

Bioarchaeological Analysis of the Human Skeletal Remains from the Late Mediaeval Cemetery of Koprivno, Southern Croatia

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Abstract

The paper presents the results of bioarchaeological analysis of the late mediaeval (13th-14th century) skeletal sample from Koprivno, southern Croatia. Skeletal remains of 21 individuals (eight males, nine females, and four subadults) were examined for the possible presence of dental pathologies (caries and alveolar bone diseases), subadult stress indicators (cribra orbitalia and dental enamel hypoplasia), degenerative osteoarthritis of the vertebrae and major joints, Schmorl's nodes on vertebrae, periostitis, and bone trauma. The analysed sample is characterised by high frequency of alveolar bone disease, most probably as a result of somewhat longer average life span (around 41 years) and very poor oral hygiene, while the data concerning dental caries indicate mixed diet evenly based on meat and cereals. High frequencies of cribra orbitalia, dental enamel hypoplasia and periostitis suggest frequent episodes of physiological stress (hunger, epidemics of infectious diseases) which is in accordance with historical data. Distribution and prevalence of cranial traumas strongly suggest a relatively high degree of interpersonal violence in the analysed community.

Keywords: Bioarchaeology; Late Mediaeval Cemetery, Koprivno, Dental Pathologies; Subadult Stress; Bone Trauma

Introduction

The late mediaeval period (13th-14th century AD) in the eastern Adriatic coast and its mountainous hinterland was firstly marked by the weakening of the royal Arpad dynasty power resulting in feudal anarchy and in later period was characterised by the Ottoman conquest and rule. This turbulent period

radically altered Croatian society, demography and economy, and its consequences are felt to this day.

In the last decade there has been an increased interest in the bioarchaeology of the late mediaeval period of this region, especially since the beginning of the Zagreb-Split high-speed motorway construction when rescue archaeological excavations uncovered several late mediaeval cemeteries containing large quantities of very well preserved human osteological material. Since then, several papers dealing with the skeletal biology of the late mediaeval skeletal samples from the area have been published in Croatia and abroad (1-5). Still, many aspects of everyday life and health conditions of these mostly rural communities that may be revealed through bioarchaeological analyses are still unknown.

In order to get a clearer picture of life quality and amount of physical stress present in a mediaeval rural community a comprehensive bioarchaeological study was conducted on the excellently preserved skeletal remains of the 21 individuals excavated from the small cemetery in Koprivno near Klis in the Adriatic hinterland.

Materials and methods

The village of Koprivno is located 13 km north of Split in southern Croatia (Figure 1). It is situated in typical Dalmatian hinterland terrain - on the edge of a large field, at an average altitude of 396 m, surrounded by karst hills, separated from the Adriatic Sea by the steep slopes of the Mosor Mountain (6). Two adjacent cemeteries (one late mediaeval and one early modern) were discovered in 2001/2002 during the rescue archaeological excavations on a section of the future Zagreb-Split high-speed motorway conducted by the Split Conservation Department and the Museum of Archaeological Monuments in Split led by archaeologist H. Gjurašin (7). Results of the bioarchaeological analysis of the population buried in the early modern period (16th-18th centuries) cemetery have already been published (8,9).

The late mediaeval cemetery contained 23 graves of which most were oriented E-W, with minor deviations, and five of them NE-SW. One third of the graves were buried in plain soil, and others were cut in bedrock. Most of the graves contained one skeleton, two graves contained remains of two individuals, while four graves (graves 5, 9, 13, and 15) were empty, with no traces of skeletal material. Finds were found only in female graves (three-bead earrings, rings with coiled thickenings, coins). Grave finds date the cemetery to a period from the late 13th to the late 14th century (7). State of preservation of the skeletons excavated from this site range from very good to excellent.

The sex and age-at-death of the adult individuals was determined using usual methods (10-14). Age-at-death for subadults was determined using epiphyseal fusion, diaphyseal lengths, and dental eruption criteria (10,15).

