

## DENTAL PATHOLOGIES IN RURAL MEDIAEVAL POPULATIONS FROM CONTINENTAL CROATIA

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**Abstract:** *The paper presents the results of an analysis of frequency and distribution of caries, ante-mortem tooth loss (AMTL) and abscesses in mediaeval rural populations (11th to 16th centuries) from continental Croatia. The presented data (high frequency of caries, similar caries frequencies between the sexes, significantly higher frequency of AMTL in females) suggests nutrition based on agricultural products rich in carbohydrates, no significant difference in the manner and type of diet between males and females, use of teeth as tools in older females, and a very low level of oral hygiene.*

**Keywords:** *Continental Croatia; Mediaeval period; Caries; Ante-mortem tooth loss; Abscesses.*

### Introduction

As one of the most enduring physical evidences of an individual's existence, teeth provide a very useful insight in the lifestyles of past populations, especially their dietary habits, but also the environmental conditions in which these populations lived. Teeth proved to be a good material for paleodental research for two reasons: firstly, they have extremely great resistance to post-mortem damages, and secondly, as dental procedures in the past were almost non-existent the epidemiology of dental pathologies can be studied in its original shape (Watt et al. 1997).

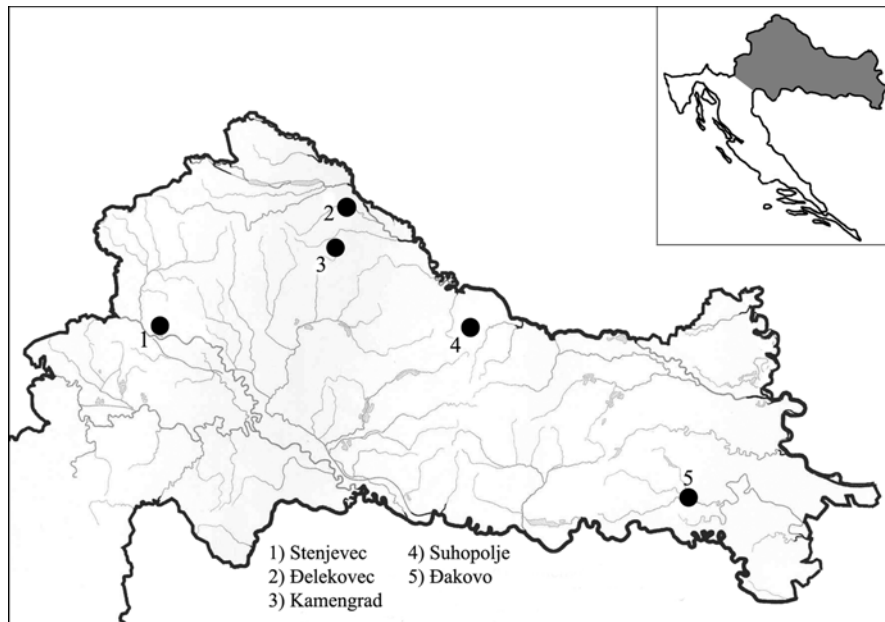
In recent paleodental literature the major emphasis has been on the differences in dental disease frequencies between various archaeological populations (e.g. Cook and Buikstra 1979, Goodman et al. 1984), but sex differences in dental disease frequencies within a population have also been reported (e.g. Swärdstedt 1966).

Until recently, data on the frequency of various dental pathologies in different archaeological populations from Croatia have been published jointly with other bioarchaeological data within holistic studies of various archaeological populations inhabiting the territory of present-day Croatia (e.g. Novak et al. 2007, Šlaus 2002, 2006), while only several studies predominantly addressed the issue of frequency and distribution of various dental pathologies (Šlaus et al. 1997, Vodanović et al. 2005).

The osteological collection of the Department of Archaeology of the Croatian Academy of Sciences and Arts in Zagreb, which stores approximately 3500 skeletons from mediaeval period, had enabled us a detailed analysis of numerous aspects of dental diseases in various Croatian archaeological populations. Hence, in this paper we tried to determine the frequency and distribution of various dental pathologies (caries, ante-mortem tooth loss, abscesses) in rural mediaeval populations from continental Croatia, to compare dental disease frequencies between males and females from this sample, and to compare the results yielded from this sample with contemporaneous archaeological populations from surrounding regions in order to get a better understanding of dietary habits, living conditions and the way of life of various mediaeval populations.

