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Teeth macroabrasion for determination of dental age and diet in the Illyrian population from the Kopila necropolis on the Island of Korčula, Croatia

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With 7 figures and 5 tables

Abstract: This paper presents the changes caused by macroabrasion of teeth on skeletal remains found in tomb No 4 in the west necropolis of the archeological site Kopila near Blato on the island of Korčula. The site archeologically dates back to the Late Iron Age, when the island was inhabited by the Illyrians. The aim of this study was to assess the dental age of the buried individuals at death and determine the type of their diet, which could give us a preliminary insight into the socio-economic standard of the inhabitants of the settlement. The analyzed sample is part of the collection of excavated skeletal remains kept in the Vela Luka Cultural Center on the island of Korčula. 284 permanent teeth, 19 fragments of the maxilla and 20 fragments of the mandible were found in the tomb, which were classified into 32 individuals and by sex. Teeth were analyzed by metric and non-metric methods of determining dental status in order to assess the dental age at the time of death and the diet of the inhabitants. The dental age of individuals was determined by the Lovejoy method and the degree of tooth wear by the Smith-Knight method. The analysis of the stable isotope ^{14}C determined the exact time of death of the analyzed individuals. The tooth wear changes were very pronounced and present on 92.9% of teeth, equally on incisors and molars ($p = 0.236$). There is no significant gender difference ($p > 0.05$ for all teeth and jaw parts). There was no difference in the degree of tooth wear of the teeth of the mandible and maxilla ($t = -0.266$, $p = 0.791$), nor in the degree of tooth wear of the teeth of the maxilla right and left ($t = -0.392$, $p = 0.702$) or in the degree of tooth wear of the teeth of the mandible right and left ($t = -0.889$, $p = 0.390$). The average age of the analyzed population sample was 35.6 (±3.1) years. They were buried between 360–40 BC. Tooth wear changes observed on the analyzed teeth indicate a diet rich in hard, weakly cariogenic food with particles that were probably of inorganic origin, which caused an increased wear of tooth structures. The population was sedentary, agricultural type and the life expectancy was normal for the Late Iron Age. Besides, their socio-economic status was good. The age at the time of their death was between 30 and 40 years. Further studies should include more accurate and standardized methods for assessing the condition.

Keywords: teeth; dental age; dental wear; Illyrians; Late Iron Age

Introduction

In bioarchaeological and forensic-anthropological research, teeth are of a great value. Due to high content of inorganic substances in the structures, they can remain preserved in the soil for thousands of years. Dental analysis can, therefore, give us valuable data not only on an individual's health, but also data on similarities or differences in the type and diet of different historical populations and groups (social, economic or those related to gender) within a community (Šlaus 2006). The role of diet and eating habits in the organization and evolution of human cultures has long been recognized since it is the direct communication of the human body with its environment (Ungar 2012; Forshaw 2014). The availability of food, its nutritional value and the method of preparation leave a mark on the health of an individual, and thus on the demographic aspect of the entire community. Population structure, intra-community death rate, and fertility rates indicate population adjustments to physical and cultural environmental influences, such as disease, periods of starvation, warfare, genetic factors, etc. (Owsley & Bass 1979).

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From the very beginning of research on human osteological remains, it has been observed that certain substances from food and the environment can eventually cause wear of tooth enamel (Robinson 1955; Jurado et al. 2008; Elgart 2010). Chewing hard, fibrous foods and using teeth as tools leads to more extensive wear. Depending on the type of food and the way it is prepared, there are variations between different population groups, and this can help to determine whether their ways of life were hunting-collecting or agricultural. In recent times, increased urbanization and consumption of processed foods have significantly reduced the incidence of tooth wear (Molnar 1972; Smith 1984; Brkić 2011).

The degree of tooth wear and its various forms, in addition to giving us data on the type of diet, have been used as one of the methods for determining age at the time of death of an individual (Rose & Ungar 1998; Forshaw 2014).

Macroscopically visible wear can also be of great benefit in determining the number of individuals and aligning dentitions in mixed sets, by placing similarly worn teeth together (Schmidt 2008).

In this paper, we have presented macroscopic changes in tooth wear for the purpose of determining dental age and diet, on the archaeological sample found in tomb No 4 at Kopila necropolis near Blato on the island of Korčula, Croatia.

The map in Fig. 1 shows the importance of the geostrategic position of the island of Korčula and Kopila in relation to significant settlements and trade flows of the Late Iron Age of the Middle Adriatic. The position of the Kopila settlement in relation to the Blato field is shown in Fig. 2.

Material and methods

The sample and related limitations

The human osteological material analyzed in this paper was discovered during archaeological excavations at the site of the Kopila necropolis in 2015 in the western nucleus of tomb no. 4. The necropolis has been under investigation since 2012. It consists of two nuclei, built of drywall with limestone, horseshoe-shaped and a dozen tombs leaning against each other. The bodies of the deceased were laid in stone coffins on fine sea pebbles. The tombs have been used many times for family burials of one community over a long period of time and with each new burial the remains of the previous one were pushed along the edge. This has led to significant fragmentation and destruction of bone remains. Therefore, the analysis focused only on hard dental tissues since they are the longest-lasting trace of human existence (Fadić & Radić 2017). The building structure of the necropolis is shown in Fig. 3.