All skeletons from the Koprivno sample were analysed for the possible presence of the following pathological changes: dental pathologies (caries and alveolar bone diseases), subadult stress

indicators (cribra orbitalia and dental enamel hypoplasia), degenerative osteoarthritis on vertebrae and major joints, Schmorl's nodes on vertebrae, periostitis, and trauma (for the definitions and methods used during the analysis see 8).

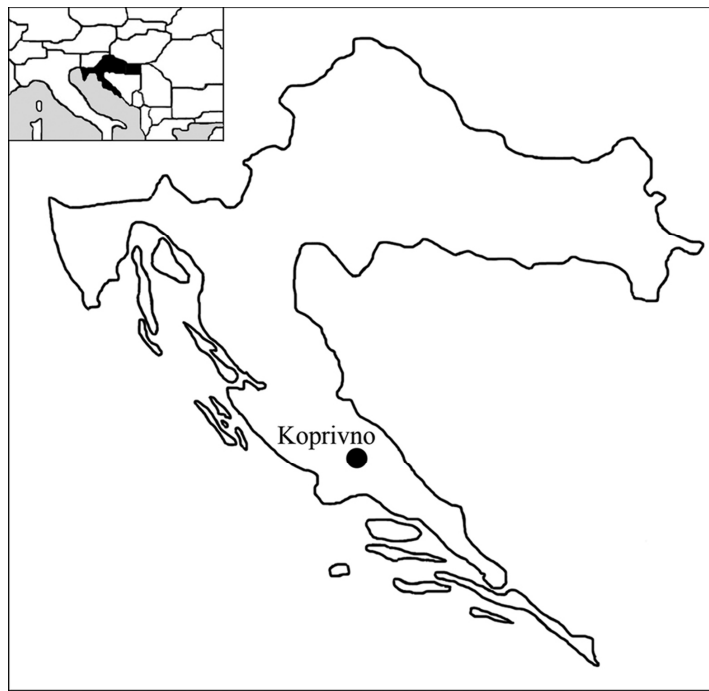


Figure 1 Map of Croatia with geographical location of Koprivno

Results

The age and sex distribution of the Koprivno skeletal sample by grave is presented in Table 1. Out of the total of 21 individuals four are subadults, eight are males, and nine are females. The average age-at-death for males is 41.0 years, and for females 41.5 years. Subadults are clearly underrepresented (only 19.0% of the total sample), but this is most probably due to the size of the analysed sample.

The frequencies of alveolar bone disease and caries are shown in Table 2. The overall frequency of alveolar bone disease in Koprivno is 13.5% (86/639); this pathology was not registered in subadults while among adults females display significantly higher frequency compared to males (19.5% vs. 10.4%; $\chi^2=8.153$, $P=0.004$). Caries is present in 8.8% (41/464) of the analysed teeth (Figure 2); carious lesions are not present among subadults while in adults females display significantly higher frequency compared to males (14.0% vs. 6.4%; $\chi^2=5.48$, $P=0.02$).

The total frequency of dental enamel hypoplasia (DEH) in the analysed sample by tooth is 47.4% (18/38; Table 3). DEH is most often recorded on the mandibular canines, while on the maxillary central incisors and maxillary canines the frequency of DEH is identical.

Cribra orbitalia, an indicator of subadult stress mostly caused by the iron deficiency, in the late

mediaeval skeletal sample from Koprivno was registered in 35% (7/20) of the analysed frontal bones, with all cases healed at the time of death.

The total frequency of Schmorl's nodes is 15.6% (36/231; Table 4; Figure 3), with significantly higher frequency in males (25.9%) than in females (5.2%) ($\chi^2=17.172$, $P<0.001$).

The frequency of vertebral osteoarthritis is presented in Table 5. The overall frequency of this pathology in Koprivno is 12.3% (39/318). OA is present in 14.6% of the female vertebrae and 9.2% of the male vertebrae - the difference is not statistically significant.