## Subjects and methods

The analysed sample consists of 197 adult skeletons from continental Croatia with nearly complete permanent dentition. Dental samples from five archaeological sites (Suhopolje, Kamengrad, Đelekovec, Stenjevec, and Đakovo) were pooled together in one composite sample in order to compare the results from this area with populations from different regions. All archaeological sites analysed in this paper are located in continental Croatia, i.e. between Sava, Drava and Danube rivers (Fig. 1). This region is rich in rivers which, in combination with a mostly flat and heavily wooded landscape, form many swamps. The almost identical climate conditions and ecological surrounding of all five sites suggests that their inhabitants had access to similar kinds of resources. All analysed sites are dated between 11th and 16th century, i.e. until the beginning of the Ottoman conquest of the region (Table 1). Skeletal material from all analysed sites came from simple or very modest inhumation graves with very sparse and uniformed grave goods, so the assumption was made that all analysed individuals belonged to a lower social class, such as peasants and serfs. Differentiation between social categories based on grave goods and burial forms could not be performed, therefore, all individuals were treated as a single social category. Although the data on the frequency of dental pathologies has partially been published for some of these sites (Šlaus 2002), the sample analysed in this article is substantially expanded with skeletal and dental material originating from the latest excavations. Also, the dental analysis was conducted in much greater detail in relation to the so far published data.



*Figure 1:* Map of continental Croatia with archaeological sites included in the analysis.  
*Table 1.* Dating and size of dental sample analysed in this paper.

Site	Dating (century)	Number of individuals	Number of examined teeth	Number of examined alveoli
Suhopolje <sup>1</sup>	12 <sup>th</sup> –15 <sup>th</sup>	39	691	1049
Kamengrad <sup>2</sup>	14 <sup>th</sup> –15 <sup>th</sup>	41	807	1074
Đelekovec <sup>3</sup>	11 <sup>th</sup> –13 <sup>th</sup>	27	488	735
Stenjevec <sup>4</sup>	11 <sup>th</sup> –13 <sup>th</sup>	36	715	994
Đakovo <sup>5</sup>	11 <sup>th</sup> –16 <sup>th</sup>	54	1227	1402
		197	3928	5254

<sup>1</sup>Tomičić et al. 2008; <sup>2</sup>Demo 1984; <sup>3</sup>Šmalcelj and Kolar 1985; <sup>4</sup>Simoni 2004; <sup>5</sup>Filipec 1997

All analyses were undertaken in the laboratory of the Department of Archaeology of the Croatian Academy of Sciences and Arts in Zagreb. Sex and age of the analysed skeletons was determined by using the standard criteria (Bass 1995, Krogman and Işcan 1986, Lovejoy 1985). All individuals over sixty years of age were classified in a single open ended group 60+.

All skeletons were analysed for the possible presence of the following pathological changes: caries, ante-mortem tooth loss (AMTL) and abscesses.

Dental caries is an infectious disease characterised by the demineralisation of inorganic portions and the destruction of organic portions of the teeth. The presence of caries was diagnosed macroscopically, under strong illumination, with the help of a dental probe. Caries was diagnosed only if there was a clear defect on the dental enamel. The number and position (occlusal, interproximal, buccal, lingual, root) of each carious lesion was noted. Caries size was classified into four categories according to Metress and Conway (1975): 1) pit or slight fissural start of lesion, 2) lesion covering less than 50% of the tooth's surface, 3) lesion covering over 50% of the tooth's surface, and 4) lesion that has completely destroyed the crown with only the root remaining.

Ante-mortem tooth loss was diagnosed by the progressive resorptive destruction of the alveolus (Lukacs 1989) and by the presence of remodelling of the alveolar bone. Besides ante-mortem tooth loss a post-mortem tooth loss was also recorded. Teeth were considered lost post-mortem if there was clear evidence of alveolar socket.

