; p<0.05; Fig. 2). This pattern suggests a conflation of level of activity (or behaviors) in later adulthood of men and women.

Reflecting the use of the upper limb for non-ambulatory activities using the hands and arms for lifting, throwing, and other activities, there is a clear increase in prevalence with age for the shoulder, elbow, and wrist/hand, and not for the hip, knee, and ankle/foot (t-test, p<0.05).

Women show greater DJD right-left asymmetry than men for all joints except the hip. This difference reaches statistical significance for the elbow (t-test; p<0.05). This pattern suggests differences in use of the upper limb, especially involving the elbow and associated functions (Fig. 3).

The development of DJD is more rapid in males than females, in general and for all specific joints (Fig. 4).

Significant regional differences existed in this trend. Prior to the High Middle Ages, age-corrected osteoarthritides is significantly lower in southern European populations than in northern European populations. Beginning in the Early Middle Ages, DJD begins to increase among Europeans living in the Mediterranean region (Fig 6).

Temporal and Regional Variation

The most profound pattern of variation is documented in the temporal reduction of DJD, based on the mean residual of DJD total score from age regression in order to correct for age (Fig. 5). The finding is consistent with the hypothesis that, overall, technology has alleviated articular degeneration during the Medieval period.

These changes affected men and women differently with notable Medieval declines in DJD among Northern European Females and increase among Mediterranean (Fig. 7).


Acknowledgements: Supported by the U.S. National Science Foundation (BCS-0527658, SES-0138129, BCS-0117958). Special thanks to Kimberly Williams for her assistance in the development of this research, and Ohio State University for continued institutional and facilities support.
**Body Size and Femur Length**

**Background**

Social scientists have long been developing and analyzing measures of social performance, a generic term that refers to well-being. Scholars have devised a large number of measures such as life expectancy at birth, infant mortality, and life expectancy at age 65, which have stimulated the public health movement. Perhaps the most widely used measure today is average adult stature, which can be related to nutritional status, socioeconomic status, and other variables. These investigations have provided important information about patterns of social inequality and the spread of disease.

Human biologists and medical anthropologists know that average stature is an excellent measure of net nutritional conditions in childhood. One may think of the body as a biological machine that consumes fuel (calories, protein, vitamins and so forth) in basal metabolism, work or physical activity and fighting infection or disease. Physical growth has a low priority under conditions of physiological stress, and persistent malnutrition leads to stunting by as much as 10 to 20 centimeters, depending upon duration and severity. Therefore average height is a useful measure of population health and well-being.

**Objectives**

We seek to measure average stature over time, across space, and by sex, to establish baseline patterns against which more recent evidence can be evaluated. We will test the null hypothesis that no differences existed over time, across space, or by sex. Ultimately we will draw comparisons with the Western Hemisphere database, which showed that physical growth was retarded in urban areas and in upland environments where food was relatively sparse.

**Methods**

Of course, we cannot observe stature directly from the skeleton, but several studies establish that height is highly correlated with femur length. In the 1950s, Trotter and Gleser measured the femur lengths and other long bones of American troops who died during the middle of the twentieth century and are now the tallest in the world, which think genetic factors were involved. The Dutch, however, were relatively short in the mid-nineteenth century and are now the tallest in the world, which discounts the role of genes.

The modern pattern is consistent with a north-south income gradient. Both measures of social performance are converging such that southern Europeans are growing faster and getting richer relative to the north. A millennium ago, however, southern Europe was richer than the north (Cameron and Neal, 2003). Quite possibly the trade and commerce that made southern Europe rich during the Middle Ages also led to the formation of inequality and the spread of disease that stunted growth. The project will investigate these ideas in future publications.

**Variation by Sex and Time Period**

Whereas rates of cranial trauma were rising among men during the Middle Ages (see trauma poster), average stature of both men and women was declining (Fig. 1). The stature decline agrees with that reported by Steckel (2004; 2005) based on published studies. Possibly the two patterns are related in that socioeconomic stress could have contributed to both malnutrition and violence. Steckel suggests, and the project will investigate, whether the outset of the Little Ice Age in the late Middle Ages led to deteriorating diets. Other sources of stress may have emerged from the growth of interregional trade and urbanization, which both led to the spread of communicable disease.

**Regional Variation**

Various cross-country studies of height in modern Europe report a north-south gradient, with the Dutch and the Scandinavians being the tallest and the Mediterranean populations of Portugal, Spain and Greece the shortest (Schmidt et al. 1995). Interestingly, this pattern also existed a thousand years earlier (see Fig. 2), which may lead one to think genetic factors were involved. The Dutch, however, were relatively short in the mid-nineteenth century and are now the tallest in the world, which discounts the role of genes.

The modern pattern is consistent with a north-south income gradient. Both measures of social performance are converging such that southern Europeans are growing faster and getting richer relative to the north. A millennium ago, however, southern Europe was richer than the north (Cameron and Neal, 2003). Quite possibly the trade and commerce that made southern Europe rich during the Middle Ages also led to the formation of inequality and the spread of disease that stunted growth. The project will investigate these ideas in future publications.

**Sexual Dimorphism**

Several studies of growth by human biologists report that women and girls are more resistant to deprivation than are men and boys (Eveleth and Tanner, 1976; 1980). As a result, the heights of men tend to rise relative to those of women if nutritional conditions improve.

Although the pattern is a bit jagged, the data in Figure 4 confirm this relationship. As average stature declined during the Middle Ages, the heights of men fell faster than those of women, such that the ratio of their heights diminished.


