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Dental health indicators of the Chernyakhov population from Shyshaki (Ukraine)

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ABSTRACT: Odontological studies of ancient populations represent different indicators related to health state, lifestyle and human diet. The aim of this paper is to determine the dental health indicators in the Chernyakhov population (the end of the IVth c. AD) from Ukraine. The paper also attempts to identify the relationship between sex and these indicators in the studied population. The sample analysed consisted of the dental remains of 25 adult individuals (11 males and 14 females) and 8 children individuals excavated from the cemetery at the archaeological site of Shyshaki (Poltava region of Ukraine). A total of 760 teeth were examined for caries, tooth wear and calculus clinically, and 647 teeth of adults were observed radiographically. The studied population presents frequency of caries in individuals of 12.5%. This indicator in adult male and female dentition is 42.86% and 14.0% respectively, and 25% in children. The presented population frequency of caries teeth was 0.88%. Females presented higher caries rate than males (2.72 % females vs. 0.36 % males) ($p<0.05$). The most frequent were caries lesions of cementum-enamel junction (40%) and combined lesions of crown and root (40%) with no difference in terms of sex. Frequency of dental wear in adult individuals and 8-10 year-old individuals was 100%. The studied population represented TWI (tooth wear index) in adults (2.26), which increased with aging, but the difference in terms of sex is insignificant. Calculus was observed in 64.28% of the females and 63.33% of the males, showing no statistical difference ($p>0.5$). These findings confirm a very low rate of caries teeth in the territory of Shyshaki during the Late Roman period, which could be related to regional diet and concentration of fluorine in drinking water. The Chernyakhov population presents high dental wear and similar frequency of dental calculus when compared to the population from Roman Britain. Females presented significantly higher frequency of caries than males, whereas no significant sex differences were found regarding dental wear, calculus, and localisation of caries lesions. The authors presume that dental health indicators in the Chernyakhov culture need to be studied more with bigger sample size and data of the populations from other regions of Ukraine.

KEY WORDS: dental anthropology, caries, toot wear, calculus, Chernyakhov culture

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Introduction

Odontological studies of ancient populations represent different indicators related to health state, lifestyle and diet of humans, and dental caries is the most visible from them (Lanfranco and Eggers 2012). The social and cultural environment has an impact on human health diet and activity, and differences in oral health between the sexes in different ancient populations could been interpreted with reference to diet (Klaus and Tim 2010; Miliauskienė and Jankauskas 2015; Michael et al. 2017).

Carbohydrates and bad oral hygiene facilitate plaque accumulation on teeth, but caries demineralization develops only with decrease in enamel resistance. Enamel resistance falls due to low fluorine content in drinking water, and diet misbalanced with minerals (Fejerskov et al. 2008). Therefore, caries rate increases in regions with low fluorine content in drinking water (Ramezani et al. 2015). Moreover, dental indicators such as tooth wear is related to caries development. Tooth wear does not only reflect ageing and food durability, but also changes the character of plaque accumulation on teeth (Esclassan et al. 2009). Calculus as a dental indicator is interpreted in terms of oral hygiene and diet; high calculus/low caries rate as evidence for a high protein diet (Lillie 1996), while elevated calculus and caries rates have been linked to carbohydrate-rich diets (Humphrey et al. 2014).

There is limited research on dental health indicators of ancient populations living in the territory of present-day Ukraine (Lillie 1996; Arnold et al. 2007; Karsten et al. 2015; Yanko et al. 2017). The authors were interested in the local ancient population from Shyshaki (Poltava region) which belongs to the Chernyakhov culture living in the territory of the Eastern Europe in the Late Roman period.