Alveolar abscess occurs when bacteria from a carious lesion spreads from the root of the tooth into the alveolus. Morphologically it is recognized by the defect on the bone, which occurs when pus from abscess breaks an opening for drainage into the bone. Infected tooth usually dies and gets extracted – naturally or surgically, while dental alveolus remodels with time (Šlaus 2006). The presence of abscesses was diagnosed using the criteria developed by Brothwell (1981).

Since dental diseases are age-dependent (i.e. their frequency increases with advanced age) when tabulating the data, age was controlled by dividing the sample into two broad categories: young adults (individuals aged between 16 and 35 years) and old adults (individuals older than 36 years).

The data on carious lesions, AMTL and abscesses are presented on the basis of relative frequencies calculated per element (tooth, alveolus) and per individual. Estimates of sex, age, and dental analysis were carried out by two observers (MN, MŠ). The eventual statistical significance was tested with the chi-square test, using Yates correction when appropriate.

## Results

The analysed sample is represented by the skeletons of 197 individuals (109 males and 88 females). The sex and age distribution in the analysed sample is presented in Table 2. The average age-at-death for males is 39.4 years, and for females 35.2 years. Youngest individual in the analysed sample died at the age of 15, while the oldest individuals lived to the age of over 60 years.

Table 2. Sex and age distribution in the analysed sample.

Sex/age	Females	Males
15–20	7	3
21–25	13	13
26–30	11	10
31–35	16	16
36–40	16	15
41–45	10	18
46–50	3	12
51–55	9	15
56–60	2	5
60+	1	2
Total	88	109
Mean age at death	35.2 ys	39.4 ys

Dental caries was observed in 73% (144/197) of analysed individuals with an average of 2.2 carious teeth per individual. Although males exhibit somewhat higher frequency than females (74.3% vs. 71.6%), the difference is not statistically significant.

Total caries frequency per tooth for this sample is 11.1% (Table 3). Males exhibit slightly higher frequency than females (11.9% vs. 10.1%). The frequency of carious lesions in both sexes is higher in the maxilla, and for males this difference is statistically significant ( $\chi^2=10.251$ ,  $P<0.01$ ). A clear correlation between the frequency of caries and higher age in the analysed sample is established (Table 4). Namely, both sexes exhibit significantly higher prevalence of caries in older individuals (35+ years) compared to the younger ones (16 to 35 years; for males  $\chi^2=28.115$ ,  $P<0.001$ ; for females  $\chi^2=32.877$ ,  $P<0.001$ ).

Table 3. Frequency of caries, AMTL and abscesses in the analysed sample.

	Males			Females			Total		
	N	n	%	N	n	%	N	n	%
Caries	2186	260	11.9	1742	176	10.1	3928	436	11.1
AMTL	2937	345	11.7	2317	341	14.7	5254	686	13.1
Abscess	2937	69	2.3	2317	43	1.9	5254	112	2.1

Table 4. Frequency of carious lesions per tooth.

		Maxilla			Mandible			Total		
		N	n	%	N	n	%	N	n	%
Males	Young	494	43	8.7	545	40	7.3	1039	83	8.0
	Old	460	95	20.6	687	82	11.9	1147	177	15.4
	Total	954	138	14.5	1232	122	9.9	2186	260	11.9
Females	Young	487	34	7.0	542	34	6.3	1029	68	6.6
	Old	301	56	18.6	412	52	12.6	713	108	15.1
	Total	788	90	11.4	954	86	9.0	1742	176	10.1

As seen in Table 5, carious lesions in both sexes were most frequently located on the interproximal surfaces (in males 65.8%; in females 65.9%). Both males and females follow the same pattern regarding the location of carious lesions: interproximal lesions are followed by occlusal, root, buccal, and lingual lesions.

Table 5. Distribution of carious lesions by location on the tooth.