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**Periosteal Lesions: A Non-specific Index of the History of Health in Europe**

**Background**

Proliferative periosteal lesions on long bones are commonly reported on ancient skeletal remains, from diverse chronological periods and geographic sites. Many events may stimulate the periosteum, such as mechanical injury (e.g., trauma, leg ulceration), metabolic or neoplastic conditions, circulatory insufficiency or infectious processes (Weston, 2008). In most cases, the underlying pathological process causing proliferative periosteal lesions (PL) is not easily established, but these lesions are most commonly attributed to the impact of infection or trauma (Larsen; 2002; Ortner, 2003).

Although these pathological changes are not pathognomonic for a particular disease, they suggest a health disruptive process often as an outcome of environmental constraints. Therefore, this parameter is of great importance in the assessment of the health history of Europe and can be used as an indirect and non-specific health indicator.

The scarcity of large-scale bioarchaeological analysis of PL often precludes a full understanding of its role in exploring living conditions of past populations. Consequently, analysis of the Global History of Health Project (GHHP) data can be an important tool for establishing general prevalence as well as geographical and chronological trends.

**Objectives**

- Evaluation of the prevalence of periosteal lesions (PL) in the GHHP European sample, as a non-specific index of temporal-spatial variation in the health status of European populations.

**Methods**

- A sample of (N = 7896) adult individuals were surveyed for the presence of periosteal bone formation on long bones.
- The severity of PL was scored using an ordinal scale (see Table 1).

**Results and Discussion**

**Overall Frequency**

- Signs of PL were present in 15.3% of the adult individuals studied.
- Bones of the lower limb were far more affected by PL than the bones of the upper limb, with highest values obtained for the tibia (18.4% in males) and lowest for the clavicle (0.3% in females) (Fig. 1).

<table>
<thead>
<tr>
<th>Score</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No osteophytically present</td>
</tr>
<tr>
<td>2</td>
<td>Moderately accentuated longitudinal ridges</td>
</tr>
<tr>
<td>3</td>
<td>Elongate, disc-shaped, or irregular osteophytes involving bone but not from end of bone (i.e., rim-like)</td>
</tr>
<tr>
<td>4</td>
<td>Moderate involvement of periosteum, but less than one half of bone width</td>
</tr>
<tr>
<td>5</td>
<td>Extensive periosteal reaction involving more than half of the bone width</td>
</tr>
<tr>
<td>6</td>
<td>Osteomyelitis infection involving most of the diaphysis with surrounding osteophytic reaction</td>
</tr>
<tr>
<td>7</td>
<td>Osteomyelitis, associated with a fracture</td>
</tr>
</tbody>
</table>

**Periosteal Lesions Temporal Trends**

- A marked decrease in PL prevalence was observed from Classical Antiquity to the Early Middle Ages (EMA) with a subsequent rise after this period (Fig. 2). These two shifts are statistically significant ($\chi^2=31.4$, $p=0.0001$ and $\chi^2=19.0$, $p=0.0001$). Lower frequency is seen for the EMA, with Classical Antiquity, the High Middle Ages and Late Middle Ages presenting steady frequencies (18.2%, 17.6%, and 17.3%, respectively).
- Inferences about the marginal values for the Prehistoric and Modern periods are limited due to sample constraints.
- The chronological pattern is mainly the result of variations in the lower limb rates ($\chi^2=84.5$, $p<0.0001$), specially the tibia. The upper limb maintains a uniformly high PL values through time ($\chi^2=4.5$, $p=0.474$) (Fig. 2, Fig. 3).

**Conclusion and Future Prospects**

Overall, chronological variation in periosteal lesions in skeletons from the GHHP can be related to demographic trends and changing social, cultural, economic and environmental factors. Future comparisons of these data with other health indicators from the GHHHP, and a more in-depth scrutiny of the patterns of periosteal lesions, will help clarify questions raised by this preliminary analysis and consequently improve our health assessment of European populations through history.
Peasants, Elite, Paupers and City Folk: A Preliminary Analysis of Stable C and N Isotopes across Europe

Introduction
The dynamics of health are intrinsically bound to nutrition and significantly impact the socio-economic state of a group or population. Precise indicators of cultural attributes such as nutrition, migration, and social stratification over space and time are made possible by stable isotope analysis. The European Module of the Global History of Health Project for the first time is processing large quantities of skeletal data from all parts of the European continent and has created the potential for detecting varying patterns in health and disease (Fig. 1).

In this present study the analysis of stable isotopes of C and N in bone collagen is conducted to elucidate aspects of nutrition. Differences in the intake of protein-rich foods can result in a pronounced trophic level effect which is reflected in 815N values (Ambrose et al. 1997, Minagawa & Wada 1984).

Objectives
• Comparison of δ15N ratios between the socially privileged and commoners in early medieval society to assess nutritional differences.
• Determining values characteristic for various geographical locations ranging from Alpine to coastal regions.

Methods
• Collagen extraction was conducted at the Ludwig-Maximilians-University in Munich according to Ambrose (1993).
• Mass spectrometry was performed with an elemental analyser (Carlo-Erba1110) connected online to a ThermoFinnigan Delta Plus massspectrometer. All carbon isotope values are reported in the conventional δ-notation in permil relative to V-PDB (Vienna-PDB). Nitrogen isotope ratios are reported in per mil (‰) relative to atmospheric N2. Accuracy and reproducibility of the analyses were checked by replicate analyses of international standards (see data sheet: e.g. USGS 24, USGS 40, IAEA N1, IAEA N2). Measurement error does not exceed 0.1‰.

