DENTAL MACROWEAR EVALUATION OF THE HUMAN SKELETAL SAMPLE DISCOVERED AT THE "VOVIDENIA" CHURCH IN IAȘI (ROMÂNIA) 16TH -17TH CENTURIES

BY
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Abstract:
Teeth are particularly important for paleoanthropological research. The loss of dental tissues in bioarchaeological context can be useful for identifying evidence regarding diet and physical properties of consumed food, including preparation techniques, being influenced by the environment through the ingestion of grit. We present a descriptive analysis of the dental macrowear of the skeleton samples (16th-17th centuries) discovered at the "Vovidenia" Church in Iași during the archaeological excavations preceding its rehabilitation. The degree of dental wear was assessed by the semiquantitative scoring system (Scott's method for recording occlusal molar wear and Smith's method for recording wear in incisors, canines, and premolars), and the quantitative assessment on dentine exposure (image analysis). The scoring system indicates that the analysed teeth showed all three grades of wear (small wear, moderately advanced wear, and advanced wear). We found an increase, with the age, of the dentine exposure percent (PDE) in M2 mandibular molar, in both males and females. Chipping and oblique dental wear were identified in some individuals, mostly in posterior teeth, being probably produced by hard food fragments. The M2 mandibular molar teeth will be included in an overall survey regarding the diet-related dental wear of the past human populations of Iași City.
Keywords: *teeth; dental microwear; human remains; "Vovidenia" Church; 16th-17th centuries; Iași (Romania).*

INTRODUCTION

In an archaeological context, the teeth are excellent biological resources for multidisciplinary research[1]. The survey of dental features represents a topic of interest in several research areas such as palaeoanthropology, archaeology, and forensic sciences. Their resistance is due to the hard tissue component (i.e., enamel, dentine, and cementum) making them more resistant the taphonomic

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[1] ESCLASSAN *et al.* 2009: 297-297; PETRARU, BEJENARU 2019: 5-14.

processes[2]. In palaeoanthropology, the dental material has been subjected to numerous research methods and techniques since they can offer information regarding the age at death, oral pathologies as indicators for nutritional deficiencies or infectious diseases, diet, patterns of phenetic variation in different geographic regions, migrations and distinctions between groups being a suitable biomarker in the biodistance analysis[3]. Also, teeth can be an indicator of cultural activities such as the use of teeth as "a third hand"[4].

Concerning the dietary reconstruction of the past human populations, several approaches are nowadays used such as dental wear, stable isotopes, phytoliths, pollen, starch grain microfossils identification, or DNA sequencing from the dental calculus material[5].

Dental wear describes the loss of dental hard tissues (i.e., enamel, dentine) usually on the occlusal surface of teeth. The dental wear has been studied through various ways such as scoring system[6], macrowear analysis by quantifying the area of dentine exposure[7], occlusal fingerprint analysis[8], microwear analysis using a scanning electron microscope (SEM)[9], and by scanning confocal microscopy combined with a scale sensitive fractal analysis[10].

Usually visible through the eye, the dental macrowear patterns can offer valuable insights especially for bioarchaeologists to corelate the diet abrasiveness and the food processing techniques with the worn surfaces of the teeth. Different types of dental wear can be grouped as follows: mechanical ones (i.e., abrasion – interaction between teeth and exogenous abrasive substances; attrition – movements of teeth against each other; abfraction –microfractures and microstructural loss at the cervical margin of the teeth), and chemical wear (erosion) caused by acidic agents[1].

Diet related macrowear has been used in several studies, in which were subjected primates, past and modern-day human populations[11]. Dental macrowear is the result of a cumulative process which takes place over an individual's life, being so an age-dependent process; it can also vary by sex, resulting different patterns of wear. It differs from the dental microwear, which is visible under a scanning electron microscope or optical microscope with a high magnification power, and which is characterized by microscopic features of wear (i.e., striae, scratches, punctures, and pits)[12]. The two forms of wear are results of the same process, but indifferent time lapse, the microwear being formed within the last weeks or even months before death and leading to macrowear. Moreover, wider scratches that characterize the microwear are frequent in teeth with grater macrowear[13].

[2] POPOVICI *et al.* 2022: 1479-1498.

[3] POPOVICI *et al.* 2021: 13-23; GROZA, BEJENARU, VĂLEANU 2021: 91-102; GARCÍA-GONZÁLEZ *et al.* 2015: 28-38; ORGAN, TEAFORD, LARSEN 2005: 801-811; GÓRKA, ROMERO, PÉREZ-PÉREZ 2016: 257-264.

[4] MOLNAR 2011: 681-689; WALSH 2022: 1-11.