Location of caries	Males		Females		Total	
	N	%	N	%	N	%
Occlusal	55	21.1	36	20.4	91	20.9
Buccal	9	3.5	11	6.3	20	4.6
Lingual	4	1.5	2	1.1	6	1.4
Interproximal	171	65.8	116	65.9	287	65.8
Root	21	8.1	11	6.3	32	7.3
Total	260	100.0	176	100.0	436	100.0

Severity of carious lesions for both sexes is presented in Table 6. When observing the total sample the most frequent are carious lesions graded 1 (39.2%), followed by carious lesions graded 2 (35.3%). Although there are no significant differences between sexes regarding the severity of the carious lesions, males exhibit higher frequency of carious lesions graded 1 (42.7% vs. 34.1%), while females exhibit higher frequency of carious lesions graded 2 (42.0% vs. 30.8%).

Table 6. Size of carious lesions.

Grade	Males		Females		Total	
	n	%	n	%	n	%
1	111	42.7	60	34.1	171	39.2
2	80	30.8	74	42.0	154	35.3
3	22	8.4	17	9.7	39	9.0
4	47	18.1	25	14.2	72	16.5
Total	260	100.0	176	100.0	436	100.0

AMTL involves 61.9% (122/197) of the analysed individuals with no significant difference between males and females (61.5% vs. 62.5%). The frequency of AMTL per alveolus for both sexes is presented in Table 7. AMTL affects 13.1% of the analysed alveoli with a significantly higher frequency in females (14.7% vs. 11.7%;  $\chi^2=9.809$ ,  $P<0.01$ ). The differences are especially visible in the older age category, where females also exhibit a significantly higher frequency of AMTL than males (24.6% vs. 17.1%;  $\chi^2=24.687$ ,  $P<0.001$ ). The frequency of AMTL in both sexes is significantly higher in the mandible than the maxilla (for males  $\chi^2=4.366$ ,  $P<0.05$ ; for females  $\chi^2=33.025$ ,  $P<0.001$ ).

The total frequency of post-mortem tooth loss in the analysed sample is 18.8% (990/5254), with incisors most frequently lost post-mortem.

Table 7. Frequency of AMTL per alveolus.

		Maxilla			Mandible			Total		
		N	n	%	N	n	%	N	n	%
Males	Young	552	14	2.5	612	28	4.6	1164	42	3.6
	Old	704	115	16.3	1069	188	17.6	1773	303	17.1
	Total	1256	129	10.3	1681	216	12.8	2937	345	11.7
Females	Young	510	5	1.0	626	45	7.2	1136	50	4.4
	Old	432	85	19.7	749	206	27.5	1181	291	24.6
	Total	942	90	9.5	1375	251	18.2	2317	341	14.7

Abscesses were observed in 32.0% (63/197) of the individuals with slightly higher frequency in males (32.7% vs. 31.8%). Abscesses affect 2.1% of the analysed alveoli with, again, somewhat higher frequency in males than in females (2.3% vs. 1.9%; Table 8). In both sexes abscesses are more frequent in the maxilla than the mandible, but these differences are not statistically significant. As in all analysed dental pathologies, the frequency of abscesses in both sexes is higher in “old” individuals compared to the “young” ones (for males 2.5% vs. 2.1%; for females 2.9% vs. 0.8%).

Table 8. Frequency of abscesses per alveolus.

		Maxilla			Mandible			Total		
		N	n	%	N	n	%	N	n	%
Males	Young	552	12	2.2	612	12	2.0	1164	24	2.1
	Old	704	25	3.5	1069	20	1.9	1773	45	2.5
	Total	1256	37	2.9	1681	32	1.9	2937	69	2.3
Females	Young	510	5	1.0	626	4	0.6	1136	9	0.8
	Old	432	18	4.2	749	16	2.1	1181	34	2.9
	Total	942	23	2.4	1375	20	1.4	2317	43	1.9

In order to put the data from our research into broader context the comparison with other contemporaneous archaeological populations from surrounding regions was made (Table 9).

Table 9. Comparison of the composite sample from continental Croatia with other mediaeval populations.