The total frequency of osteoarthritis in major joints in the analysed sample is 20.7%, with a higher frequencies in females (29.6%) compared to males (12.9%), but without statistical significance. In both sexes osteoarthritis most often appears in shoulder joints (Table 6).

Periostitis in the Koprivno sample was observed in four skeletons (two subadults and two adults) or 19.0% of the total sample. All of the recorded cases of this pathology represent mild, healed form of periostitis, localised in the area of the lower extremities, primarily on the tibia and fibula.

The total long-bone trauma frequency is 1.9% (4/219; Table 7). Traumas were recorded on the clavicle (1/32 or 3.1%; Figure 4), humerus (1/31 or 3.2%), ulna (1/31 or 3.2%) and tibia (1/28 or 3.6%). Cranial injuries were also observed in Koprivno - four of the 17 (23.5%) well-preserved adult skulls exhibit some type of trauma. All fractures were situated on the cranial vault: two on the frontal bones, one on the left parietal, and one on the right parietal bone. The most impressive bone trauma in the Koprivno sample was recorded on the left parietal bone of the male skeleton aged between 50 and 55 years (grave 22): it is a massive antemortem penetrative fracture of elongated shape, 43 mm in length (Figure 5); the edges are smooth and remodelled suggesting that the individual survived the injury, while the depth of the lesion and area of impact certainly indicate post-traumatic complications such as epilepsy and/or other cerebral and neurological complications.

Discussion

Although the analysed skeletal sample from Koprivno is relatively small, it may reveal new insights into the way of life of this small rural community during the late Middle Ages, especially since the written historical sources that might contribute to our knowledge of the Koprivno settlement during this period are very scarce.

The average age-at-death of the adults from the Koprivno sample is similar to the data recorded in some other rural communities from the same region, such as the adjacent early modern period (16th-18th century) Koprivno-Kod križa site (8) and the nearby late mediaeval (14th-16th century) Dugopolje site (2).

Table 1 Sex and age of the analysed individuals by grave number

| Grave | Sex | Age (years) |
|------------|----------|-------------|
| 1 | Female | 35-40 |
| 2 | Female | 50-55 |
| 3, ind. A | Female | 60+ |
| 3, ind. B | Male | 55-60 |
| 4 | Female | 20-25 |
| 6 | Male | 40-45 |
| 7 | Male | 45-50 |
| 8 | Subadult | 1-2 |
| 10 | Subadult | 12-14 |
| 11 | Male | 30-35 |
| 12 | Female | 25-30 |
| 14 | Male | 35-40 |
| 16 | Subadult | 3-4 |
| 17 | Female | 60+ |
| 18 | Male | 16-18 |
| 19, ind. A | Female | 25-30 |
| 19, ind. B | Male | 35-40 |
| 20 | Female | 55-60 |
| 21 | Subadult | 12-13 |
| 22 | Male | 50-55 |
| 23 | Female | 15-16 |

Table 2 Frequency of alveolar bone disease and carious lesions

| | Subadults | | Females | | Males | |
|------------------------------|-----------|-----|---------|------|--------|------|
| | n/N | % | n/N | % | n/N | % |
| Alveolar bone disease | 0/80 | 0.0 | 60/308 | 19.5 | 26/251 | 10.4 |
| Carious lesions | 0/62 | 0.0 | 28/200 | 14.0 | 13/202 | 6.4 |

n=number of tooth sockets with abscess or antemortem tooth loss; number of teeth with carious lesions; N=number of examined tooth sockets/teeth



Figure 2 First left maxillar molar exhibiting large carious lesion. Female, grave 2 (photo by Vyroubal V., 2008)



Figure 3 Schmorl's node on the superior vertebral plate. Male, grave 7 (photo by Novak M., 2004)

Table 3 Frequency of dental enamel hypoplasia by tooth

| Tooth | N | n | % |
|--------------|----|----|------|
| Maxillary I1 | 11 | 4 | 36.4 |
| Maxillary C | 11 | 4 | 36.4 |
| Mandibular C | 16 | 10 | 62.5 |