[5] LARSEN *et al.* 2022: 618-637; JUHOLA *et al.* 2019: 105888; GISMONDI *et al.* 2018: 13-23; PETRARU, BEJENARU, POPOVICI 2022: 77-92.

[6] SCOTT 1979: 213-217; MOLNAR 1971: 175-189; SMITH, KNIGHT 1984: 435-438.

[7] GALBANY *et al.* 2011: 51-59; CALHOUN *et al.* 2022: 103123; CLEMENT, HILLSON 2012: 517-524.

[8] KULLMER, MENZ, FIORENZA 2020: 25-43; FIORENZA 2015: 1-15.

[9] GREEN, CROFT 2018: 53-73; SOŁTYSIAK 2011: 2805-2810.

[10] UNGAR *et al.* 2003: 185-193; SCOTT, HALCROW 2017: 1-11.

[11] FIORENZA *et al.* 2019: 174-188; GALBANY *et al.* 2016: 457-465; TOMCZYK, ZALEWSKA 2016: 49-57; NORMANDO *et al.* 2020: 1-9.

[12] PETRARU *et al.* 2020: 1-13.

[13] SCHMIDT 2010: 67-73; SCHMIDT *et al.* 2019: 207-226.

Although there are several studies addressing dental wear characterization of past human population, the understanding of dental macrowear is still limited in Romania, even if this targeted area has a rich archaeological heritage.

The aim of this study is to assess the dental macrowear in the human skeletal sample discovered at the "Vovidenia" Church from Iași County (Romania), by semiquantitative scoring system and by quantitative analysis of occlusal dentine exposure.

There are some limitations to this study: (1) several skeletons are poorly preserved, with most teeth being lost postmortem; (2) the statistical analysis is restricted by the small number of the recovered teeth.

Material and Methods

Archaeological context and sample description

During the archaeological excavations conducted in 2021 at the "Vovidenia" Church in Iași (Iași County, Romania) (Fig. 1), preceding his rehabilitation, several human skeletons were discovered. The osteological material was found in seven archaeological units (i.e., Unit 1, Unit 2, Unit 3, Unit 4, Unit 5, Unit 6, and Unit 7), situated inside and outside the church (Fig. 2). Dating of the skeletons was made according to the archaeological inventory, and they belong to the 16th-17th centuries[14]. The human remains discovered in Unit 1 were previously studied, in terms of biometry, sex and age at death, pathologies, abnormalities, and non-metric traits, by Groza and collaborators[15]. Based on unpublished data of Groza and collaborators, all the skeletal remains discovered at "Vovidenia" Church belonged to 114 individuals (minimum number of subjects): 43 adults, 33 children and 38 with indeterminable ages. This paper is focused only on the individuals in which teeth were available, excepting one particular individual with preserved teeth was not included in this study. This one is attributed to Maria Schilet, according to the funerary stone, and will be subjected to a separate multidisciplinary research[16].

[14] PÎRNĂU *et al.* 2021: 536-541.

[15] GROZA *et al.* 2022: 181-200.

[16] PÎRNĂU *et al.* 2021: 536-541.