Case Studies
Germany: a separate burial ground
It is a common conception that socially privileged individuals are better nourished and therefore healthier, taller and have a potentially longer life expectancy than their non-privileged contemporaries.

Germany, cont.
Palaeodietary analyses of four early medieval socially stratified separated burial sites in southern Germany (Etting-Sandfeld, Untering-Ahlbachanger, Grossmehring, Kelheim), do not generally confirm the hypothesis that the socially privileged were necessarily better nourished than the common people (Fig. 2). High trophic levels may prove misleading, since the consumption of "cheaply acquired" animal products like milk, cheese, and eggs can result in consumer 815N values more elevated than those produced through the consumption of "expensive" meat. Consequently, poorer people can exhibit higher 815N ratios compared to wealthy individuals.

Schleswig: a Viking coastal trading center in northern Germany
Although the site is situated in close proximity to the sea, and the assumption of a marine-based diet is not supported, the individuals buried here subsisted on terrestrial foods (Fig. 3).

Switzerland: upper crust and lower class, urban laborers
The different 17th-18th C. sites in Bern were examined: the Bundesgasse churchyard, in which the town’s wealthier citizenry was interred, and the Grosse-Schanze burial ground located outside of the city boundaries, comprised primarily of lower-class, urban dwellers called “Hinterasse”, literally “those sitting in the back”. Statistically, C and N analysis revealed no significant differences between the two groups or between males and females, underlining the results found at the aforementioned German sites (Fig. 4).

Austria: an early medieval Alpine farming population
Adult δ15N ratios exhibit a very high degree of variability, which is remarkable for a presumably agrarian based population. A number of individuals are separated by a full trophic level (Fig. 5). The δ15N values for adults ranged between 7.78‰ and 11.91‰. Overall, there was no significant difference between males and females, but, it is interesting to note that 15 of the lowest 20 nitrogen ratios belonged to males and 13 of the highest 20 also belonged to males. The δ13C outlier may have augmented his diet with fish from the nearby river.

Lithuania: two urban burial sites
Collagen ratios were determined from a random sample originating from two different sites, Krieviaikiskis dated to the 13th to 15th C. and Vilnius dating from the 15th to 17th C. Although the present sample is not large enough to draw serious conclusions, this preliminary study, illustrated in Fig. 6, indicates the possible presence of sex based differences where females appear to have higher δ15N values.

Analysis in Progress:
• Minortenweg, a high medieval poorhouse cemetery in Regensburg, Germany: Were the needy, sick, or otherwise handicapped individuals recovered from poorhouse cemeteries chronically undernourished, and how large were the catchment areas of such pre-industrial institutions?
• Altdorf, a 19th-20th C. northern German skeletal series from the Late Industrial Age, a period with little dietary isotope data.
• Three sites in Poland including Kaldus, an 11th-12th C. urban series, Kamionki, a 17th-18th C. rural series, and 16th-19th C. Pien.
• Blackgate, Newcastle upon Tyne, skeletons from a late medieval non-European mainland seaport.


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The History of Anemia and Related Nutritional Deficiencies in Europe: Evidence from Cribra Orbitalia and Porotic Hyperostosis

Background
Porous lesions on the outer table of the cranial vault (porotic hyperostosis) and orbital roof (cribra orbitalia) are among the most common pathological lesions seen in ancient human skeletal collections. These conditions are frequently associated with substandard living conditions. They can be a result of marrow expansion associated with both acquired and inherited hemolytic and megaloblastic anemias.

Cribra orbitalia and porotic hyperostosis, given their prevalence and etiology, are a key indicator for assessing past quality of life. This project records and interprets variation by age and sex, geographical region, and natural and cultural contexts, which is highly informative for overall quality of life and its fluctuations through broad cultural periods of European history.

Objectives
• Assess the relationship between living conditions and survivorship over time and across different regions of Europe over the last 10,000 years, following the major cultural shifts of human history.
• Test the hypothesis that cultural developments improved human living conditions.
• Shed light on the genetic and acquired origins of anemia, and account for the observed variation.

Methods
Using the following standardized recording system, 6,697 of the individuals in the Global History of Health Project European sample for cribra orbitalia and 7,702 individuals for porotic hyperostosis were scored.

Cribra Orbitalia: The porosity/pitting of the roof areas of the eye orbits was assessed for cribra orbitalia when at least one eye orbit was present. The scoring of the condition was as follows: No orbits present for observation (score=0); pitting present with at least one observable orbit (score=1); gross lesion with excessive expansion and exposed diploë (score=3).

Porotic Hyperostosis: The pitting on the squamosal portions of the occipital and the parietal bones was assessed for porotic hyperostosis. The scoring of the condition was as follows: No parietals present for observation (score=0); pitting absent with at least one observable parietal (score=1); presence of pathological pitting (score=2); gross lesion with excessive expansion and exposed diploë (score=3).

Methods, cont.

Porotic Hyperostosis: The pitting on the squamosal portions of the occipital and the parietal bones was assessed for porotic hyperostosis. The scoring of the condition was as follows: No parietals present for observation (score=0); pitting absent with at least one observable parietal (score=1); presence of pathological pitting (score=2); gross lesion with excessive expansion and exposed diploë (score=3).

Age Variation and Survivorship
The average age at death of people lacking cribra orbitalia was 35.8 years, versus 22.5 years for people with the condition (Table 1). For porotic hyperostosis, the age differential was somewhat less with people lacking it having an average age at death of 32.7 years and people with it an average age at death of 27.5 years. The average age at death of people having both conditions (22.1 years) is not significantly (t = 0.4207, p<0.06) younger than that of people having only cribra orbitalia (22.7 years).