Jaw bone fragments and teeth from the tomb no. 4 were first inventorized and categorized by the degree of preservation in 4 categories, depending on the size of preserved surface, in this case only fragments of maxillae and man-

Fig. 1. Middle Adriatic in Protohistory / Hellenism (from: Radić & Borzić (2017), Island of Korčula: Illyrians and Greeks).

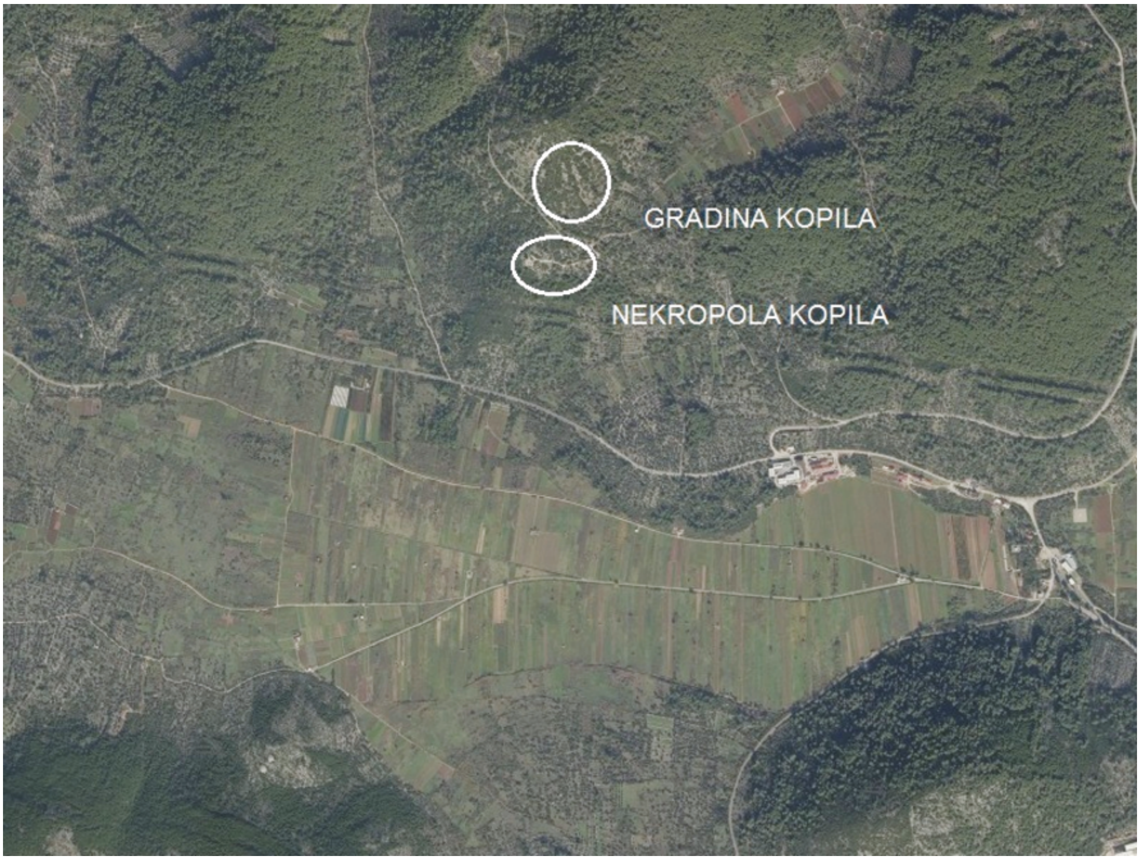

Fig. 2. Blato field and position of the Kopila (from Radić & Borzić (2017), Island of Korčula: Illyrians and Greeks).

Fig. 3. Kopila necropolis (from: Fadić & Radić (2017), City of the Dead over field of life – Necropolis of hillfort settlement Kopila on island Korčula).

dibles (Buikstra & Ubelaker 1994; Vodanović et al. 2004; Vodanović 2008). Teeth are listed according to the pattern in the Microsoft Excel software in which the presence, antemortal/postmortal loss, the degree of development, morphological features and pathological changes were recorded.

Due to the high number of burials in the tomb, it is necessary to determine the minimal number of individuals, i.e. how many individuals were present without duplication any elements. Also, the researcher must be careful about the developmental age of every tooth (Schmidt 2008). In this analysis, the division per groups of the exhumed samples was also taken into account because the previously dead individual was pushed towards the edge of the tomb by every new burial.

The sex of individuals was determined using odontometric methods, by measuring with a sliding caliper (Vodanović et al. 2007; Capitaneanu et al. 2017). Where possible, the sex was determined by visual inspection of morphological features of the skull (Šlaus 2006).

The age of individuals, due to poor preservation and fragmentation of the sample, was determined by the analysis of wear on the occlusal surfaces of teeth by the method described by Lovejoy (1985), and in one sample by the stage of tooth development according to Cameriere (2008) and Brkić et al. (2016).