The Chernyakhov (Santa-de-Mures) culture subsisted in a wide area of Ukraine, Poland, Moldova and Romania for a short historical period between the III^{d} and Vth cc. and strongly influenced the development of the Slavs. The Goths migrated to Scythia in the II^{d}–III^{d} cc. AD after the fall of Roman Empire and nearly became a dominant force in the Chernyakhov culture (Gwinn 2017). The aboriginal population from the Ukrainian area represented by the early Slavs, Sarmatians, and late Scythians (Magomedov 2001) accepted the achievements of Roman material culture – glass, pottery, jewellery production, metallurgy of ferrous metals, burning charcoal and lime, and others (Liubychev 2019; Petrauskas et al 2019); but archaeological and palaeoenvironmental evidence did not document changes in the dietary habits after the Goths appearance. The time of the Chernyakhov culture was characterized by flourishing agriculture in its territory when land farming was simplified by the use of a plug with a steel tip (Zynkivskaya 2013). Gorbanenko (2014) claims that a 1/4 of grains found in the soil were barley; rye and emmer wheat each made up approximately 1/5 of grains; common wheat was nearly a 1/6; and millet was less than a 1/7. During that period the Chernyakhov people applied mill stones for grain grinding, which were borrowed from the Roman Empire, and produced more refined food than previously used stone mortar and pestle. Animal husbandry, as revealed by survival of bone remains, seemed to favour cattle, sheep, goat and pig breeding (Shyshkyn 1999).

The Chernyakhov culture used both cremation and inhumation. Moreover, ritual cremations of destroyed burials with skeletal fragments was described in a few populations including the present one (Kokowski 1997; Heiko 2010; Petrauskas 2014). In addition, destruction of skeletons from the studied population relates to grave robberies and economic activity of modern inhabitants. In spite of the fact that the number of skulls could be limited, analysis of dental health indicators allowed the researchers to obtain data not only regarding biological condition, but also the diet of the present population.

The aim of this paper is to determine the dental health indicators in the Chernyakhov population (the end of the IVth c. AD) from Ukraine. The paper also attempts to identify the relationship between sex and these indicators in the studied population.

Materials and methods

Analysed skeletons of the Chernyakhov culture were collected at excavations nearby the town of Shyshaki (Poltava region) in 2012–2016, which were conducted by the staff of the Archaeological Site Preservation and Research Centre (Poltava). The chronological period was defined by archaeologists as the end of the IVth c. AD by the observing the nature of the burials and material culture remains. All the individuals were excavated from the cemetery.

The Chernyakhov culture was presented by 25 skeletons of adults and 8 children skeletons. The general preservation state of the bones and dental pieces was highly variable across individuals, from completely preserved skulls with complete mandibles, to cases where only small fragments of the maxilla or mandible were preserved as defined by Vodanovic et al. (2005). Sex in adults was diagnosed by AAV on the basis of cranial and pelvic morphological features (Buikstra and Ubelaker 1994). Adult skeletal age at death was diagnosed by AAV on the basis pubic symphysis morphology, the auricular surface of the ileum, and the sternal end of the ribs (Byers 2005), which was from 18 to 70 years old. Finally, each adult skeleton was assigned to one of four age categories: 18–25 years old (young adult), 26–35 years old (early middle adult); 36–45 years old (late middle adult) ≥46 years old (mature adult) (Powers 2012). Age of a dead child was determined by dental development (Nelson and Ash 2009) and was from 6 months to 10 years old. Examined children were divided into two subgroups: primary dentition (6 month–2 years old) and mixed dentition (8–10 years old).

AVA and NVY performed the dental examinations. Next categories of missing teeth are recorded as being ante-mortem, post-mortem, and unerupted, Unerupted teeth included impacted and congenitally missing teeth. Caries was diagnosed macroscopically under a bright light, with the help of a dental probe; only presence of cavity was estimated as caries. The location of carious lesions (root, CEJ (cementum-enamel junction), crown), as well as their location on the crown (proximal, labial/buccal, lingual, occlusal surfaces), were analysed. Combined lesions included involvement of root and crown. Frequency of dental caries was calculated for teeth and individuals in %. The authors numbered the teeth according to the Fédération Dentaire International (FDI 1971). Additionally, dental radiographic examinations were performed in adult individuals after the clinical ex-

amination using retroalveolar X-ray films for maxilla and panoramic X-ray films for mandible. All upper teeth were radiographed by groups of three anterior or two posterior teeth.

Dental wear was recorded in adults according to Smith and Knight tooth wear index (TWI) (1984), which includes 5 scores. Score 0 represented no wear, score 1 represented slight loss of enamel surface, score 2 represented exposing dentine for less than one third of surface, score 3 represented exposing dentine for more than one third of surface, and score 4 represented complete dentine loss–pulp exposure. Dental calculus accumulation was evaluated macroscopically and calculated for individuals in %.