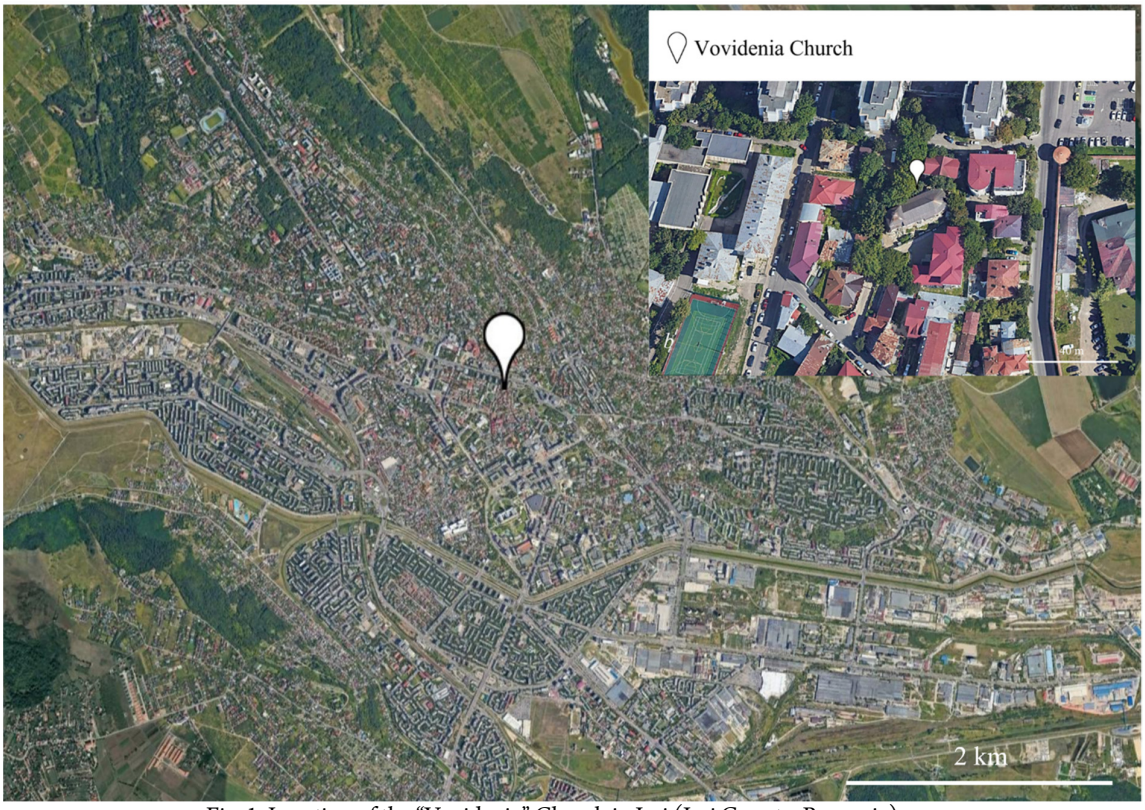

Fig. 1. Location of the "Vovidenia" Church in Iași (Iași County, Romania), detail of location (Map Source: Google Earth Pro).

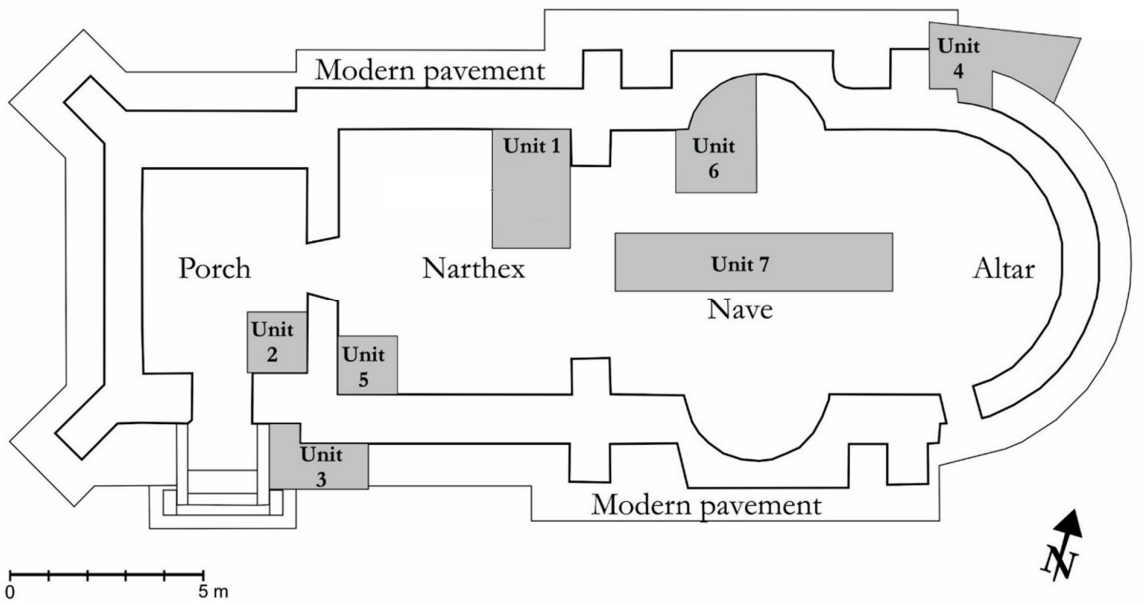

Fig. 2. General plan of the "Vovidenia" Church and location of archaeological units (GROZA *et al.* 2022: 181-200).

Sample preparation

This study was carried out on 181 teeth from 18 individuals, males, and females (Table I). All prelevated teeth were cleaned using cotton wool with ethanol, and then they were prepared for stereomicroscopically inspection. All teeth surfaces were examined and digitized using a Carl Zeiss Stemi 2000-C stereomicroscope with a Canon Power Shot G9 attached. Noted dental observations included the number of teeth, antemortem teeth lost (AMTL) and antemortem chipping. Chipping was recorded as antemortem if the affected areas where similar in the colour to the adjacent areas of the crown, and the edges of the chipped areas were smooth[17].