Other non-destructive methods of age assessment – the degree of obliteration of cranial sutures, increased apical translucency, and the pulp / tooth ratio were not used in this paper due to the poor condition of the remains (Vodanović et al. 2011).

The Lovejoy method is based on comparing the degrees of tooth wear. This method is not population specific and this must be taken into account when determining age in different populations. The determination was performed in 9 stages: A (12–18), B (16–20), C (18–22), D (20–24), E (24–30), F (30–35), G (35–40), H (40–50), I (45–55) (Lovejoy 1985).

The degree of tooth wear was determined macroscopically, by the size of the area of enamel and dentin loss caused by chewing, in 5 degrees (0–4), by the method of Smith & Knight (1984) (Buikstra & Ubelaker 1994; Bardsley 2008; Rubini et al. 2020).

In this study, 24 teeth were isolated and sent to the laboratory of Isotoptech Zrt., Debrecen, Hungary, to isolate the stable isotope ^{14}C, to determine the temporal dating of individuals. The measurement was performed by accelerator mass spectrometry (AMS), which measures the ratio of ^{14}C to ^{12}C. The advantages of this method are that the age of a very small sample can be determined, the age limit is 60,000 years, short measurement time and small error, and the disadvantages are the cost due to measurements on expensive nuclear machines. The samples were prepared by the closed tube graphitization process and tested by the MICADAS (mini radiocarbon dating system) system (Rinyu et al. 2013; Újvári et al. 2014).

Statistical analysis

Statistical analysis was performed using statistical software packages STATISTICA version 12 (StatSoft, Inc. 2013, www.statsoft.com) and MedCalc version 20,015 (MedCalc Software Ltd, Ostend, Belgium; https://www.medcalc.org; 2021). Categorical variables are shown as number and share (%), and continuous variables as arithmetic mean (AM), and standard deviation (SD). The normality of the distribution was determined using the Kolmogorov-Smirnov test. The difference between the groups was determined for categorical variables using the chi-square test or Fisher exact test, depending on the distribution, and for continuous variables by Student's t-test or analysis of variance (ANOVA). The correlation of individual variables was determined by regression analysis. Statistical significance was determined for all tests at the level of $p < 0.05$ with appropriate corrections in multiple comparisons.

Results

A total of 284 permanent teeth, 19 fragments of the maxilla and 20 fragments of the mandible were found in tomb No. 4 of the west nucleus of the Kopila necropolis. They have been classified into n = 32 individuals according to morphological characteristics and segments by which they were excavated.

75% of them were poorly preserved and highly fragmented remains, where only the maxilla or only the mandible with less than 50% of the surface of the alveolar process was preserved or only teeth, without alveoli, were present. Of the total number of teeth, n = 99, 34.8% of them were in the alveoli, while n = 185, that is 65.2% of them were not present in the alveoli. N = 10, (3.52%), teeth were lost antemortem, and n = 102, that is, 35.9% of teeth were lost postmortem.

There were n = 15 probable males, n = 9 probable females, and for n = 8 individuals it was not possible to determine sex due to poor preservation.

Carious was detected in n = 17 (5.99%) teeth, in n = 11 (34.37%) individuals, older age groups (> 35 g), molars and premolars were affected in 94%. Single carious lesions were present in 82.3%, and in 76.4% of teeth proximal caries was detected. Small fissure caries was present in 23.5% of teeth, and 76.5% of teeth had a greater destruction of the crown with pulpal exposure. Periapical changes were present on 2 premolars, in two individuals.

Calculus accumulations as well as hypoplastic changes were not observed.

Alveolar bone resorption could be measured in 13 individuals, on average 4.84 mm orally. Dehiscences were observed in 9 individuals, mostly in males (72%) in older age groups, with an average value of 10.95 mm.

The age of individuals was determined by the method of analysis of tooth wear according to Lovejoy (1985) and by determining the degree of tooth development according to Cameriere (2008).

There were two (n = 2) individuals under the age of 20, one of whom was an adolescent aged 13–14. There were five (n = 5) individuals aged 20–24, three (n = 3) aged 24–30, three (n = 3) aged 30–35, and six (n = 6) aged 35–40, and eleven (n = 11) individuals over 40. The distribution of individuals by age and sex is shown in Table 1.

The average age of all individuals was 35.6 years (± 3.1 years, SD 11.1).

Tooth wear was very pronounced and present in 92.9% of teeth, both on incisors and molars ($p = 0.236$). The extent of the tooth wear did not differ significantly with regard to gender ($p > 0.05$ for all teeth and parts of the jaw). Also, there was no difference either between mandibular and maxillary teeth ($t = -0.266$, $p = 0.791$), right and left side of the maxilla ($t = 0.392$, $p = 0.702$), or right and left side of the mandible ($t = -0.889$, $p = 0.390$), (Table 2). 93.3% of them had oblique abrasions. The degree of tooth wear and its distribution by sex is shown in Table 3.