N=number of examined teeth; n=number of teeth with DEH, I=incisor; C=canine

Table 4 Frequency of Schmorl's nodes by vertebrae

| | Thoracic | | Lumbar | | Total | |
|---------|----------|------|--------|------|--------|------|
| | n/N | % | n/N | % | n/N | % |
| Females | 4/74 | 5.4 | 2/41 | 4.9 | 6/115 | 5.2 |
| Males | 19/81 | 23.5 | 11/35 | 31.4 | 30/116 | 25.9 |

n= number of vertebrae with Schmorl's nodes; N= number of examined vertebrae

Table 5 Frequency of degenerative osteoarthritis by vertebrae

| | Cervical | | Thoracic | | Lumbar | | Total | |
|----------------|----------|-----|----------|------|--------|------|--------|------|
| | n/N | % | n/N | % | n/N | % | n/N | % |
| Females | 0/42 | 0.0 | 15/74 | 20.3 | 8/41 | 19.5 | 23/157 | 14.6 |
| Males | 0/45 | 0.0 | 6/81 | 7.4 | 10/35 | 28.6 | 16/161 | 9.9 |

n=number of vertebrae with osteoarthritis; N=number of examined vertebrae

Table 6 Frequency of degenerative osteoarthritis by major joints

| | Shoulder | | Elbow | | Hip | | Knee | |
|----------------|----------|------|-------|------|-----|-----|------|------|
| | n/N | % | n/N | % | n/N | % | n/N | % |
| Females | 2/4 | 50.0 | 3/7 | 42.9 | 0/8 | 0.0 | 3/8 | 37.5 |
| Males | 3/7 | 42.9 | 0/8 | 0.0 | 0/8 | 0.0 | 1/8 | 12.5 |

n=number of joints with osteoarthritis; N=number of examined joints

Table 7 Frequency of long-bone traumas by bone

| | N | n | % |
|-----------------|-----|---|-----|
| Clavicle | 32 | 1 | 3.1 |
| Humerus | 31 | 1 | 3.2 |
| Radius | 28 | 0 | 0.0 |
| Ulna | 31 | 1 | 3.2 |
| Femur | 32 | 0 | 0.0 |
| Tibia | 29 | 0 | 0.0 |
| Fibula | 28 | 1 | 3.6 |
| Total | 211 | 4 | 1.9 |

N=total number of long bones; n=total number of long bones with trauma



Figure 4 Fracture of the right clavicle. Female, grave 2 (photo by Novak M., 2004)



Figure 5 Massive fracture of the left parietal bone. Male, grave 22 (photo by Novak M., 2004)

Frequencies of alveolar bone disease and carious lesions in Koprivno are similar to those observed in the early modern Koprivno-Kod križa skeletal sample (8). The values observed in both sites most probably reflect a relatively long average life span, very poor oral hygiene, and varied nutrition (evenly based on proteins and carbohydrates). As for the first hypothesis, it is well known that dental pathologies, like some other pathologies such as bone trauma and degenerative osteoarthritis, are age-dependent, i.e. their frequencies increase with advanced age. High frequency of antemortem tooth loss in Koprivno might also be a result of an inadequate oral hygiene, because insufficient oral hygiene that removes dental plaque is the basis of future dental loss (16), i.e. gingival inflammation, which is caused by bacterial plaque, leads to bone resorption and results in tooth loss. Considering the type of diet as one of the possible reasons, the lower frequencies of caries are usually recorded in populations whose diet was generally based on proteins (meat), while the higher frequencies are noted among populations dependent on agriculture (e.g. 17-19). According to available historic and ethnographic data (although for somewhat later period) the inhabitants of this region were primarily engaged in transhumant pastoralism and extensive form of agriculture, and their diet was mainly based on meat and animal products, as well as cereals such as barley, rye and oats (20,21).