Site	Dating (century)	Prevalence of caries (%)	Prevalence of AMTL (%)
Continental Croatia	11 <sup>th</sup> –16 <sup>th</sup>	11.1	13.1
Bijelo brdo, Croatia <sup>1</sup>	10 <sup>th</sup> –11 <sup>th</sup>	9.5	6.7
Nova Rača, Croatia <sup>2</sup>	14 <sup>th</sup> –17 <sup>th</sup>	9.4	10.9
Zagreb, Croatia <sup>3</sup>	14 <sup>th</sup> –16 <sup>th</sup>	13.6	16.4
Gračanica and Dići, Serbia <sup>4</sup>	14 <sup>th</sup> –19 <sup>th</sup>	8.9	10.4
Središče, Slovenia <sup>5</sup>	10 <sup>th</sup> –15 <sup>th</sup>	7.1	9.0
Szabolcs, Hungary <sup>6</sup>	10 <sup>th</sup> –12 <sup>th</sup>	9.1	11.8
Zalavár, Hungary <sup>7</sup>	11 <sup>th</sup>	12.1	39.4
Devín-Hrad, Slovakia <sup>8</sup>	11 <sup>th</sup> –12 <sup>th</sup>	7.9	16.8
Ducové, Slovakia <sup>9</sup>	10 <sup>th</sup> –15 <sup>th</sup>	9.5	22.7

<sup>1</sup>Vodanović et al. 2005; <sup>2</sup>Šlaus et al. 1997; <sup>3</sup>Šlaus et al. 2007; <sup>4</sup>Djurić Srejić 2001;

<sup>5</sup>Leben-Seljak and Štefančič 2001; <sup>6</sup>Pap 1986; <sup>7</sup>Frayer, 1984; <sup>8</sup>Beňuš 1999;

<sup>9</sup>Hanáková and Stloukal 1984

### Discussion

The information on the diet of Croatian mediaeval populations, especially rural, is provided by *urbarii* (legal documents which defined relationships between feudal lords and peasants). Probably the most important is the *urbarium* from the monastery of Streza, dated to 15th century, which describes the size and structure of the natural annuity that peasants were obliged to give to their feudal lords (Kolar Dimitrijević 2003). This *urbarium* thoroughly exhibits which types of food were used by the lower social categories, such as peasants, during the Late Middle Ages in continental Croatia. Millet was the main crop that made the basis of the everyday diet, because it is easily cultivated, has a short period of vegetation, and can be sown in the dry and sandy soil. Wheat was considered the most important cereal for baking bread, while buckwheat and guinea corn also had a very important role in the everyday diet. Beside these crops, rye and barley were also cultivated in large amounts. On the other hand, pork, poultry and fish were the most common source of protein for Croatian peasants during the Late Middle Ages (Adamček 1980). Therefore, the relatively high frequency of caries, recorded in the sample from continental Croatia, corresponds to the data provided by *urbarii*, suggesting a diet primarily based on products rich in carbohydrates, i.e. a high proportion of cereals in the everyday diet.

The frequency of carious lesions in the analysed sample (73%) is higher than the frequencies recorded in other mediaeval populations in the surrounding regions, ranging from 39% in Ducové, Slovakia (Beňuš 1999) to 70% in Zalavár, Hungary (Frayer 1984). However, in comparison to modern populations from the region, these frequencies are considerably lower, because the frequency of caries in adults in modern populations is almost 100% (e.g. Ivanković et al. 2003, Vrbič 2000). Djurić Srejić (2001) noted a similar situation when she compared the frequency of caries between the medieval Serbian populations and modern populations from the territory of former Yugoslavia.

Males exhibit a slightly higher frequency of caries than females, which is most probably the result of a longer average life span of males (4.2 years). Simply put, males had more time to develop carious lesions and more time for it to progress from a small lesion to a severe problem (Šlaus et al. 1997). Somewhat higher prevalence of caries in males could be a result of differences in behavioural activities such as diet, cultural practices and oral hygiene. Namely, Šlaus and his associates (1997) suggested that the higher frequency of caries in younger males in Nova Rača is probably caused by their importance in obtaining food through skill-intensive agricultural labour, i.e. young males were selectively buffered from the effects of malnutrition and had more access to limited food resources than young females. This assumption might be also applied for the “young” age group in the sample from continental Croatia.