Analysis of the mortality profiles of people dying with and without cribra orbitalia and porotic hyperostosis suggest that the conditions producing these lesions have a negative effect on survivorship (Figs. 1 and 2). The difference in mortality rate is especially clear for cribra orbitalia for older children and adolescents. The age distributions of burials with cribra orbitalia and porotic hyperostosis are similar, which suggests similar etiologies. There is a steep drop in the prevalence of the lesions among people dying during the first decade of life and then a gradual rise among adults into the fifth decade. After that, their frequency decreases significantly with few people who reach an elderly age.

Sex Variation
There were also sex differences in these conditions.
• Women are more likely to have cribra orbitalia than men ($\chi^2=10.6, \ p=0.005$) and
• Men are more likely to have porotic hyperostosis than women ($\chi^2=14.9, \ p=0.001$).

Regional and Environmental Variation
Logistic regression indicates that
• people living in rural villages and eastern Europe ($\chi^2=57.7, \ p<0.00001$) are much more likely to have cribra orbitalia ($\chi^2=30.9, \ p<0.00001$) than people living elsewhere.
• porotic hyperostosis is more common among people in eastern Europe than in western Europe ($\chi^2=126.5, \ p<0.0001$).
• cribra orbitalia and porotic hyperostosis are rare among medieval European communities associated with the boreal forest (subtaiga) vegetation region ($\chi^2=176.699, \ p<0.0001$).
• both conditions seem to be somewhat more frequent near the coast, but the relationship is not very strong.


Acknowledgements: Supported by the U.S. National Science Foundation (BCS-0527658, SES-0138129, BCS-0117958). Special thanks to Kimberly Williams for her assistance in the development of this research, and Ohio State University for continued institutional and facilities support.
Understanding the Impact of Infectious Disease on European Populations: Contributions from the Global History of Health Project

**Background**

Today we are seeing emerging and re-emerging infectious disease plaguing both developing and developed societies around the world (http://www.who.int/en/). The emergence of agriculture, the development of urbanism and the rise of industrial societies have all impacted the frequency of infectious disease documented in historical writing and art and in skeletal remains from archaeological sites through time.

Bioarchaeology, in particular has documented a rise in infections with increasing complexity (e.g., see Cohen & Crane-Kramer 2007). One could argue that, of all measures of health in the past, infectious disease allows us to explore in detail a whole range of factors within people’s environments that could have contributed to their quality of life.

**Results: Temporal and Regional Variation**

Data were recorded from 83 sites located in Austria, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Romania, Switzerland, Turkey, the UK and Ukraine. Only eight cemetery sites were unusual contexts (battlefields, monasteries, a nunnery, and a military hospital).

Accepting that around 3-5% of untreated people with these infections develop bone changes, the following was observed:

- **TB:** 1.1% of individuals with observable vertebrae (73 of 6560) had suggestive lesions of TB on at least one thoracic or lumbar vertebra. Pleural periositis was seen in 1.15% of ribs (375 of 32,485). Twenty-eight individuals had both vertebral and rib changes, but rib changes are not pathognomonic for TB (Roberts and Buikstra 2003).

- **Leprosy:** 0.79% of individuals with observable nasopharyngeal areas (36 of 4571), 0.21% with observable foot bones (11 of 5213), and 0.06% with observable hand bones (3 of 5347) displayed suggestive leprosy changes. Most individuals were only affected in the nasopharyngeal area, and very few in the hands or feet, a feature common for skeletons from non-leprosy hospital cemeteries.

**Context of Sites**

**TB:** The earliest example was dated to 2500-2400 BP (Iron Age Italy). More individuals in Classical Antiquity (1.9%) and the Early Middle Ages (1.3%) were affected than in the later periods (Fig. 6) – this is unusual when the global evidence is considered (Roberts & Buikstra 2003), but may reflect the nature of the samples examined. Pleural periositis was seen most frequently in the Early Middle Ages (EMA) (2.2% of ribs observed) – (Fig. 7). Those with vertebral changes derived from both urban and rural sites but the EMA is dominated by rural sites (EMA) (2.2% of ribs observed) – (Fig. 7). Those with vertebral changes derived from both urban and rural sites but the EMA is dominated by rural sites which is expected since that period is dominated by rural living (e.g., see Hills 1999).

**Leprosy:** Leprosy is first documented in the Classical Antiquity period, increasing into the Early Middle Ages and then declining until the early modern period (Fig. 8). Leprosy today is noted to be a rural disease, consistent with rural living in the EMA. A decline in leprosy and an increase in TB from the 14th century AD in Europe has been noted by many (e.g., see Manchester 1984, but also see Wilbur et al. 2002 on clinical data), but the GHP data here also show a decline in TB. Those with nasopharyngeal changes derived from both urban and rural sites but urban sites dominate in the Late Middle Ages; no individuals derived from leprosy hospital sites.

**Conclusions and Future Research**

The mycobacterial diseases are present in the data collected from the 10,969 skeletons examined. Some of the data support previous observations on leprosy and TB in Europe (e.g., a decline in leprosy into the Late Middle Ages), but others do not (e.g., a decline in spinal TB in the Middle Ages). Increases in population density and close contact with animals with urbanism in the high and Late Middle Ages, necessary for the transmission of TB, are suggested to cause a rise in TB, as is the rise of industrial societies associated with poverty, unhealthy work practices and increased mobility. Additional data collected for the GHP will refine our understanding of the impact of both infections on European populations, as well as enhanced exploration of the epidemiological factors affecting frequency.