Frequency of dental enamel hypoplasia in Koprivno is similar to the results noted in other Croatian late mediaeval populations (e.g. 1,2). Relatively high frequency of DEH in Koprivno suggests that almost half of the analysed individuals survived strong metabolic stress during childhood, possibly during the weaning period. Specifically, some authors (e.g. 22,23) noted that most of the hypoplastic defects in sedentary populations are formed between the first and third year of life, i.e. during the transition from

the diet based on the sterile breast milk to the diet rich with micro organisms.

Cribriform orbitalia is generally accepted as a reliable osteological indicator of subadult anaemia caused by iron deficiency resulting from inadequate nutrition, endemic parasitism and/or chronic gastrointestinal disease (24,25). In general, frequencies of cribriform orbitalia like in Koprivno (35%) are usually observed in sedentary populations characterised by inadequate sanitary conditions and low levels of hygiene (e.g. 26,27).

Schmorl's nodes on the vertebrae testify to strong mechanical burdens of the spine. As males in Koprivno exhibit significantly higher frequency of Schmorl's nodes compared to females these data strongly suggest a sex-based division of labour where males performed more difficult physical tasks, the fact also confirmed by the ethnographic data. Namely, males in Koprivno performed physical activities associated with transhumant pastoralism and agriculture (plowing, hoeing, carpentry, preparation and treatment of hides, woodcutting) (28,29), while females regularly performed tasks related to dairy and textile processing (milking, production of cheese, screening and wool spinning, weaving) and all activities related to the household (washing and cleaning, cooking, taking care of children) (30,31).

Advanced age, repetitive mechanical loading, and movement are stressed as the main factors influencing the presence and severity of degenerative osteoarthritis in archaeological series (32). Thus the considerably higher frequency of osteoarthritic changes on all analysed segments of the vertebrae and major joints among females in comparison to males in both samples is most probably the result of a somewhat longer average life span of females.

The frequency and distribution of periostitis in Koprivno implies the emergence of systemic bacterial infections which corresponds to the available historic data witnessing that the population of this region during the late mediaeval and early modern period often suffered and died of fever and/or malaria, diphtheria, leprosy, tuberculosis, typhoid, pox and syphilis (33).

Bone fractures recorded in the late mediaeval skeletal sample from Koprivno might suggest a relatively high degree of interpersonal violence in this community, especially since several authors (34-36) point out that high frequencies of head and face trauma are a conclusive proof of intentional violence. The type of cranial lesions observed in Koprivno according to Wells (37) '...could have been caused by an accidental blow on the head...[or]...a battle wound caused by an accurately directed slingshot'. The massive cranial trauma recorded on the left parietal bone of the older male buried in grave 22 is most probably caused by mace, poleaxe or a similar weapon. Some of the bone traumas might be the result of minor interpersonal conflicts within the community (domestic violence, disputes over livestock, fertile land or sources of potable water, etc.), but some are probably the result of large scale battles fought between various noble families in this area during the 13th and 14th centuries. One such battle took place in the immediate vicinity of Koprivno - the Battle of Blizna, fought in 1322 between the army of a coalition of several Croatian noblemen and Dalmatian coastal towns with the support of the Croatian-Hungarian king Charles I Robert of Anjou against the forces of a noblemen Mladen II Šubić and his allies (38).

Although the skeletal sample studied in this paper is small, the results of bioarchaeological analysis suggest that life in Koprivno during the late Middle Ages was not easy. The average life span of the late mediaeval inhabitants of Koprivno is similar to other archaeological populations from this part of Croatia. The frequency of alveolar bone disease and dental caries indicate a very low level of oral hygiene and diet based on carbohydrates and proteins alike. High frequencies of indicators of subadult stress (dental enamel hypoplasia and cribra orbitalia) and periostitis, as well as the frequency and distribution of cranial traumas strongly indicate frequent episodes of hunger, occurrence of epidemics of various infectious diseases, high risk of interpersonal violence and other physiological stress situations that significantly worsened the living conditions in this community during the 13th and 14th centuries. In addition, a number of pathological changes found in the spine, such as Schmorl's nodes, suggest that the inhabitants of this region in order to ensure basic living conditions had to invest very large amounts of physical effort that had a negative effect on their health.

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