According to the degree of wear, grades 2 and 3 were most common in 63.1% of them; hence the dentin was exposed without pulp exposure.

An average degree of the tooth wear of all teeth of individuals by age is shown in Fig. 4.

The average values (AM, SD, 95% CI) of the degree of tooth wear according to age groups are shown in Table 4.

The average degree of differs stooth wear statistically significantly with respect to age groups ($F = 12.011$, $p < 0.001$, ANOVA) and increases linearly with age (Fig. 4).

It was found that there was a statistically significant relationship between age and average degree of wear of all teeth, teeth in the mandible, mandibles right and left and maxillae right and left ($r = 0.856$, $p < 0.001$; $r = 0.935$, $p < 0.001$;

Table 1. Distribution of the number of individuals by age and sex.

Stage	Years of age	Male		Female		Indeterminate		Sum:	
		No.	%	No.	%	No.	%	No.	%
A	12–18	1	6.67	0	0.00	0	0.00	1	3.13
B	16–20	0	0.00	0	0.00	1	12.50	1	3.13
C	18–22	0	0.00	0	0.00	0	0.00	0	0.00
D	20–24	3	20.00	0	0.00	2	25.00	5	15.63
E	24–30	2	3.33	1	11.11	0	0.00	3	9.38
F	30–35	1	6.67	1	11.11	1	12.50	3	9.38
G	35–40	2	13.33	2	22.22	2	25.00	6	18.75
H	40–50	3	20.00	2	22.22	1	12.50	6	18.75
I	45–55	2	13.33	3	33.33	0	0.00	5	15.63
	Cannot be determined	1	6.67	0	0.00	1	12.50	2	6.25
	Total	15	100.00	9	100.00	8	100.00	32	100.00

Table 2. Summary of the degree of tooth wear changes – distribution by teeth.

	Maxilla															
	Right								Left							
	I1	I2	C	P1	P2	M1	M2	M3	I1	I2	C	P1	P2	M1	M2	M3
Total number of teeth	4	8	10	11	4	10	11	3	4	6	7	12	10	12	13	3
Average degree of abrasion	2.0	1.8	2.0	2.2	1.5	2.7	2.2	1.7	2.8	2.0	2.0	2.3	2.2	2.4	2.3	1.0
	Mandible															
	Right								**Left**							
	I1	I2	C	P1	P2	M1	M2	M3	I1	I2	C	P1	P2	M1	M2	M3
Total number of teeth	7	5	9	11	10	12	11	3	4	9	10	13	12	17	16	7
Average degree of abrasion	2.6	2.2	2.6	2.2	2.1	2.8	2.6	2.0	1.8	2.1	2.3	2.3	2.3	2.6	2.8	2.4

Table 3. Degree of tooth wear changes – distribution by sex.

Sex	Maxilla															
	Right								Left							
	I1	I2	C	P1	P2	M1	M2	M3	I1	I2	C	P1	P2	M1	M2	M3
M	2.0	2.0	2.3	2.3	1.7	2.6	2.1	2.0	3.0	2.3	2.2	2.6	2.6	2.5	2.4	1.0
F	0.0	1.3	1.3	2.0	1.0	3.0	2.3	1.0	2.0	1.5	1.0	1.5	1.5	2.6	2.4	1.0
Sex	**Mandible**															
	Right								**Left**							
	I1	I2	C	P1	P2	M1	M2	M3	I1	I2	C	P1	P2	M1	M2	M3
M	2.2	1.8	2.4	2.0	2.0	2.7	2.5	1.0	1.3	2.0	1.8	2.1	1.8	2.4	2.7	3.0
F	3.5	4.0	4.0	2.7	2.3	3.0	3.0	4.0	0.0	2.5	3.0	3.3	3.0	3.0	2.8	1.7

Table 4. Average degree of tooth wear by age groups.

Age (years)	AM	SD	95% CI	N
12–18	0.38	0		1
16–20	1	0		1
20–24	1.6	0.67	0.76–2.43	5
24–30	1.91	0.51	0.65–3.18	3
30–35	2.11	0.27	1.45–2.78	3
35–40	2.42	0.55	1.85–2.99	6
40–50	2.79	0.41	2.14–3.45	4
45–55	3.75	0.25	3.44–4.06	5

r = 0.810, p (0.001; r = 0.906, $p < 0.001$; r = 0.594, $p = 0.007$; r = 0.523, $p = 0.046$; r = 0.572, $p = 0.013$, respectively). The best level of association was found for the degree of tooth wear in the mandible (r = 0.935, $p < 0.001$), which is shown in Fig. 5. The degree of tooth wear has shown an error for prediction of age of ± 1.8 years. The distribution of the degree of tooth wear changes in separate sets of teeth individuals according to age and sex is shown in Figs 6 and 7. The results of AMS ^{14}C analysis isolated from the teeth confirmed the period in which these ancient populations lived (Table 5).

Table 5. AMS ^{14}C analysis report.