The Chi-square test was used to explain the significant differences in caries frequencies and dental calculus. Tooth wear was expressed as the mean±standard deviation where p values were based on a one-sided Student`s t test of statistical significance. The results were classified as statistically significant if $p < 0.05$.

Results

From the 760 teeth examined, 280 belonged to males, 367 to females, and 113 to children. The minimum number of teeth presented for one adult individual was 12 and the maximum 29. Antemortem loss included 50 teeth in adults (6.33%) (28 female teeth and 22 male teeth). Four impacted and two congenitally missed teeth third molars were confirmed by X-ray radiographs. Postmortem tooth loss was 49 female teeth, 52 male teeth and 10 children teeth (12.07%). The information on sex, age, number of individuals and present teeth, and frequency of caries in the Chernyakhov population is shown in Table 1.

Adults showed caries frequency in teeth at 1.7% vs children – at 0.88% ($\chi^2 = 0.41$, df = 1, p = 0.5). This indicator was in individuals 28% and 12.5% accordingly ($\chi^2 = 8.76$, df = 1, p = 0.003). Females showed caries frequency in individuals at 42.86% vs males – at 9.09% ($\chi^2 = 97.4$, df = 1, p< 0.0001). Caries frequency in teeth is 2.72% in females

Table 1. Sex, number of individuals and teeth examined in this study, and caries frequency

Sex	Age of individuals	Number of individuals	Caries frequency in individuals, %	Teeth present	Caries frequency in teeth, %
Female	18–25 years	5	1 (20.00)	136	2 (1.41)
	26–35 years	3	1 (20.00)	89	1 (1.05)
	36–45 years	2	2 (40.00)	49	5 (9.43)
	46–65 years	4	2 (40.00)	93	2 (2.02)
In total		14	6 (42.86)	367	10 (2.72)
Male	18–25 years	3	0	82	0
	26–35 years	1	0	24	0
	36–45 years	3	0	89	0
	46–69 years	4	1 (25.00)	85	1 (1.10)
In total		11	1 (9.09)	280	1 (0.36)
Both sexes		25	7 (28.00)	647	11 (1.70)
Children	6 months–2 years	4	0	29	0
	8–10 years	4	1 (25.0)	84	1 (1.19)
In total		8	1 (12.5)	113	1 (0.88)

and 0.36% in males, showed significant statistical difference (χ^2 = 5.29, df = 1, p = 0.02). There was no statistical significance between age groups in frequency of caries teeth. The information on sex, age, number of individuals, location of caries on individual tooth surfaces in the Chernyakhov people is shown in Table 2.

The Chernyakhov population represents two crown caries, therefore, proximal, labial/buccal, lingual, occlusal localisations of caries were united into location on the crown. Female teeth present CEJ caries lesions (40%), as well as crown lesions (10%), root lesions (10%), and combined lesions (40%), were spread from enamel to cement of root (Fig. 1). Only one male presented a combine caries lesion, also one child had lesion on proximal surface.

The information on sex, age, number of presented teeth, dental wear in adults in the Chernyakhov population is shown in Table 3. Frequency of tooth wear in the permanent dentition (adults) and mixed dentition (8–10-year-old children) was 100%. 6-month-old to 2-year-old children (primary dentition) did not have tooth wear. The studied population represented a high TWI in adults (2.26). χ^2 test showed that the mature females had statistically significant dental wear (χ^2 = 47.65, df = 1, p< 0.0001) than

Fig. 1. Fragment of maxilla of 40–45-year-old woman from burial 150: 1 – combined caries lesion in the 16 tooth, 2 – CEJ lesion in the 17 tooth