Tooth type	N (%)	Maxillary teeth N (%)		Mandibular teeth N (%)	
		Right	Left	Right	Left
I1	11 (6.07)	2 (5.12)	2 (5.55)	4 (7.27)	3 (5.88)
I2	10 (5.52)	2 (5.12)	1 (2.77)	4 (7.27)	3 (5.88)
C	27 (14.91)	6 (15.38)	6 (16.66)	6 (10.90)	9 (17.64)
P1	26 (14.36)	6 (15.38)	5 (13.88)	8 (14.54)	7 (13.72)
P2	27 (14.91)	8 (20.51)	5 (13.88)	8 (14.54)	6 (11.76)
M1	28 (15.46)	8 (20.51)	9 (25)	6 (10.9)	5 (9.80)
M2	34 (18.78)	6 (15.38)	7 (19.44)	11 (20)	10 (19.60)
M3	18 (9.94)	1 (2.56)	1 (2.77)	8 (14.54)	8 (15.68)
Total	*181*	*39*	*36*	*55*	*51*

Tabel I. Tooth type taken into study by jaw; M3 – third molar, M2 – second molar, M1 – first molar, P2 – second premolar, P1 – first premolar, C – canine, I2 – lateral incisor, I1 – central incisor; N – number of teeth.

Macrowear scoring

Macrowear scoring was performed according to the method proposed by Scott (1979)[18] for molar teeth (M) and Smith's (1984)[19] scaling technique for incisors (I), canines (C) and premolars (P). Three stages of dental wear were considered, according to the degree of dentin exposure: teeth with invisible or very small wear facets (Scott scale: 4-9; Smith scale:1-2), teeth with moderately advanced wear facets (Scott scale: 10-22; Smith scale: 3-5), and molars with highly advanced wear facets (Scott scale: 23-40, Smith scale: 6-8)[20].

Macrowear analysis

Quantitative occlusal macrowear analysis was performed only to the M2 molars and was based on the methodology proposed by Galbany et al (2011)[21]. Based on digital images of the occlusal molar plane and a millimetric scale at the same height, the total occlusal area (TOA) and dentine exposure area (DEA) are expressed in mm^2 using ImageJ software[22]. When several isolated areas of dentine were present on the occlusal surface, each was quantified separately, then all were

[17]SCOTT, WINN 2011: 723-731.

[18] SCOTT 1979: 213- 217; SCHMIDT 2010: 67-73.

[19] SMITH 1984: 39-56.

[20] TOMCZYK *et al.* 2020: 375-381.

[21] GALBANY *et al.* 2011: 51-59.

[22] ABRÀMOFF, MAGALHÃES, RAM 2004: 36-42.

summed (Fig. 3) and accounted as total dentine exposure area TDEA[23]. The percentage of dentine exposure (PDE%) was calculated for each molar: PDE = TDEA × 100/TOA[24].

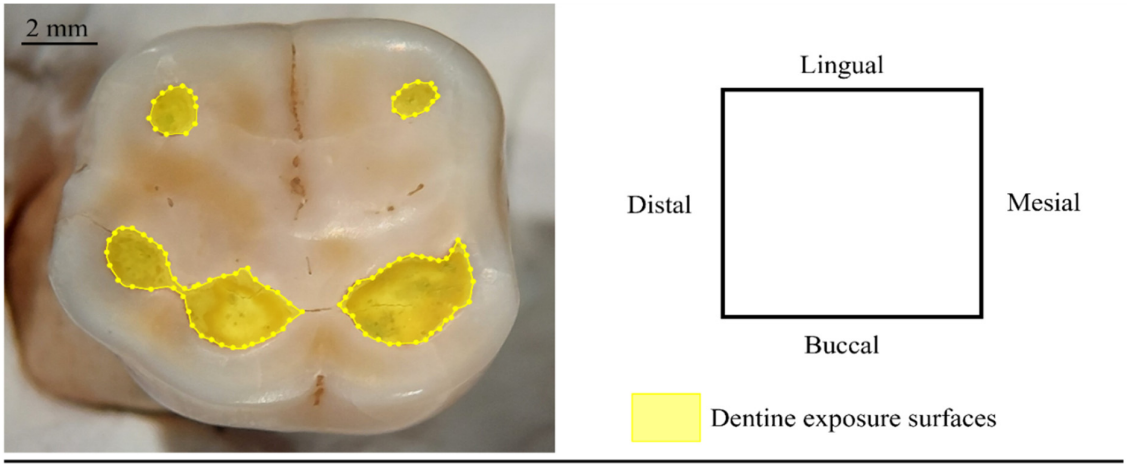

Fig. 3. Example of dentine exposure surfaces on the occlusal surface of M_1 mandibular molar.