Sample No.	Conventional ^{14}C age (yrs BP) ($\pm 1\sigma$)	Calibrated calendar age (cal AD/BC) (2σ)
1	2104 ± 24	BC 200–40
2	2165 ± 26	BC 360–160
3	2158 ± 23	BC 360–60
4	2140 ± 23	BC 350–50
5	2186 ± 24	BC 360–160
6	2130 ± 22	BC 350–50
7	2121 ± 23	BC 340–50
8	2181 ± 25	BC 360–150
9	2176 ± 26	BC 360–120
10	2160 ± 23	BC 360–100
11	2147 ± 23	BC 350–50
12	2204 ± 25	BC 370–170
13	2246 ± 23	BC 390–200
14	2216 ± 22	BC 380–190
15	2163 ± 26	BC 360–60
16	2110 ± 31	BC 340–40
17	2157 ± 23	BC 360–50
18	2142 ± 22	BC 350–50
19	2276 ± 23	BC 400–200
20	2156 ± 23	BC 360–50
21	2175 ± 22	BC 360–150
22	2186 ± 22	BC 360–160

Discussion

Tooth wear, due to hard food or the use of teeth as tools, is one of the most important bioarchaeological changes, along with carious changes, periapical processes, changes in supporting tooth tissue, congenital or developmental anomalies, cultural modifications, and possible hypoplastic changes (Šlaus 2006; Forshaw 2014). Analyzes of these changes have led to knowledge about the health status of the population. Likewise, they have led to the knowledge about their standard and socio-economic characteristics.

By researching the causes of dental wear, Molnar (1972) defined methods for analyzing data, and identified three pervasive themes: diet reconstruction, determining the time of death, and cultural modification. Broca (1897) was the first to introduce a 5-level molar scoring system for molars, which has been refined by other authors (e.g., Smith 1984; Lovejoy 1985; Rose & Ungar 1998; Rubini et al. 2020).

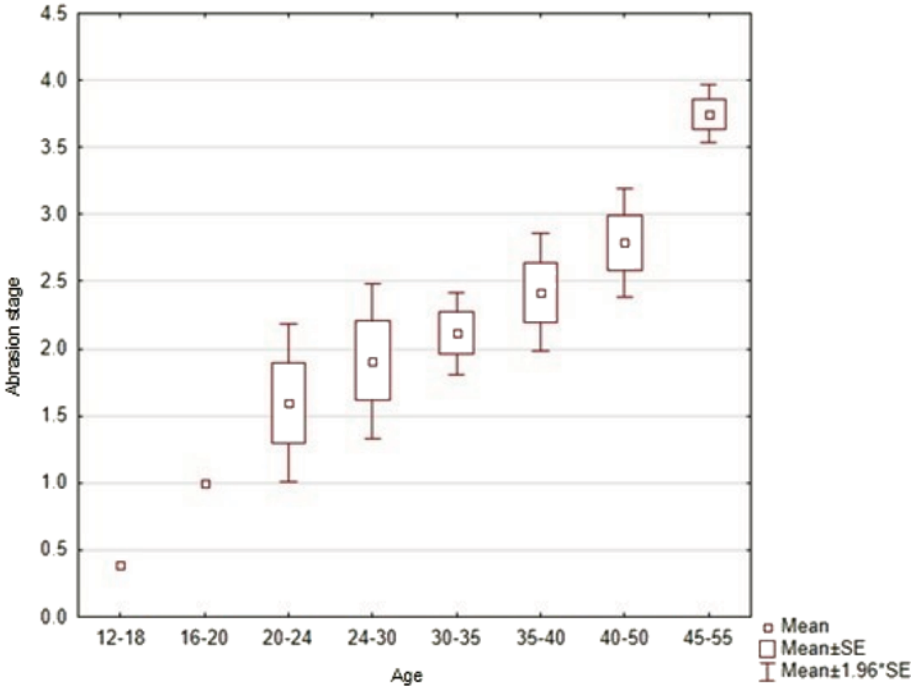

Fig. 4. Average degree (arithmetic mean, standard error and 95% range of standard error) of tooth wear of all teeth of individuals by age (F = 12.011, p < 0.001, ANOVA). AM-arithmetic mean, SD-standard deviation, 95% CI – 95% confidence interval of arithmetic mean, N-number of units.