**Acknowledgements:** Supported by the U.S. National Science Foundation (BCS-0527665, SES-0138129, BCS-0117958). Special thanks to Kimberly Williams for her assistance in the development of this research, and Ohio State University for continued institutional and facilities support.
Summary Measurement of Health and Wellbeing: The Health Index

Background
Health is an important aspect of a society’s well-being and standard of living. All scholars who study demography realize there are numerous measures of health, which fall into two main categories: mortality and morbidity. The first can be expressed by age-specific death rates, which in turn can be summarized by life expectancy at birth (or at other ages such as age 10 or 20). Morbidity refers to illness or disability that limits functional capacity. It can take many forms such as acute infections, degenerative joint disease, broken bones that limit mobility, and so forth.

Objectives
Our goals are to measure and analyze health as can be learned from skeletal remains. Specifically we wish to know how societies of the past compared with each other and with populations today. Thus we require a broad measure that incorporates conditions in childhood as well as degenerative processes associated with aging. In combination with contextual information on sites where people lived we can analyze or try to explain why some populations were healthier than others, and thus uncover influences on health in today’s world.

Methods
Ideally we would have information on both mortality and morbidity. Unfortunately mortality rates are difficult to estimate from skeletal remains because some individuals, especially children, may have been missed in excavation. Moreover, the age distribution of deaths is influenced by fertility and by migration. Therefore it is difficult to determine the population at risk, which is required to calculate mortality rates.

Skeletal remains do provide useful measures of morbidity. Pathological lesions such as linear enamel hypoplasias reflect physiological stress associated with malnutrition and/or illness. Our procedure is based on the health index, which is explained in chapter 2 of The Backbone of History. The index includes 7 dimensions: LEH; femur length; cribrum orbitale and porotic hyperostosis; periosteal reactions; trauma; degenerative joint disease; and dental health. In the European project we added an 8th dimension incorporating child as well as old age indicators of health.

Concluding Remarks
Our measure of health assembled from skeletal remains compresses information on 7 variables into a single number. It adjusts for the age distribution of deaths and imposes the same age pattern of mortality on all sites. It has the virtue of incorporating child as well as old age indicators of health.

Strong geographic patterns of health were found across Europe, notably by elevation. In addition, health deteriorated over time from the classical to modern periods. We have only just begun to explore the possible pathways by which geography and time imposed their effects on health as seen through skeletal remains. We have found, however, patterns that differ considerably from those observed in the Western Hemisphere. It is plausible that health in Europe was affected by a complex process. In any event, we look forward to this exciting journey of discovery.
The European Project: Introduction to Goals, Materials, and Methods

Background

This project stems from a smaller, more focused effort on the Western Hemisphere that originated in 1988, when Richard Steckel and Jerome Rose began to organize physical anthropologists, economists and historians in a retrospective study of health centering on the quincentennial of 1492. Building upon ideas in Paleopathology at the Origins of Agriculture, they organized planning conferences at Ohio State University, which would pool skeletal data from the following health indicators: stature (from long bone lengths); dental health; degenerative joint disease; signs of anemia (cholecalciferol and porotic hyperostosis); linear enamel hypoplasias; trauma; and skeletal infections. Eventually, they and numerous collaborators assembled a combined database of 12,520 individuals, who had lived 65 locations in the Western Hemisphere from approximately 5000 BC to the early twentieth century, a research effort published as The Backbone of History: Health and Nutrition in the Western Hemisphere.

Objectives

The frequency and severity of skeletal lesions in the Western Hemisphere database correlates with a variety of ecological or environmental variables such as settlement size, elevation, topography, and subsistence patterns. The responsiveness or sensitivity of health to the environment in these data suggested there would be great potential for understanding the long-term evolution of human health by gathering and analyzing skeletal and environmental data from other areas of the world.

The European project substantially exceeds the Western Hemisphere project in size, scope and complexity. By creating several large databases, investigators and collaborators are able to reinterpret the history of human health from the late Paleolithic era to the early twentieth century. During this period, human health and welfare were transformed enormously by the transition from foraging to farming; the rise of cities and complex forms of social and political organization; European colonization; and industrialization. With a trans-Atlantic network of collaborators, the project undertakes large-scale comparative studies of the causes and health consequences of these and other dramatic changes in arrangements for work, living, and human interaction.

Methods

Much information about the project is available from the following website: http://www.ohiostate.edu/anthro. Here one can find the codebook, description of software, and copies of grant proposals. Briefly, over 70 collaborators in a trans-Atlantic consortium have agreed to code skeletal data, most of which are from previously analyzed collections. We are also collecting contextual information about the sites, including the size of the community and a variety of ecological variables available from GIS databases.

Beginning with a project organizational meeting at Ohio State University in June of 2001, various project conferences advanced the agenda at the European PPA meetings in Coimbra in 2002. We held additional gatherings at various AAPA meetings in the U.S. and in Rome (2005), Athens (2006), Munich (2008) and Douai (2009). Early meetings improved the codebook, and subsequent gathering emphasized the software for coding skeletal remains; criteria for coding sites; aspects of project administration; and ultimately, results.

The Database

Various criteria influenced the choice of skeletal collections to be coded, including state of preservation and the quantity and quality of contextual information that was available. Everyone on the project agreed on the need for temporal and geographic diversity. Some regions are missing, such as Southern France and much of Spain, but subsequent efforts will attempt to obtain data from these areas. On the right, in an evolving list, we acknowledge the work of people who have contributed to or are currently contributing to the project.