Results and Discussion

The scoring system showed that all three grades of wear were identified in the analysed dental sample (i.e., small wear, moderately advanced wear, and advanced wear). The dental scores are shown in Figure 4, in each individual by each tooth. Furthermore, based on the obtained scores, the teeth were grouped according to Tomczyk et al. (2020)[18], as following: with invisible or very small wear facets, with moderately advanced wear facets, and teeth with advanced wear facets. The mandibular molars were more worn out in comparison with the maxillary ones, especially in the first and second molars (Fig. 5); 71.42% of the second mandibular molars (M_2) exhibit a moderately advanced wear and 23.89% an advanced occlusal wear, while 84.61% of the maxillary second molars (M2) show a moderate wear and 15.38% an advanced occlusal wear. As expected, the same trend values for wear were obtained for the first molars (M1) but with higher percentages for the teeth with advanced wear (Fig. 5). In some molar and premolar teeth where the wear was highly advanced, the pulp chamber was affected. The maxillary premolars (P^1, P^2) and canines (C) showed a more accentuated wear than the mandibular ones. The maxillary second premolars (P^2) indicated an advanced wear (scores of 6, 7, and 8) in 23.07% of the samples, while no mandibular second premolars (P_2) fell into this category. Also, 16.66% of the maxillary canines (C) showed an advanced wear in comparison with the mandibular ones which were less worn-out (26.66% small wear, and 73.33% moderate wear). The same characteristic is also revealed for the incisors (I1, I2), but this result may be affected by the small sample size.

The antemortem and postmortem tooth loses were marked. Teeth were considered to have been lost postmortem if there was evidence of an alveolar socket.

[23] CLEMENT, HILLSON 2012: 517-524; CLEMENT, HILLSON, AIELLO 2012: 367-376.

[24] PETRARU, BEJENARU, POPOVICI 2022: 77-92.