In the analysed sample carious lesions were most frequently located on the interproximal surfaces of teeth, followed by occlusal, root, buccal and, at the end, lingual lesions. According to Šlaus (2006) and Vodanović and his associates (2005), such distribution is characteristic for archaeological populations that have sustained on more solid and less processed food than modern populations. Solid diet has strong abrasive effect on the occlusal surface of the tooth, which therefore becomes smoother and less suitable for the development of caries than the irregular and more corrugated occlusal surfaces of modern populations. In archaeological populations interproximal surfaces and the roots of teeth are the most common places where caries develops while in modern populations that sustain on softer diet caries usually develops on occlusal surfaces of teeth (Šlaus 2006).

Regarding the intensity of carious lesions in the analysed sample, in most cases it is graded 1 and 2. However, in this sample relatively frequent (16.5%) were carious lesions graded 4. The frequency of carious lesions graded 4 in this series is somewhat higher than the frequencies recorded by Djurić Srejić (2001) in the mediaeval sample from Serbia (6%) and by Šlaus and his associates (1997) in Nova Rača (males 15.0%, females 6.2%).

Numerous authors reported lower frequencies of alveolar bone diseases in populations whose diet was primarily based on hunting and gathering, while higher frequencies were more often observed in populations sustained on agriculture (e.g. Kelley et al. 1991, Littleton and Frohlich 1993). So, in this context, the relatively high total frequency of AMTL in the analysed sample (13.1%) might be an additional confirmation of the assumption that the diet of the studied mediaeval populations from continental Croatia was mainly based on cereals. In accordance with this high frequency of caries that was recorded in the analysed sample, many authors suggest that the largest portion of AMTL may be attributed to carious lesions, along with some other pathologies like periapical osteitis and accumulation of calculus (e.g. Bonfiglioli et al. 2003, Lukacs 1989), or nutritional deficiency diseases, dental ablation for aesthetic or ritual reasons, and traumatic injuries (Lukacs 2006). High frequency of AMTL in Croatian sample also suggests a low level of oral hygiene, for, according to Hillson (1996), insufficient oral hygiene that removes dental plaque is the basis of future dental loss. Hillson (1996) reported that gingival inflammation, which results from bacterial plaque, leads to bone resorption and, eventually, tooth loss.

Males and females from the analysed sample exhibit significantly higher frequencies of AMTL in the mandible than the maxilla. Bonfiglioli and her associates (2003)



suggested this is caused by the fact that the upper teeth tend to have more roots than the lower teeth and are less susceptible to ante-mortem loss.

The frequency of AMTL in the studied sample is significantly higher in females. These differences are probably not associated with the average life span and potential differences in the diet between sexes, but are probably the result of differences in non-masticatory functions of teeth. In other words, there was probably some differential use of dentition as tools between males and females. Šlaus (2006) suggested that the higher frequency of AMTL in females in the early mediaeval Croatian populations from the eastern Adriatic coast is a result of sexual division of labour in which females used their teeth as a tool. He assumed that due to the loss of late Antique technologies during the mediaeval period the use of teeth as tools intensified, which resulted in the increased mechanical load of teeth during processing organic materials, such as basket weaving or leather processing (Šlaus 2006). The fact that the frequency of AMTL is similar between younger males and females, and that older females exhibit significantly higher frequency of AMTL in relation to older males, strongly suggests that predominantly older females practised these activities.

Caries is probably the main etiologic factor of abscesses in the analysed sample, while attrition is responsible for only a small portion of recorded abscesses. Other sources of infection, such as deep periodontal pockets and injuries have not been observed. Since caries is the main source of abscess in the analysed sample, and males exhibit slightly higher frequency of caries than females, it resulted in somewhat higher frequency of abscesses in males. Abscesses are more frequent in the old age category in both sexes, and probably reflect a progressive deterioration of the tooth; caries appears at a young age but needs time to invade the pulp cavity and cause abscess (Beckett and Lovell 1994).

Comparing the dental health of the mediaeval rural populations from continental Croatia with other contemporary populations from Central Europe, one may notice that the frequencies of caries and AMTL are similar in most of the observed samples, strongly suggesting a diet based on agricultural products. The differences between some of the samples are most probably a result of the local socio-economic factors and different age distributions between the samples.