Table 2. Location of caries on individual tooth surfaces in the study sample

Gender	Age of individuals	Location on the crown		Root		CEJ		Combined	
		n	%	n	%	n	%	n	%
Female	18–25 years	0	0	0	0	0	0	2	100
	26–35 years	0	0	0	0	0	0	1	100
	36–45 years	1	20	0	0	3	60	1	20
	46–65 years	0	0	1	50	1	50	0	0
In total		1	10	1	10	4	40	4	40
Male	18–25 years	0	0	0	0	0	0	0	0
	26–35 years	0	0	0	0	0	0	0	0
	36–45 years	0	0	0	0	0	0	0	0
	46–70 years	0	0	0	0	0	0	1	100
In total		0	0	0	0	0	0	5	50
Both sexes		1	9.09	1	9.09	4	36.67	5	45.55
Children	6 months–2 years	0	0	0	0	0	0	0	0
	8–10 years	1	100	0	0	0	0	0	0
In total		1	100	0	0	0	0	0	0

Table 3. Sex, number of teeth examined in this study, and tooth wear index (TWI)

Sex	Age of individuals	Teeth present	TWI, score (M±m)
Female	18–25 years	136	1.29±0.38
	26–35 years	89	1.90±0.07
	36–45 years	49	2.88±0.39
	46–65 years	93	3.18±0.05
In total		367	2.13±0.99
Male	18–25 years	82	1.09±0.36
	26–35 years	24	2.0±0.13
	36–45 years	89	2.92±0.03
	46–70 years	85	3.19±0.05
In total		280	2.39±0.06
Both sexes		647	2,26±0.46
Children	6 months–2 years	29	0
	8–10 years	84	0.62±0.06

young females; the same results were obtained for the males (χ^2 = 53.41, df = 1, p< 0.0001). Tooth wear was not different between males and females (p>0.5). In the 8–10-year-old children (mixed dentition) TWI was 0.62. In children, the most pronounced tooth wear with dentine exposed was observed in primary molars and canines, and enamel of the first permanent molars which showed slight attrition. Caries lesion was found in dentin exposed by wear in 40–45-year-old women. Calculus was observed in 64.28% (9/14) of the females and 63.33% (7/11) of the males, showing no statistical difference (p>0.5). The children did not present dental calculus.

Table 4 compares data (frequency of caries and calculus) from Shyshaki to data from the Early Iron Age (the 6th–5th cc. BC) sites in Ukraine (Kaskova et al 2019), and data collected from the same period (the 3d–5th AD) in England (Bonsall (2005). Data of adult individuals are compared.

The Scythian population presented lower frequency of caries teeth (0.15%) than the Chernyakhov population (1.70%) (χ^2 = 45.27, df = 1, p<0.0001). Frequency of caries teeth in the sub-Roman population (8.98%) was significantly higher compared to the Chernyakhov population (χ^2 = 39.87, df = 1, p<0.0001) and the Scythian population

Table 4. Frequency of dental caries and calculus in adults of the compared populations

Period, place	4th–5th c. AD, Ukraine*		6th–5th c. BC, Ukraine[1]		3rd–5th c. AD, England[2]	
	Females	Males	Females	Males	Females	Males
Frequency of caries teeth, %	2.72	0.36	0.08	0.21	9.4	8.7
Total frequency of caries teeth, %	1.70		0.15		8.98	
Frequency of calculus in individuals, %	64.28	63.63	9.0	11.0	39.1	64.3
Total frequency of calculus in individuals, %	64.0		10.0		53.26	

* present data, [1] Kaskova et al. 2019, [2] Bonsall 2005.

(χ^2 = 458, df = 1, p<0.0001). Difference in frequency of calculus in individuals between the Chernyakhov population (64.0%) and the population from Roman Britain (53.26%) was not statistically significant (p = 0.3). The frequency of calculus in the Scythian population was lower (10%) than in the sub-Roman population (p<0.0001) and the Chernyakhov population (p<0.0001). The Scythian population had similar caries and calculus rates in terms of sex (p>0.2). In Roman Britain the males had higher calculus rate than the females (χ^2 = 12.43, df = 1, p = 0.0004), but similar caries rate (p>0.5).

Discussion

The study of dental health in ancient populations can provide important information on past dietary habits and environment impact, especially if the teeth keep relatively well in archaeological contexts. There have been numerous bioarchaeological studies of caries as an indicator of past diet (Hillson et al. 2013; Bonsall 2014; Forshaw 2014; Tosso et al. 2019).