Acknowledgments


Grant Support: By the U.S. National Science Foundation (BCS-0527658, SES-0138129, BCS-0117958). Special thanks to Kimberly Williams for her assistance in the development of this research, and Ohio State University for continued institutional and facilities support.
The History of Growth Disruption in European Children: Evidence from Hypoplastic Teeth

Background

Over many decades palaeopathologists have investigated disturbances in dental development, in particular the abnormal quality of teeth, which in principle may affect all tissues of a tooth. The most common is deficient enamel development, expressed as pits or linear grooves. Such hypoplastic lesions relate to developmental stress caused by various conditions, among them infectious diseases (e.g., congenital syphilis, tuberculosis), malnutrition (rickets, anemia, dietary shift at weaning), genetic causes and other factors (e.g., toxins, trauma). Within this project we scored only transverse linear hypoplasias (LEH). They provide an index of (non-specific) developmental stress and shed light on an, up to now, epidemiologically insufficiently recorded and investigated feature for the reconstruction of past European children’s lives.

Objectives

• Draw inferences about stress in early childhood as indicated by mild and severe LEHs in relation to sex, period and region.
• Test the hypothesis that the settlement type (rural/urban) in relation to the time period affected the stress level of children in Europe.

Methods

The sample investigated for LEH included a total of 5,782 adult individuals. Since transverse linear hypoplastic lesions occur most often on the anterior teeth, we examined the incisors (either I1 or I2) and canines exclusively. We investigated primarily the teeth on the left side of the upper and lower jaws. In cases where the left tooth was not preserved, the right one was used as a substitute. Teeth which have lost more than 50% of the crown height due to wear or other causes were excluded or scored as “unobservable.”

The scoring scheme for enamel hypoplasia considered three degrees of development: 1= no LEH or very mild (Fig. 1), 2= one LEH (more pronounced), so that it can be identified by running the fingernail across the tooth; 3= two or more LEHs (Fig. 2). All examinations were carried out macroscopically.

LEH by Sex and Age

Males (N=2591) exhibited significantly more hypoplastic lesions than females (N=2046) (41.6% : 37.6%, chi-square=7.4, p=0.007). This result may reflect that male individuals in the past were more prone to stress in early childhood than females. In this regard, it is of interest that recent clinical studies pointed out males are more prone to infectious diseases (e.g., malaria) than females, suggesting a correlation between sex hormones and susceptibility or protection.

The frequency of people with hypoplastic defects decreases significantly with increasing age at death (this is observable in males and in females): people older than 60 years exhibited LEH less often. The average age at death of people (both sexes included) with LEH was 34.3 years. And lacking LEH was 35.7 years; this is significantly different (t=2.8, d.f.=5641, p=0.005; (Fig. 3), indicating that less physiological stress during childhood leads to a longer life.

Temporal Variation of Mild/Severe LEH

Based on a sample of 5,782 individuals, 29.1% exhibited mild LEH and 11.3% had severe LEH (Table 1). However, the results are not consistent when compared to the frequency of burials with mild and severe linear enamel hypoplasia by period (Fig. 4). Whereas mild forms decrease impressively from the Early Middle Ages to modern time, the severe forms increase continuously until the Late Middle Ages. measured.

Rural-Urban Differences in LEH

With regard to settlement type – rural/village or townicity – LEH data suggest that developmental disruption in children living in rural areas increases between Classical Antiquity to the Late Middle Ages. Children who grew up in an urban area, in contrast, show an initial increase in LEH between Classical Antiquity and the Early Middle Ages, but than a conspicuous decline through modern times. Only for the Early Middle Ages is there a statistically significant rural-urban difference (chi-square=30.3, p<0.0001, see Fig. 5). In this period the rural areas might have provided better living conditions to those of densely populated cities with their inadequate hygiene and the higher risk of infectious diseases.

Table 1: Temporal Variation in LEH

<table>
<thead>
<tr>
<th>Period</th>
<th>Absent</th>
<th>Mild</th>
<th>Severe</th>
<th>Total</th>
<th>% Mild</th>
<th>% Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ancient/Prehistoric</td>
<td>43</td>
<td>27</td>
<td>7</td>
<td>77.0</td>
<td>35.1</td>
<td>9.1</td>
</tr>
<tr>
<td>Classical Antiquity</td>
<td>710</td>
<td>239</td>
<td>95</td>
<td>1042</td>
<td>22.9</td>
<td>8.9</td>
</tr>
<tr>
<td>Early Middle Ages</td>
<td>1,572</td>
<td>939</td>
<td>290</td>
<td>2,801</td>
<td>33.5</td>
<td>10.4</td>
</tr>
<tr>
<td>High Middle Ages</td>
<td>371</td>
<td>162</td>
<td>656</td>
<td>1,190</td>
<td>26.9</td>
<td>11.5</td>
</tr>
<tr>
<td>Late Middle Ages</td>
<td>293</td>
<td>142</td>
<td>519</td>
<td>954</td>
<td>27.4</td>
<td>16.2</td>
</tr>
<tr>
<td>Modern</td>
<td>496</td>
<td>172</td>
<td>113</td>
<td>781</td>
<td>23.2</td>
<td>15.2</td>
</tr>
<tr>
<td>Total</td>
<td>3,445</td>
<td>1,681</td>
<td>1,681</td>
<td>6,782</td>
<td>29.1</td>
<td>11.3</td>
</tr>
</tbody>
</table>