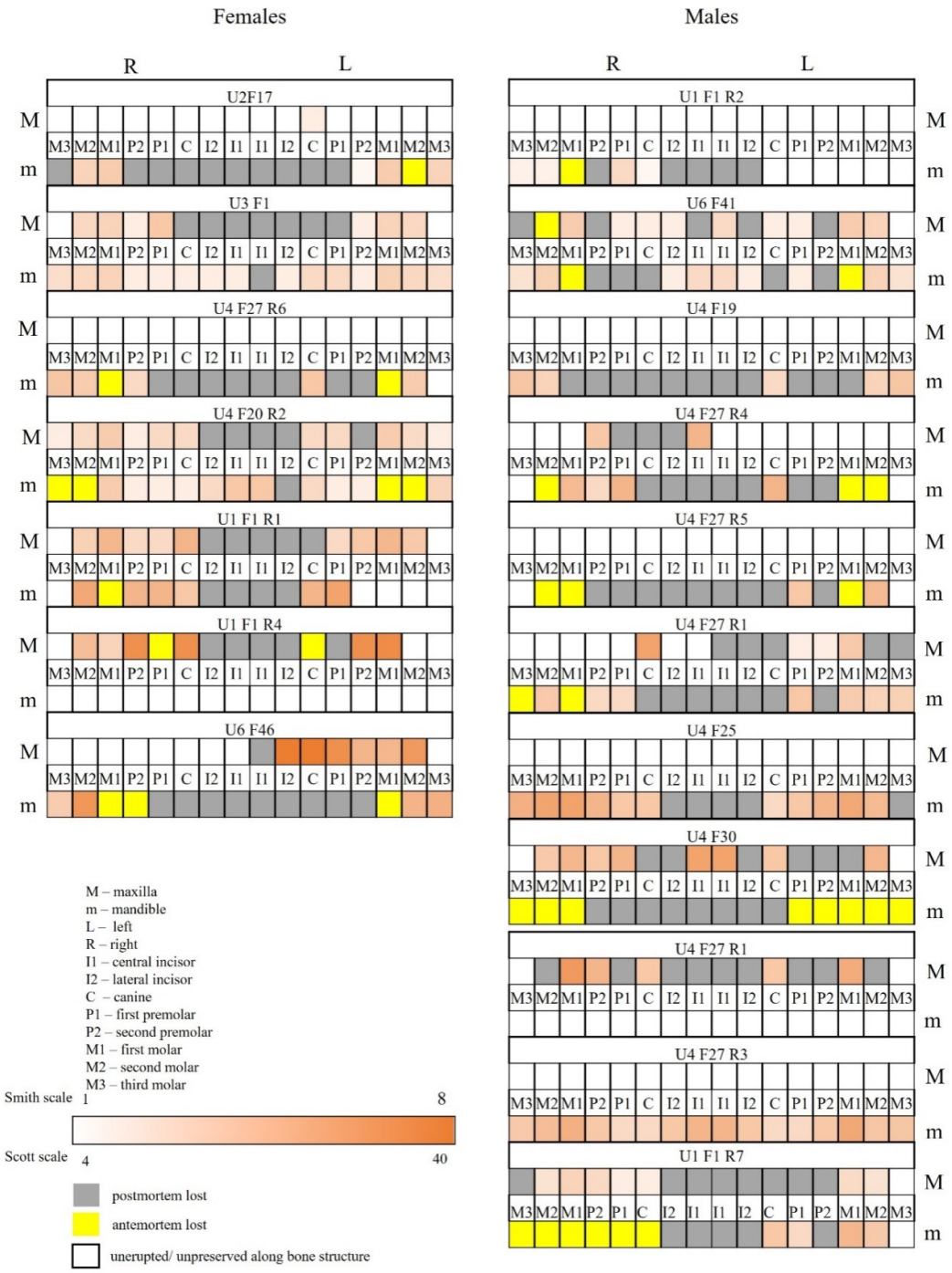

Fig. 4. Distribution of teeth and dental wear in all 18 analysed individuals from "Vovidenia" Church from Iaşi.

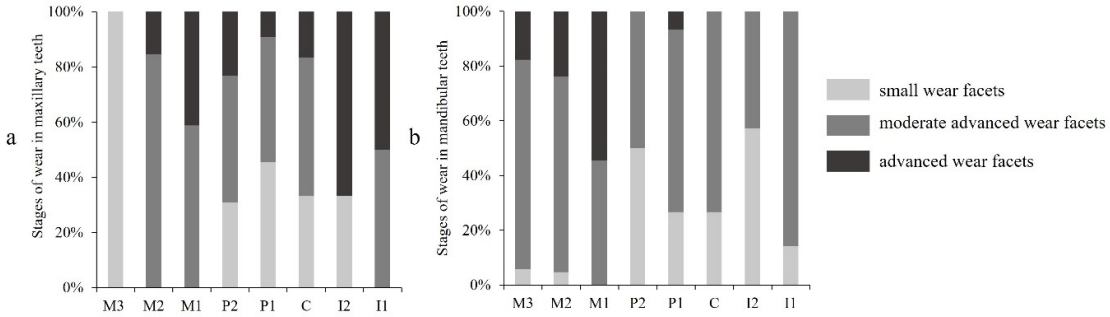

Fig. 5. Macrowear scoring in the dental sample from "Vovidenia" Church from Iaşi: stages of the dental wear in maxillary teeth (a) and mandibular teeth (b); M3 – third molar, M2 – second molar, M1 – first molar, P2 – second premolar, P1 – first premolar, C – canine, I2 – lateral incisor, I1 – central incisor.

The AMTL was recorded when traces of bone remodeling process were discernible[25]. Prevalence of antemortem tooth loss was calculated[26].

The AMTL affected both males and females. In our material, the maxillary teeth were less prone to the antemortem loss. The AMTL prevalence in the maxillary second molars M^2 is 5.88% followed by the maxillary first premolars P^1 (5.26%) and the canines (4.76%). The most prone to tooth lost during the life are the molars followed by the premolars; the first mandibular molar (M_1) has the AMTL prevalence of55.55%, followed by the second mandibular molar and third molar (27.58%, and 17.39% respectively). Similar results are found in a study by Grimoud (2011)[27]. Comparing four sites from the Chalcolithic to the Middle Ages, in France, the prevalence of teeth lost antemortem is higher for molars, followed by premolars. In our study, the premolar teeth are the least prone to antemortem loss (second P_2 premolar prevalence = 10.34%, first P_1 premolar prevalence = 3.44%. Unlike the maxillary anterior teeth, the mandibular anterior teeth (i.e., C, I_1, I_2) showed no signs of AMTL.

The antemortem tooth loss can be the result of multiples factors[28]. Attrition is one of the primary causes of ATML being linked to excessive wear and caries in the posterior teeth, while the presence of AMTL in the anterior teeth can be caused by extramasticatory behaviour and less by dental caries as those usually have a low frequency in these teeth[29].

The dental material was examined under stereomicroscope and special types of wear were identified: chipping (Fig. 6.a-c), and oblique wear (Fig. 6.d). Antemortem chipping was identified in 8 individuals in which the most affected teeth were the molars and premolars and less the anterior teeth – in only one canine tooth (Fig. 6). Chipping is defined as a microfracture on the dental crown being a result of high pressure applied on tooth. An aberrant fracture was observed on the buccal side of second maxillary premolar P^2 (Fig. 6.e,f). The fracture involves both the crown, and the dental root, and it is characterized by smooth edges of enamel and cement. On the surface of the damaged tissues some coarse scratches were identified bringing further proof that the dental

[25] LEE *et al.* 2019: 176-181.