### **Conclusion**

This paper presents the results of an analysis of human dental material of rural populations that inhabited continental Croatia during High and Late Middle Ages (11th to 16th centuries). Archaeological context in which these skeletons were found (simple inhumation graves, very sparse and poor grave goods) suggests that they belonged to lower social categories, such as peasants. Written historical sources testify that the diet of those social classes in continental Croatia during the mediaeval period was based mainly on cereals, with only occasional consumption of meat. High frequency of caries observed in the analysed sample supports this claim, and strongly suggests nutrition based on agricultural products rich in carbohydrates. Similar frequency of caries between the sexes suggests that there was no significant difference in the manner and type of diet between males and females. Dental analysis showed significantly higher frequency of AMTL in females, especially in the older age category, which suggests that the older females practised activities in which they used their teeth as tools (e.g. basket weaving or leather

processing). The data presented in this paper (high frequency of caries and AMTL) also strongly suggests a very low level of oral hygiene in continental Croatia during the mediaeval period.

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## References

- Adamček, J. (1980): *Agrarni odnosi u Hrvatskoj od sredine 15. do kraja 17. stoljeća*. Sveučilišna naklada Liber. pp. 853.
- Bass, W.M. (1995): *Human Osteology*. A Laboratory and Field Manual of the Human Skeleton. Missouri Archaeological Society. pp. 327.
- Beckett, S., Lovell, N.C. (1994): Dental disease evidence for agricultural intensification in the Nubian C-group. *Int. J. Osteoarchaeol.*, 4: 223–240.
- Beňuš, R. (1999): Zdravotný stav chrupu obyvateľ'stva ranostredovekého Devína (11–12. stor.n.l.). *Bulletin Slovenskej Antropologickej Spoločnosti*, 2: 1–5.
- Bonfiglioli, B., Brasili, P., Belcastro, M.G. (2003): Dento-alveolar lesions and nutritional habits of a Roman Imperial age population (1<sup>st</sup>–4th c. AD): Quadrella (Molise, Italy). *Homo*, 54: 36–56.
- Brothwell, D.R. (1981): *Digging up bones*. Cornell Univ. Press. pp. 208.
- Cook, D.C., Buikstra, J.E. (1979): Health and Differential Survival in Pre-historic Populations: Prenatal Dental Defects. *Am. J. Phys. Anthropol.*, 51: 649–664.
- Demo, Ž. (1984): Castrum Keukaproncha/Kuwar: počeci istraživanja. *Pod. Zbor.*, 84: 320–360.
- Djurić Srejić, M. (2001): Dental Paleopathology in a Serbian Medieval Population. *Anthropol. Anz.*, 59: 113–122.
- Filipec, K. (1997): Đakovo – župna crkva, treća godina zaštitnih iskopavanja. *Opusc. Archaeol.*, 21: 239–242.
- Frayer, D.W. (1984): Tooth size, oral pathology and class distinctions: evidence from the Hungarian Middle Ages. *Anthrop. Közl.*, 28: 47–54.
- Goodman, A.H., Martin, D., Armelagos, G.J., Clark, G. (1984): Indications of Stress from Bones and Teeth. In: Cohen, M., Armelagos, G.J. (Eds) *Paleopathology at the Origins of Agriculture*. Academic Press. pp. 13–49.
- Hanáková, H., Stloukal, M. (1984): Der Gesundheitszustand des Gebisses der mittelalterlichen und der neuzeitlichen Population in Ducové. *Anthropologie*, 22: 103–110.
- Hillson, S. (1996): *Dental Anthropology*. Cambridge Univ. Press. pp. 373.
- Ivanković, A., Lukić, I.K., Ivanković, Z., Radić, A., Vukić, I., Simić, A. (2003): Dental caries in postwar Bosnia and Herzegovina. *Community Dent. Oral Epidemiol.*, 31: 100–104.
- Kelley, M.A., Levesque, D.R., Weidl, E. (1991): Contrasting patterns of dental disease in five early northern Chilean groups. In: Kelley, M.A., Larsen, C.S. (Eds) *Advances in Dental Anthropology*. Wiley-Liss. pp. 203–213.
- Kolar Dimitrijević, M. (2003): Urbar pavlinskog samostana u Strezi 1477. *Podravina*, 3: 103–123.
- Krogman, W.M., Işcan, M.Y. (1986): *The human skeleton in forensic medicine*. C. C. Thomas. pp. 551.
- Leben-Seljak, P., Štefančič, M. (2001): Dental caries in skeletal samples from north-eastern Slovenia. *Anthropological Notebooks*, 7: 84–99.
- Littleton, J., Frohlich, B. (1993): Fish-eaters and farmers: dental pathology in the Arabian Gulf. *Am. J. Phys. Anthropol.*, 92: 427–447.
- Lovejoy, C.O. (1985): Dental wear in the Libben population: its functional pattern and role on the determination of adult skeletal age at death. *Am. J. Phys. Anthropol.*, 68: 47–56.