Temporal and Regional Variation

To investigate possible geographical and/or climatic influences in LEH formation, we divided the European sites into four main areas (Northeast, Northwest, Southeast and Southwest). Considering the region as well as the time period, an increase of LEH (in general) through time in western Europe and a decline through time in eastern European sites was observed (Fig. 6). This trend is of great interest, but will be discussed and re-investigated following a re-definition of the geographic areas and consideration of the significance of other relevant variables (sex, rural/urban).
Historical Patterns of Traumatic Injury and Violence in Europe

Background
Social scientists have long sought to understand the origins of conflict, violence, and physical injury. Today various agencies collect relevant information from police reports, court records, emergency room admissions, special surveys, and so forth. Unfortunately written sources are often thin for the recent historical past and frequently unavailable for more distant eras. Nevertheless, pressing social questions remain over humankind’s predilections for conflict and aggression, which are best studied across diverse socioeconomic settings. The near and distant past therefore provide an excellent laboratory for studying precursors or determinants of aggression. Physical anthropologists have learned that skeletal remains provide a valuable biological record for measuring trauma, for which data are available deep into the human past.

Objectives
We seek to measure rates of trauma over time, across space, and by age and sex, to establish baseline patterns against which twentieth-century evidence can be evaluated. We will test the null hypothesis that no differences existed over time, across space, or by age and sex. Ultimately we will draw comparisons with the Western Hemisphere database, which showed that rates of trauma were independent or uncorrelated with the frequencies of other types of pathological lesions.

Methods
The European database, which is described in the introductory poster, records trauma for the following skeletal elements: cranial vault; nasal bones; non-nasal facial bones; long bones; and weapon wounds on any bone. As part of the procedure, the coder also noted whether the lesion was well-healed, partially healed or occurring at death, the last coded as positive only if there was clear and convincing evidence of a perimortem injury.

Because skeletal injuries tend to accumulate as people age (shown below), one may also adjust (divide) results further by the sum of years lived by the population or group under study. In the cause of cranial trauma, for example, the final result is the number of injuries per effective cranial vault year lived. This equals the number of injuries (in the numerator) divided by the effective number of vaults times the number of years lived (the sum of ages at death). Because the age distribution of deaths was similar across categories used in the analysis, however, the age-adjusted results are similar.

Methods, cont.
Because trauma frequencies depend upon the completeness of the skeleton and the age of the individual, it is important to standardize. We did this by using data collected on the completeness (percent present or observable) of each major skeletal element. This information was then converted into full skeleton equivalents. For example, if two individuals had cranial vaults that were 40 and 60 per cent complete, together they make the equivalent of one complete cranium. The procedure requires an assumption that portions of bone are missing at random, or at least that trauma had no systematic relationship to the portions of bones observable or unobservable. To obtain frequencies, the number of traumas (in a category such as the site, region or time period) was divided by the number of skeletal equivalents for that category.

Because skeletal injuries tend to accumulate as people age (shown below), one may also adjust (divide) results further by the sum of years lived by the population or group under study. In the cause of cranial trauma, for example, the final result is the number of injuries per effective cranial vault year lived. This equals the number of injuries (in the numerator) divided by the effective number of vaults times the number of years lived (the sum of ages at death). Because the age distribution of deaths was similar across categories used in the analysis, however, the age-adjusted results are similar.

Age and Sex Variation
Figure 1 gives a frequency distribution of non-weapon injuries for males and females by age at death. Relatively few injuries occurred among children under age 10 but the curve rose steeply in the teens and twenties, reaching a peak in the thirties. The age pattern of injury resembles that found in the Western Hemisphere data and in modern epidemiological evidence. The rapid decline in the forties, also found in the Western Hemisphere, may reflect selective elimination (death) of the violent or the accident prone.

Temporal and Regional Variation
Broken bones in the wrists and ankles often result from accidental falls, and occur more frequently in uneven terrain. Cranial injuries, on the other hand, are a barometer of deliberate interpersonal violence.

Figure 2 shows that these injuries were several times more likely among men compared to women, a pattern found in the Western Hemisphere and in modern evidence. Indeed the male-female contrast is so common that one might doubt the quality of the skeletal evidence if it was not observed. As the Middle Ages unfolded the rate of cranial vault injury among men rose dramatically, increasing nearly three fold. No such pattern existed among the women, for whom the trend was flat, and even declined in the late Middle Ages. At this point we can only speculate as to the causes, but this was an era in which cities were fortified with walls, and fortresses were built to house professional soldiers. A surge in population and growing scarcity of land may have contributed to strife.

Figure 3 shows that the rate of cranial injuries varied systematically by region, with the southwest most prone and the northwest the least prone to this type of trauma. Considering the four quadrants, one can see that the highest rates occurred along the southwest-northeast corridor and the lowest rate existed along the northwest-southeast diagonal. Note that the bulk of the data come from the Middle Ages. Until we conduct additional analysis of this interesting pattern we are withholding speculation on its possible causes.


Acknowledgements: Supported by the U.S. National Science Foundation (BCS-0527658, SES-0138192, BCS-0117958). Special thanks to Kimberly Williams for her assistance in the development of this research, and Ohio State University for continued institutional and facilities support.
The History of European Oral Health: Evidence from Dental Caries, Dental Abscesses, Antemortem Tooth Loss

Background
Oral health is an important indicator of diet, economy and quality of life. Most accessible indices are those derived from the observation of carious lesions, antemortem tooth loss and alveolar abscesses. This contribution focuses on the first two of these sources.