We have suggested that agricultural intensification recorded in the area of the Chernyakhov culture (Zinkovskaya 2015; Gwinn 2017) might have provoked increase in caries rate as happened in the Late Medieval population from Poland during intensification of agricultural production (Tomczyk et al. 2020). Diet of the Chernyakhov people mostly consisted of cereals and meat of domestic animals. However, despite the fact that frequency of caries teeth in the adult Chernyakhov population (1.7%) was bigger compared to the Scythian population, which lived earlier in same area (0.15%) (p<0.0001), these indices were very low. Same very low frequencies of caries teeth were found in children from the Chernjakhov (1.26%) and the Scythian population (0.26%) (Yanko et al 2017). Consequently, the authors suggested that caries rates in the compared populations were not only attributed to the consumption of carbohydrates, but also to the fluorine concentration in drinking water and dental wear.

Poltava region has areas with different level of fluorine in aquifer, and present-day concentration of fluorine in drinking water in Shyshaki reaches up 3 mg/l (high level) (Toronchenko 2013). In addition, Kaskova et al (2011) found that frequency of caries in modern adolescents from areas with high fluorine concentration of 54% was lower than in adolescents from areas with low fluorine concentration in drinking water (74.5%). That concentration of fluorine in aquifer has not changed since ancient times. Mentioned Scythian population inhabited areas with high and normal concentration of fluorine in drinking water. Frequency of caries teeth in the British population (8.98%) in same late Roman period (Bonsall 2015) was higher compared to the Chernyakhov population (p<0.0001).Present-day drinking water in Ancaster and Winchester (England) has a low level of fluorine (drinking water quality information). Thus, the authors suggest that very low caries frequency in the studied Chernjakhov population was attributed with high concentration of fluorine in drinking water in Shyshaki. In addition, caries frequency of the present population may have been smaller than this indicator in other populations from the same culture from the territory of Ukraine.

Frequency of caries teeth in the Chernyakhov females was significantly higher than in males (p<0.05) (Table

1). However, this sex difference was not attributed to the factors of age or tooth loss in mature adult category, where males and the females presented almost the same number of tooth loss (46 male teeth vs. 50 female teeth). Higher rates of caries among females may hint at some difference in carbohydrates being consumed. The compared Scythian and sub-Roman populations did not demonstrate sex differences in caries frequencies (Table 4).

In the Chernyakhov population, a male presented a combined caries lesion; 88.88 % of the females presented CEJ and combined lesions, 11.11% of females presented crown caries, and 11.11% root caries. One 9–10-year-old child had proximal caries localisation that is typical for this age due to physiological spaces between primary teeth, but the number of children was too small (n = 8). Our findings are consistent with data of the Scythian population from the area of Ukraine where 100% of females and 89% of males presented combined lesions (Kaskova et al. 2019). The rate of CEJ showed the highest prevalence (33.33%) in the Ancaster and Winchester populations. It should be noted that inhabitants of Roman Britain had a predominantly cereal-based diet in that period (Britton and Huntley 2011). In later ages, consuming food rich in simple sugars usually accompanied increase in caries rate, and occurrence of occlusal and approximal lesions (Lanfranco and Eggers 2012). The authors explain occurrence of CEJ and root lesions by plaque accumulation in the cervical part of crown, which causes gum recession and caries development in these areas.

The fact that adults in the Chernyakhov population present a few caries lesions in the crown (Table 3) could be explained by dental wear. The authors note the high degree of dental wear in the Chernyakhov adult individuals (2.26) compared to data of contemporary population (Wetselaar et al. 2016). There was no significant difference between males and females for tooth wear which may be related to the diet of the studied population. It is clear, that 6-months-old to 2-year-old children were breast fed and did not have tooth wear. In 8–10-year-old children, this indicator showed both physiological attrition and impact of the diet. Also age-related increase was found in tooth wear among both sexes. Despite dental wear, fissure caries may occur in young and early middle adults and persist in the mouth long enough to initiate the development of large cavity. However, one late middle female in this study had caries lesion of dentine exposed by wear. In addition, fissure caries was not detected in mature adults (Table 2), when defective fissures and cervical surfaces could have been worn away due to intense attrition.