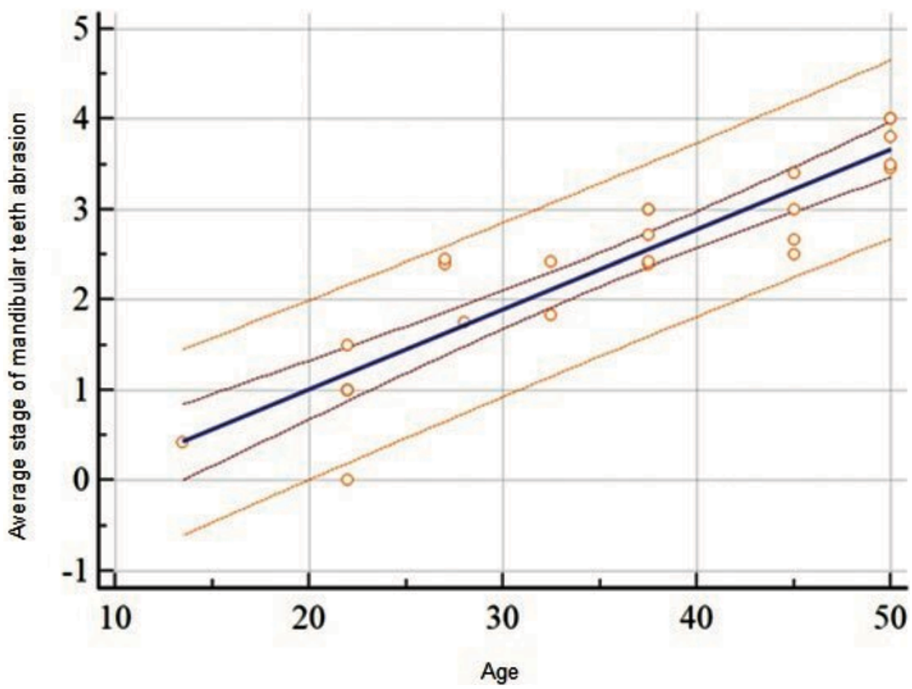

Fig. 5. Relationship between age and average degree of mandibular tooth wear; dashed lines along the central regression line indicate 95% CI of the regression line, and dashed lines wider than the line indicate 95% CI of predictive values (r = 0.935, p < 0.001).

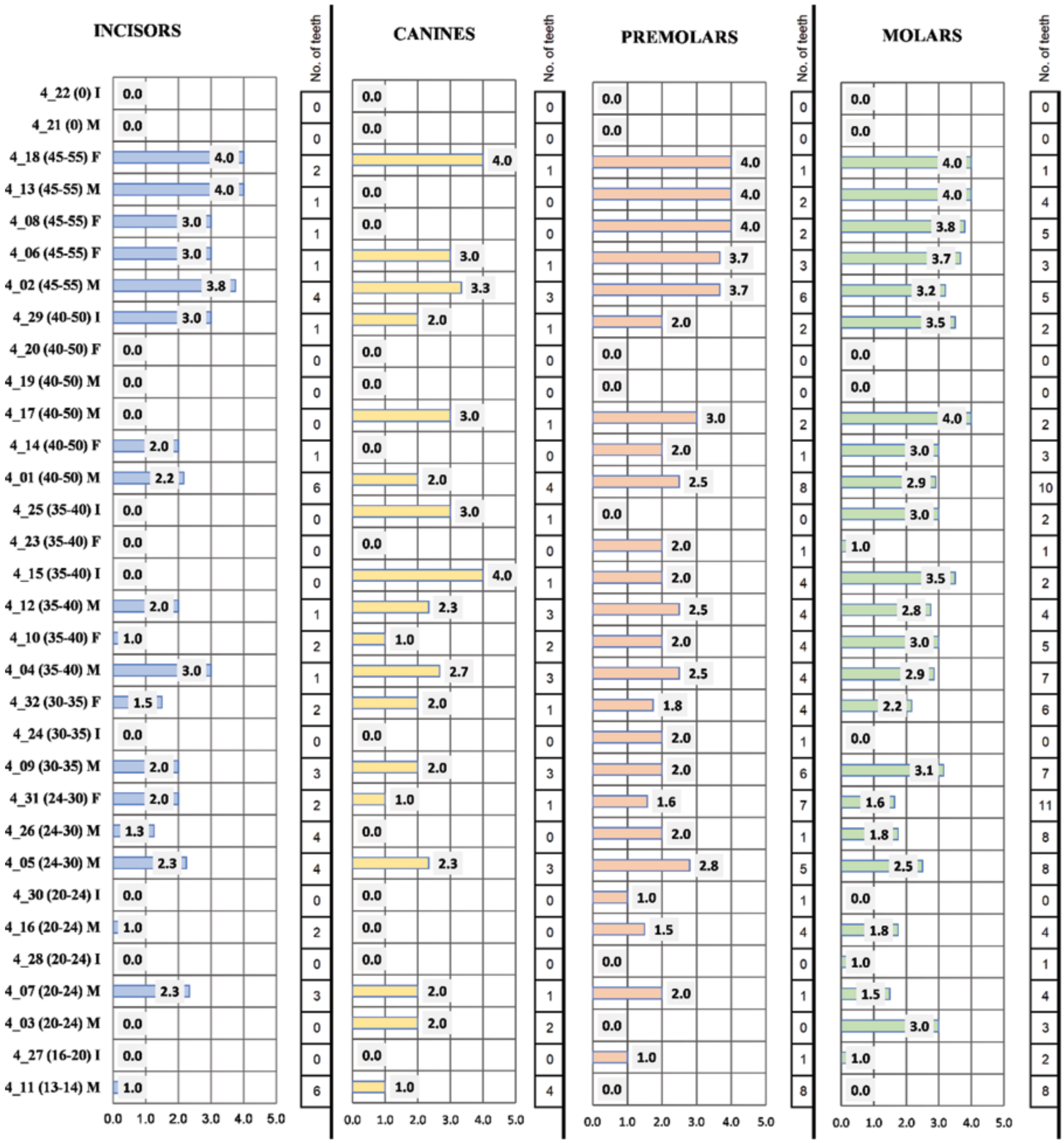

Fig. 6. Degree of tooth wear per unit.