- Lukacs, J.R. (1989): Dental paleopathology: methods for reconstructing dietary patterns. In: Išcan, M.Y., Kennedy, K.A.R. (Eds) *Reconstruction of Life from the Skeleton*. Alan R. Liss. pp. 261–286.
- Lukacs, J.R. (2006): Dental trauma and antemortem tooth loss in prehistoric Canary Islanders: prevalence and contributing factors. *Int. J. Osteoarchaeol.*, 17: 157–173.
- Metress, J.F., Conway, T. (1975): Standardized system for recording dental caries in prehistoric skeletons. *J. Dent. Res.*, 54: 908.
- Novak, M., Šlaus, M., Pasarić, M. (2007): Bioarheološke osobine novovjekovne populacije s nalazišta Koprivno-Kod križa kraj Klisa. *Opusc. Archaeol.*, 31: 303–346.
- Pap, I. (1986): Oral pathology and social stratification in the Hungarian Middle Ages. *Ann. Hist.-Nat. Mus. Natl. Hung.*, 78: 339–345.
- Simoni, K. (2004): *Stenjevec: starohrvatsko groblje*. Arheološki muzej Zagreb. pp. 63.
- Šlaus, M. (2002): *The Bioarchaeology of continental Croatia. An analysis of human skeletal remains from the prehistoric to post-medieval periods*. Archaeopress. pp. 111.
- Šlaus, M. (2006): *Bioarheologija – demografija, zdravlje, traume i prehrana starohrvatskih populacija*. Školska knjiga. pp. 254.
- Šlaus, M., Novak, M., Bedić, Ž., Vyroubal, V. (2007): Antropološka analiza kasnosrednjovjekovnog groblja kraj crkve svetog Franje na Opatovini u Zagrebu. *Arh. Rad. Ras.*, 15: 211–247.
- Šlaus, M., Pećina-Hrnčević, A., Jakovljević, G. (1997): Dental disease in the late medieval population from Nova Rača, Croatia. *Coll. Antropol.*, 21: 561–572.
- Šmalcelj, M., Kolar, S. (1985): Đelekovec kod Koprivnice – bjelobrdska nekropola. *Arh. Preg.*, 17: 130–133.
- Swärdstedt, T. (1966): *Odontological aspects of a Medieval Population in the province of Jämtland/Mid-Sweden*. Tieden-Barnängen Tryckerier. pp. 119.
- Tomičić, Ž., Dizdar, M., Jelinčić, K. (2008): *Kliškovac – Terezovac – Suhopolje. Od mjestopisa do arheološke spoznaje!* Institut za arheologiju u Zagrebu and Općina Suhopolje. pp. 8.
- Vodanović, M., Brkić, H., Šlaus, M., Demo, Ž. (2005): The frequency and distribution of caries in the mediaeval population of Bijelo Brdo in Croatia (10th–11th century). *Arch. Oral. Biol.*, 50: 669–680.
- Vrbič, V. (2000): Reasons for the caries decline in Slovenia. *Community Dent. Oral. Epidemiol.*, 28: 126–132.
- Watt, M.E., Lunt, D.A., Gilmour, W.H. (1997): Caries prevalence in the permanent dentition of a mediaeval population from the south-west of Scotland. *Arch. Oral. Biol.*, 42: 601–620.

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