Adults in the studied population showed calculus frequency (64.0%) comparable to the population from Roman Britain (53.26%) with no difference in terms of sex (Table 4). However, males in the sub-Roman population from Britain (Bonsall 2015) experienced higher calculus rates than the females, which could be explained by possible differences in fluid consumption or greater consumption of silica-rich foods. Frequency of calculus among Scythians was lower (10%) than in the Chernyakhov population. However, calculus could have been removed during excavation. There were no sex differences in calculus rate in the Scythian population ($p>0.1$). Thus, the authors did not identify the relationship between sex and tooth wear, sex

and dental calculus in the Chernyakhov population. In addition, the number of examined samples was not enough to ensure age-related increase in frequency of caries and dental calculus.

Unfortunately, there are no isotope evidences about the diet in the Chernyakhov culture. The results originating from Neolithic settlement Çatalhöyük (Agarwal et al 2015), where isotope evidence indicated similar diets of males and females, did not present sex difference in the caries. However, researchers, who found that females from different historical populations consumed a small amount of protein (Toso et al. 2019) or more millet items (Dotsika et al. (2018) than males, could not declare sex difference in caries rate due to small sample sizes. Therefore, to understand better the relationship between sex and dental health indicators it is important to study enough sample sizes and conduct isotope analysis of their remains to elucidate diet.

Studies conducted in skeletal populations in their archaeological and anthropological context can substantially enrich our understanding of past human societies. If extra data is collected from other regions of Ukraine where the Chernyakhov culture existed, this study could be used for further investigation of the effect of diet and concentration of fluorine in drinking water on caries in ancient populations.

Conclusions

These findings confirm a very low rate of caries teeth in the territory of Shyshaki during Late Roman period, which could be related to regional diet and concentration of fluorine in drinking water. The Chernyakhov population presented a high dental wear, similar frequency of dental calculus when compared to the population from Roman Britain. Females presented significantly higher frequency of caries than males, whereas no significant sex differences were found regarding dental wear, calculus, and localisation of caries lesions. The authors presume that dental health indicators in the Chernyakhov culture need to be studied more with bigger sample size and data of the populations from other regions of Ukraine.

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The Author's contribution

NVY conceived of the paper aim and design, served as principal investigator for the research project, wrote the draft and approved the final version; AVA served as an investigator for the project and was involved in grafting the manuscript; LFK analysed data and grafted the manuscript; All authors contributed to approved, final version of the manuscript

Conflict of interest

The authors declare no conflict of interest.

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References

Agarwal SC, Beauchesne P, Glencross B, Larsen KP, Meskell L, Nacamura C, et al. 2015. Chapter 7. Roles for the sexes. The (Bio) archaeology of women and men at Çatalhöyük. In: I Hodder and A Marciniak, editors. Assembling of Çatalhöyük. Leeds: Maney. 87–95.

Arnold, W.H., Naumova, E.A., Koloda, V.V., Gaengler, P. 2007. Tooth wear in two ancient populations of the Khazar Kaganat region in the Ukraine. Int J Osteoarchaeol, 17:52–62.

Bonsall L. 2014. A comparison of female and male oral health in skeletal populations from late Roman Britain: implications for diet. Arch Oral Biol 59:1279–300.

Britton K, Huntley J. 2011. New evidence for the consumption of barley at Romano-British military and civilian sites, from the analysis of cereal bran fragments in faecal material. Veget Hist Archaeobot 20:41–52.

Buikstra JE, Ubelaker D. 1994. Standards for data collection from human skeletal remains, Arkansas. Archaeological Survey Research Series No 44. Arkansas: Fayetteville.

Byers SN. 2005. Introduction to forensic Anthropology: A Textbook. London: Pearson.

Dotsika E, Michael DE, Iliadis E, Karalis P, Diamantopoulos G. 2018. Isotopic reconstruction of diet in Medieval Thebes (Greece). J Archaeol Sci: Reports 22:482–91.

Drinking water quality information. Available at: http://waterquality.anglianwater.com/map.aspx.

Esclassan R, Grimoud AM, Ruas MP, Donat R, Sevin A, Astie F, et al. 2009. Dental caries, tooth wear and diet in an adult medieval (12th–14th century) population from mediterranean France. Arch Oral Biol 54:287–97.