Introduction
Dental caries is closely connected to diet, especially high intake of carbohydrates. An essential turning point in Central European dietary habits was the shift from hunting and gathering to agriculture during the Early Neolithic (Wittwer-Backofen & Tomo 2008), featuring high correlations between the consumption of carbohydrates, wheat grinding techniques and caries intensity (Roberts & Cox 2003).

Further increases in caries frequency can be expected with the introduction of cane sugar from colonial trading around 1500 AD and the extraction of sugar from beets starting in the early 19th century. Poor hygiene, a lack of certain trace elements or highly abrasive food particles may also promote caries.

Severe lesions often result in antemortem tooth loss or alveolar abscesses, which are serious, and potentially fatal, restrictions on the quality of life. Differences in caries frequencies between males and females have been observed both in modern (Alvarez-Arenal et al. 1996) and Neolithic populations (Larsen 1998, Lukacs 1996).

Materials and Methods
Dental data is available from 10,003 individuals within the data base and have been explored for chronological trends, regional variance, age-relatedness and sex differences. To avoid shifts in caries and antemortem loss frequencies due to different age distributions in time periods and regions, we used standardized decade age groups starting above 20 years of age. Only sites represented by more than 100 observable teeth have been considered to avoid bias by small sample sizes.

Spatial analyses were based on a subdivision of Europe into four regions with distinct climatic conditions (Fig. 1) following long-established geographic regions.

Results

Age-relatedness
As expected, caries affliction increases with age. This steady trend is little influenced by other factors. Additionally, the increase is linear, i.e. the increments are similar both for older and younger ages.

Sex Differences
In Northeast Europe females are more strongly afflicted by caries and antemortem tooth loss than men. However, this trend is not very pronounced and not at all universal.

Discussion and Outlook
Spatial analysis has shown a distinct development in Central Southeast Europe that contrasts with other regions. Caries and antemortem tooth loss frequencies peak here considerably earlier and subsequently decrease towards the late Middle Ages; this runs against all trends elsewhere. Further analysis will concentrate on possible factors for this shift.

Additionally, the inclusion of earlier periods would allow for tracing the history of oral health from the major impact of the Neolithic transition to ‘modern’ sugar consumption.

References

Figure 1: Climatic regions within Europe used for the spatial analysis of oral health data and referred to in other graphics (Kettle et al. 2008, Table 1 presented in Deine 2008).

Figure 2: Diachronic trends in caries frequencies according to region. The cumulative curve labeled ‘both sexes’ includes skeletons for which sex could not be determined. These are not represented in the ‘male’ and ‘female’ curves. All data has been standardized for each age group to avoid bias through varying age distributions.

Figure 3: Diachronic trends in caries and antemortem tooth loss frequencies according to region. The cumulative curve labeled ‘both sexes’ includes skeletons for which sex could not be determined. These are not represented in the ‘male’ and ‘female’ curves. All data has been standardized for each age group to avoid bias through varying age distributions.

Figure 4: Diachronic trends in caries frequencies according to region. The cumulative curve labeled ‘both sexes’ includes skeletons for which sex could not be determined. These are not represented in the ‘male’ and ‘female’ curves. All data has been standardized for each age group to avoid bias through varying age distributions.

Figure 5: Diachronic trends in caries and antemortem tooth loss frequencies according to region. The cumulative curve labeled ‘both sexes’ includes skeletons for which sex could not be determined. These are not represented in the ‘male’ and ‘female’ curves. All data has been standardized for each age group to avoid bias through varying age distributions.

Figure 6: Diachronic trends in caries frequencies according to region. The cumulative curve labeled ‘both sexes’ includes skeletons for which sex could not be determined. These are not represented in the ‘male’ and ‘female’ curves. All data has been standardized for each age group to avoid bias through varying age distributions.

Figure 7: Diachronic trends in caries and antemortem tooth loss frequencies according to region. The cumulative curve labeled ‘both sexes’ includes skeletons for which sex could not be determined. These are not represented in the ‘male’ and ‘female’ curves. All data has been standardized for each age group to avoid bias through varying age distributions.

Figure 8: Diachronic trends in caries frequencies according to region. The cumulative curve labeled ‘both sexes’ includes skeletons for which sex could not be determined. These are not represented in the ‘male’ and ‘female’ curves. All data has been standardized for each age group to avoid bias through varying age distributions.

Figure 9: Diachronic trends in caries and antemortem tooth loss frequencies according to region. The cumulative curve labeled ‘both sexes’ includes skeletons for which sex could not be determined. These are not represented in the ‘male’ and ‘female’ curves. All data has been standardized for each age group to avoid bias through varying age distributions.

Figure 10: Diachronic trends in caries frequencies according to region. The cumulative curve labeled ‘both sexes’ includes skeletons for which sex could not be determined. These are not represented in the ‘male’ and ‘female’ curves. All data has been standardized for each age group to avoid bias through varying age distributions.

Figure 11: Diachronic trends in caries and antemortem tooth loss frequencies according to region. The cumulative curve labeled ‘both sexes’ includes skeletons for which sex could not be determined. These are not represented in the ‘male’ and ‘female’ curves. All data has been standardized for each age group to avoid bias through varying age distributions.
The collaborators in the Global History of Health Project dedicate this symposium to the memory of Phillip L. Walker.

Phillip L. Walker
July 22, 1947- February 6, 2009

Without his tremendous work and enthusiasm this symposium would not have been possible.