[26] NOVAK 2015: 1299-1309.

[27] GRIMOUD *et al.* 2011: 1-7.

[28] TROMBLEY *et al.* 2019: 253-269.

[29] MOLNAR 2011: 562-565.

fracture occurred during the life (Fig. 6.g,h). This fracture could have been produced by a very high pressure on the buccal part of the premolar dental crown being more likely a consequence of an extramasticatory activity rather than mastication, given that the tooth belonged to a male of about 40-45 years old.

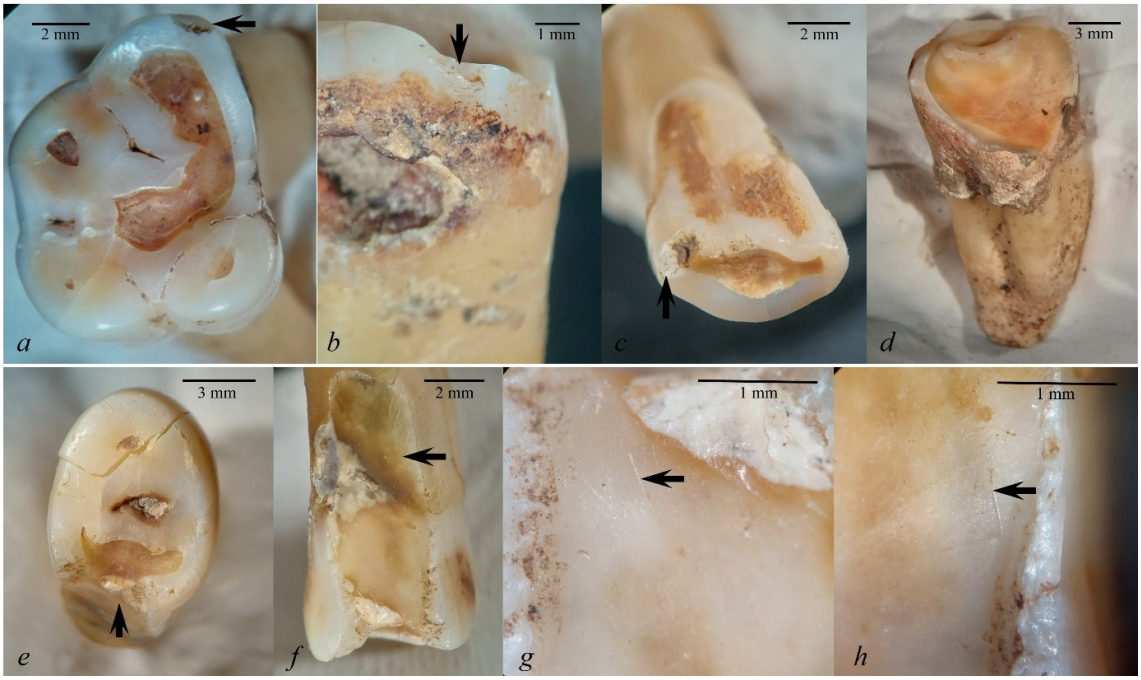

Fig. 6. Chipping, fractures and oblique wear identified in the dental sample from "Vovidenia" Church; a. right M_1 mandibular molar – occlusal view, chipping – black arrow; b. left M^2 maxillary molar – lingual view, chipping – black arrow; c. right mandibular canine – incisal view, chipping – black arrow; d. rightM_2 mandibular molar – concave oblique wear; e. right P^2 maxillary premolar – occlusal view, fracture – black arrow; f. right P^2 maxillary premolar – buccal view, fracture surface – black arrow; g, h. details of dental wear of the fracture surface, coarse scratches – black arrow.

All maxillary and mandibular M2 molars were subjected to *image analysis* in order to quantify the percent of dentine exposure. When the two mandibular/maxillary molars were available, the mean of the two values from the antimeres molars was used, while when the M2

molar was present only on one side the obtained PDE was used as such. On the occlusal surfaces, one to four zones of dentine exposure were identified. Where the macrowear is advanced, the exposed dentine zones coalesce resulting a large concave dentine basin. Furthermore, cupping or scooping of dentine was identified in several individuals. Based on a study conducted by GANSS *et al.* (2002)[30], in which one medieval human group and two contemporary groups with different patterns of dental wear, dentine cupping should be considered a result of both mechanical and chemical wear or a mechanical wear only when it refers to occlusal surfaces. Being less mineralized than enamel, the dentine is more vulnerable to dental wear, especially to an abrasive diet. In the M2 teeth belonging to a female (U6 F46) of old adult age, the image analysis shows a dentine exposure

[30] GANSS, KLIMEK, BORKOWSKI 2002: 54-60.

of 50.94% on the maxillary M^2 molar, while in another female of similar age at death the PDE has a much lower value (0.29%).