Fejerskov O, Nyvad B, Kidd EAM. 2008. Dental caries. The disease and its clinical Management. 3ed. Wiley-Blackwell.

Forshaw R. 2014. Dental indicators of ancient dietary patterns: dental analysis in archaeology. Br Dent J 216:529–35.

Gorbanenko SA. 2014. Paleoetnobotanichni dani z poselennya chernyaxivs`koyi kul`tury` pobly`zu s. Komariv (za rezul`tatamy` flotaciyi) [Palaeoethnobotanical data from Cherniakhiv culture's settlement near the village Komariv (based on flotation)]. Arheologichni doslidzhennya L`vivs`kogo universy`tetu [Archeological studies of Lviv university] 18:261–72.

Gwinn DM. 2017. The Goths. Lost Civilizations. Reaktion books.

Heiko A.V 2010. Rozkopki mogilnika chernyahivskoyi kulturi Shishaki u 2009 r. Arkheolohiya i davnya istoriya Ukrayiny [Archaeology and ancient history of Ukraine] 4:222–5.

Hillson SW, Larsen CS, Boz B, Pilloud MA, Sadvari JW, Agarwal .SC., et al. 2013. Chapter: 17. The human remains I: Interpreting community structure, health and diet in Neolithic Çatalhöyük. In: Ian Hodder, editor. Humans and Landscapes of Çatalhöyük: Reports from the 2000–2008 Seasons. Cotsen Institute of Archaeology/ British Institute at Ankara. 339–96.

Humphrey LT, De Groote I, Morale, J, Barton N, Collcutt S, Ramsey CB, et al. 2014. Earliest evidence for caries and exploitation of starchy plant foods in Pleistocene hunter-gatherers from Morocco. PNAS 111:954–59.

Karsten J, Heins, S, Madden G, Sokhatskyi M. 2015. Dental health and the transition to agriculture in prehistoric Ukraine: A study of dental caries. Eur J Archaeol 18:562–79.

Kaskova LF, Levchenko NV, Andriianova OYu, Amosova LI, Morhun NA, Abramova OE, et al. 2011. Epidemiolohichni doslidzhennia – osnova planuvannia zakhodiv profilaktyky stomatolohichnykh zakhvoriuvan u ditei [Epideomiological studies are the base for planning of dental diseases prevention in children]. Ukrainian Dental Almanac 2:25–6.

Kaskova LF, Chupryna LF, Morhun NA, Polesskyi MV, Artemiev AV. 2019. Karies

naseleniya rannego zheleznogo veka Poltavskoj i sopredel'nyh oblastej kak otrazhenie social'nyh aspektov byta [Caries of the Early Iron century population of Poltava and correlated areas as reflection aspects of social life]. Ukrainian Dental Almanac 1:31–6.

Klaus HD, Tam ME. 2010. Oral health and the postcontact adaptive transition: A contextual reconstruction of diet in Mórrope, Peru. Am J Phys Anthropol 141:594–609.

Kokowski A. 1997. Die Maslomecz-Gruppe. Ihre Chronologie und Beziehungen innerhalb desgotischen Kulturkreises. Ein Beispiel für den kulturellen Wandel der Goten im Verlaufihres Wanderungen. BRGK 78:642–748.

Kubehl K, Temple DH. 2020. Reproductive life histories influence cariogenesis: Exploring sex-specific variation in dental caries and survivorship in the human past. Am J Phys Anthropol 172:376–85.

Lanfranco LP, Eggers S. 2012. Caries through time: an anthropological overview. In: Ming-Yu Li, editor. Contemporary Approach to Dental Caries. InTech. Available at: www.intechopen.com/books/contemporary-approach-to-dental-caries/caries-archaeolo-gical-andhistorical-record.

Lillie M. 1996. Mesolithic and Neolithic Populations of Ukraine: Indications of Diet From Dental Pathology. Curr Anthropol 37:135–42.

Lyubichev MV. 2019. Rannyaya istoriya dnepro-donetskoy lesostepi I–V vekov [Early history of Dnieper-donetsk forest-steppe in the I–V centures]. Part 1. Kharkiv: Esthet print.