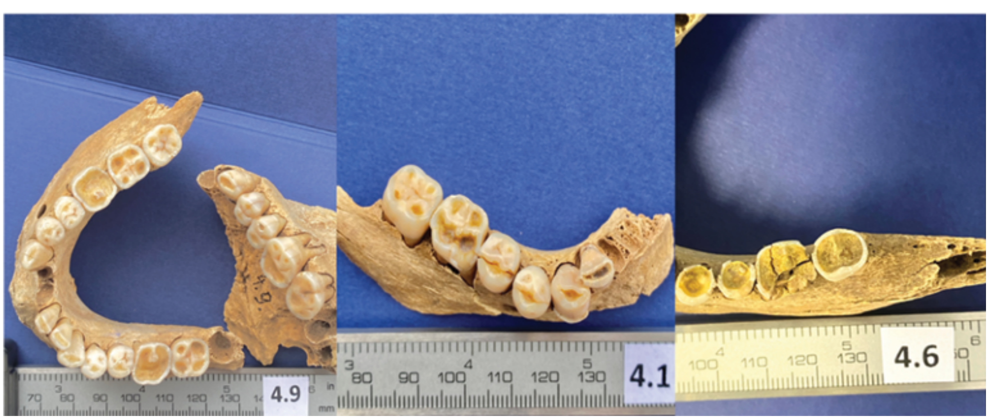

Fig. 7. Very pronounced tooth wear on the occlusal surfaces of permanent teeth.

Depending on the type of food and the way it is prepared, there are variations between different population groups, especially noticeable after the "first food revolution", which followed the transition from hunting-gathering lifestyle to agricultural. In the new era after the industrial revolution, the "second food revolution" followed, when the consumption of soft, processed foods increased, which was reflected in the reduction of total dental wear (Molnar 1972; d'Incau et al. 2012; Radović & Stefanović 2013). In 1984, Smith, by studying the differences in wear patterns between hunting and gathering and agricultural communities came to the conclusion that there was certain regularity in the angle of wear of teeth, which occurs due to the composition and method of food preparation. Thanks to the chewing of hard, fibrous food, where the teeth do not make frequent mutual contacts during mastication, flat molar wear develops, which is typical of hunting and gathering communities. Agricultural communities that prepare food mostly by cooking and grinding, and the teeth are in contact for a long period of time, develop oblique molar wear (Smith 1983; Forshaw 2015). The Kopila population mostly shows sloping molar wear; hence we can conclude that they belonged to the agricultural community.

The incidence of carious changes is a good indicator of dietary differences within a single population or between different population groups. Although the etiology of caries includes several interacting causes, such as bacterial plaque, nutritional elements, tooth structures, saliva composition, etc., studies carried out on ancient populations indicate that carbohydrate diet and food preparation play a major role in the formation of carious lesions (Šlaus 2006; Forshaw 2014; Duyar & Erdal 2003). Hunting and gathering populations are thought to have a lower incidence of caries due to lower carbohydrate consumption, while switching to a sedentary, agricultural lifestyle brings a diet richer in carbohydrate and plant foods, and changes in food preparation, resulting in a higher incidence of caries (Manzi et al. 1999; Duyar & Erdal 2003; Šlaus 2006; Novak et al. 2007; Vodanović 2008; Lanfranco & Eggers 2010; Radović & Stefanović 2013; Forshaw 2014; Forshaw 2015). In the Kopila population, which was primarily agricultural, the incidence of caries is relatively low; it is more frequent in older members of the community where the size of the lesion is more pronounced. This can also be attributed to the pronounced tooth wear, which is also present in young people. Molar wear can theoretically eliminate fissures and thus remove carious tissue, but then the wear must be very rapid to exceed the rate of caries development. However, it is possible that due to strong masticatory forces, cracks in the enamel and dentin occur, which can lead to the penetration of caries into the deeper structures of teeth. Accelerated and strong attrition increases the likelihood of tooth root caries because it leads to exposure of the root surface due to continuous eruption (Hilson 2001). In the Kopila population, root caries is not very pronounced, which can be explained by the fact that the food they consumed had little cariogenic potential. The greater the cariogenic potential of food, the greater the chance for caries to develop in sites other than the occlusion fissures of teeth. If the intake of carbohydrate food is higher and more frequent, carious lesions will develop faster and will cause greater destruction of the tooth tissue. Also, an increased cooking temperature and more processed foods lead to greater cariogenicity and smaller abrasiveness (Lanfranco & Eggers 2010).

Increased wear of tooth enamel can also be influenced by various inorganic particles in the environment such as silicate phytoliths that are present in some plants or gravel grains in shells, and the use of teeth as tools (Forshaw 2014). Forshaw (2009) described the impact of the action of inorganic particles found in bread and desert sand particles causing considerable wear of the teeth of the ancient Egyptians. Larsen (1985) observed changes in the anterior teeth of eldery Aboriginal adults caused by the use of teeth as a tool in the construction of baskets and nets. Berbesque et al. (2012) described gender differences in tooth wear in the Hadza hunting-gathering group, where women spent more teeth eating roots.