Magomedov BV. 2001. Chernyahovskaya kultura. Problema etnosa [Chernyakhov culture. Problem of ethnos].. Monumenta Studia Gothica. Lublin: UMCS.

Michael D, Iliadis E, Manolis SK. 2017. Using dental and activity indicators in order to explore possible sex differences in an adult rural medieval population from Thebes (Greece). Anthropol Rev 80:427–47.

Miliauskienė Ž, Jankauskas R. 2015. Social differences in oral health: Dental status of individuals buried in and around Trakai Church in Lithuania (16th–17th c.c.). Anthropol Anz 72:89–106.

Nelson SJ, Ash MMJ. 2009. Wheeler's Dental Anatomy, Physiology and Occlusion: 9th Revised ed. Philadelphia: Elsevier.

Petrauskas OV. 2014. Razrushennyie pogrebeniya na mogilnikah chernyahovskoy kulturyi Podneprovya – analiz arheologicheskoy strukturyi [Die zerstörten Bestattungen auf den Gräberfelden der Černjachov-Kultur aus dem Dnepr-Gebiet – ein Analyse der archäologischen Strukturen]. In: G. Ivakyn, editor. Vid Venediv do Rusi [From Venedi to Rus]. Kyiv: IA NASU. 125–52.

Petrauskas O, Avramenko M. 2019. The settlement Komariv – glass-production centre in the European Barbaricum: a cultural and natural environment. Plural. History, culture, society 2: 68–91.

Powers N editor. 2012. Human osteology method statement. Available at: www.museumoflondon.org.uk/application/files/4814/5633/5269/osteology-method-statement-revised-2012.pdf.

Ramezani G, Valaie N, Rakhshan V. 2015. The effect of water fluoride concentration on dental caries and fluorosis in five Iran provinces: A multi-center two-phase study. Dent Res J (Isfahan) 12(1):31–7.

Smith BG, Knight JK. 1984. An index for measuring the wear of teeth. Br Dent J 156:435–8.

Shyshkin R. 1999. Hospodarsko-ekolohichna model Cherniakhivskoi kultury (za materialamy serednoho Podniprovia) [Economic-ecological model of Chernjachiv culture (according materials from the Middle Dniper region)]. Археология [Archaeology] 4:76–88.

Tomczyk J, Szostek K, Lisowska-Gaczorek A, Mnich B, Zalewska M, Trzeciecki M, et al. 2020. Dental caries and isotope studies in the population of Radom (Poland) between the 11th and 19th centuries. Int J Osteoarchaeol 1–11.

Toronchenko O.M. 2013. Ekolohichne doslidzhennia kontsentratsii ftoru u pytnii vodi Poltavskoi oblasti ta analiz vplyvu na zdorovia naselennia [Ecological study of

fluorine concentration in drinking water of Poltava region and analysis of its impact on health of the population]. World of medicine and biology 42:52–7.

Toso A, Gaspar S, Banha da Silva R., Garcia S, Alexander M. 2019. High status diet and health in Medieval Lisbon: a combined isotopic and osteological analysis of the Islamic population from São Jorge Castle, Portugal. Archaeol Anthropol Sci 11:3699–716.

Vodanović M, Brkić H, Slaus M, Demo Z. 2005. The frequency and distribution of caries in the mediaeval population of Bijelo Brdo in Croatia (10th–11th century). Arch Oral Biol 50:669–80.

Wetselaar P, Vermaire JH, Visscher CM, Lobbezoo F, Schuller AA. 2016. The prevalence of tooth wear in the Dutch adult population. Caries Res 50:543–50.

Zinkovskaya IV. 2015. K istoricheskoy otsenke ostrogotskogo korolevstva Ermanariha [About historical evaluation of ostgoths kingdom of Ermanaric]. Nauchnyie vedomosti. Seriya Istoriya. Politologiya. Ekonomika. Informatika [Scientific records. Series History. Political science. Economics. Informatics] 33:30–9.

Yanko NV, Artemyev AV, Kaskova LF. 2017. Frequency of dental caries in children in the Early Iron Age and the Medieval populations from Ukraine. Anthropol Rev 80:415–26.