It is known that the Illyrian population first used the rotary grinder for grinding grain only with the arrival of ancient Greeks, and the grain was ground by hand stone grinding before that period. Food was prepared over fire lit on bare ground or on a simple ceramic or untreated stone base, often using peka, massive lids made of baked clay (Stipčević 1991). This leads us to the conclusion that it is possible that a larger number of inorganic particles from the environment led to accelerated tooth wear. Occlusive traumas caused by long-term chewing of hard, fibrous foods are also indicated by pronounced dehiscence in men of older age groups (Jorgić-Srdjak et al. 1998; Šlaus et al. 2011).

Studying the Etruscan-Celtic population from the necropolis of Monte Bibele, Italy, from 4th–3rd centuries BC, Gualandi (1992) found a relatively low incidence of caries (11.92%), with twice as much interproximal caries as occlusal and heavy tooth wear (grade 4) in degree in 30.41% indicating a diet of carbohydrate foods, rich in abrasive particles from the environment. Massoti et al. (2013) also found slightly higher rates of caries (26.2%), calculus (73.7%), and tooth wear (98.7%) due to the consumption of seafood, fish and shellfish, as well as flour, coarsely ground with stone mills in the Etruscan community of Spina. Unlike the Etruscans, the Scandinavian population from Alvastra, Sweden, shows a frequency of 92.6% of caries incidence and a diet rich in starchy, sticky foods (Liebe-Harcort 2012). The first insight into the dental health of the Iron Age population of South Africa from Zambia is provided by the study of Gibbon & Grimoud (2012). The mixed economy population shows an indication of caries of 11%, calculus of 8%, and tooth wear of 58%. The wear on the front teeth is flatter and more pronounced, indicating the use of teeth as tools. The study indicated that they consumed hand-ground cereals and brushed their teeth with herbal chewing sticks (Gibbon & Grimaud 2012).

In the analysis of prehistoric communities, the exact chronological age of the individual is not as important as in modern forensic cases, where an accurate age determination is important for determining the identity of the deceased. Biological age depends on genetic and environmental factors, and accordingly on physical activity. Furthermore, health, and diet can influence changes in the age rate of various tissues, including bone and skeletal. Since these influences may vary among individuals, those of the same chronological age within a single population may exhibit different biological ages. Therefore, biological age is calculated at certain intervals, depending on the method, usually 5–10 years (Schmidt 2008; Garvin et al. 2012).

The average life expectancy of a certain population in an area can be longer or shorter, depending on the socio-economic living conditions. If the average life expectancy of a population is shorter, it is likely that community lived in poorer living conditions (Manzi et al. 1999).

Deevey (1950) found that the average life expectancy in ancient times in the Greek population was about 35 years, while among the Romans it was about 32 years. Garland (1990) claimed that the average age of the ancient Greeks was "well below fifty". However, it should be taken into account that these studies included children, infants and early childhood, and victims of various accidents and violent deaths due to war. Montagu (1994) found that those who survived the sensitive years of early childhood and in ancient times could experience a greater old age. Therefore, he considered that it would be better to distinguish between the terms "life span" and the term "length of life". Life span is defined as the maximum age above which an individual cannot live even in the most favorable conditions. It is probably in the range of 115–120 years, and has not changed since the beginnings of known history. Length of life, however, varies among populations depending on environmental conditions (Montagu 1994). With the rise of civilization, life expectancy has increased (Angel 1947).

The Kopila population of the Illyrians buried in tomb 4 had an average life expectancy of 35.6 (± 3.1) years, which is the usual age for the Late Iron Age. The remains of weapons were found along with several skeletons of the deceased, and they were probably the soldiers killed in battles. Since the soldiers are mostly younger men, it is likely that their age had an impact on reducing the average life expectancy of the study population.

Conclusion

The analysis of the dental macrowear showed that frequent and extensive abrasions possibly indicates that diet of the inhabitants was rich in less-cariogenic, poorly processed and abrasive food, which required stronger masticatory forces.

The method of food preparation and various inorganic particles in the food resulted in increased wear of tooth structures. Wear is also present in the young population, while in the elderly it is more pronounced on all teeth and to a greater extent. Since the female members of the community buried in this tomb are mostly elderly, we could not determine with certainty the differences between the sexes. Dental age based on macroabrasion of dental surfaces suggests that the inhabitants of the Kopila necropolis wear aged 30–40 years at the time of death, and the analysis of the stable isotope ^{14}C confirmed a lifetime of 4th to the 1st century BC. Further studies should include more accurate and standardized methods for assessing the condition.

Compliance with ethical standards

This research was approved by the Ethics Committee of the School of Dental Medicine, University of Zagreb at the 18th regular session held on June 4th 2020, decision number: 05-PA-30-XVIII-6/2020.

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