It is well known that the dental wear is a multifactored process being also influenced by age[31]. The obtained PDE values for the mandibular M2 molars discovered at "Vovidenia" Church were subjected to sex and age at death criteria (YA – young adults: 20-34 years old), MA – middle adults: 35-49 years old, OA – old adults: > 50 years old[31]) (Fig. 7). As expected, our raw obtained data showed increasing values along with increasing age, in both males and females. Due to the small sample size, statistical could not be performed.

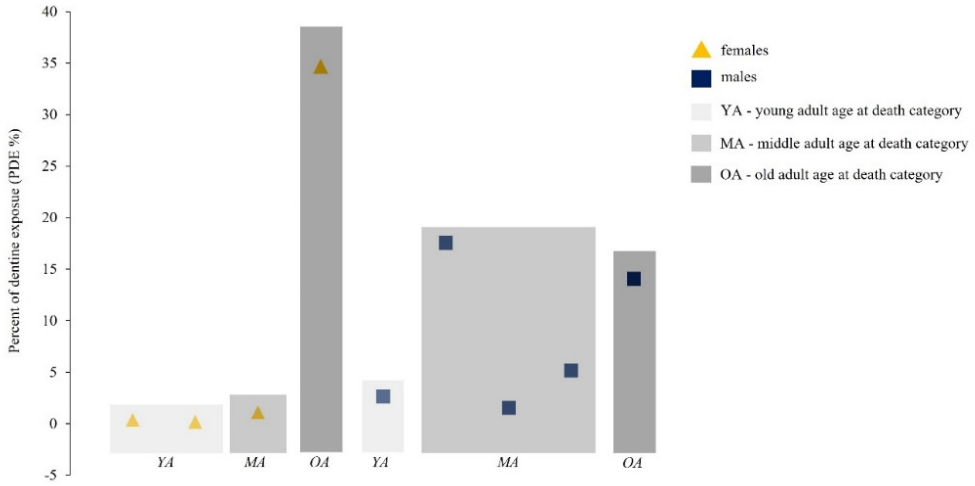

Fig. 7. Percentage of dentine exposure (PDE%) of mandibular M2 molars from "Vovidenia" Church by age at death and sex categories proposed by BUIKSTRA, UBELACHER 1994[32].

A study regarding the dental macrowear in the human skeletons of 17th century, discovered at "Curtea Domnească" from Iași (Romania), indicates that percentages of dentine exposure depend on sex, being higher in males[33]. Microscopical approach of dental wear, in the same skeletal sample, revealed that the microwear resulted from hard and abrasive diet[12].

The analysis of tooth macrowear in skeletons discovered at "Vovidenia" Church from Iași identified three grades of wear (i.e., small wear, moderately advanced wear, and advanced wear), all suggested by both the scoring system and the image analysis. AMTL affected the posterior teeth, especially the mandibular M_1 molar, and it can be associated with excessive dental wear (attrition) and dental pathologies such as caries. Chipping and heavy oblique wear were identified also in the posterior teeth being an indicator of hard food and hard particles and grit within. Atypical wear (oblique wear plane) was identified being an indicator of hard and abrasive diet. The archaeological studies on food resources in Medieval Iași city suggest the use of cereals such as rye, barley,

[31] FIORENZA *et al.* 2018: 153-161.

[32] BUIKSTRA, UBELAKER 1994: 258.

[33] PETRARU, GROZA, BEJENARU 2018: 45-54.

buckwheat, and millet[34]. Also, during the famine in the second half of the 17th century some cereals were replaced by dried bulrush as an alternative flour. The food preparation techniques and storage, including grounding cereals and baking bread on the clay oven floor may add to the content of abrasive particles in the food leading to advanced wear[35].

Conclusions

In the human skeletal remains of 16th-17th centuries, discovered at the "Vovidenia" Church in Iași (Romania), the scoring system and quantification of dentine exposure revealed that dental wear increases with age in both males and females. Chipping was identified mostly in the posterior teeth and could be the result of the use of food and hard particles and grit within. Atypical wear (oblique wear plane) was identified being an indicator of an abrasive diet. Although our results could not be subjected to statistical analysis to certify some aspects regarding dental wear, the analysed M2 teeth will be integrated in an overall study regarding the diet-related dental wear in the past human populations of Iasi city.

Acknowledgements

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[34] BILAVSCHI 2013: 119-152.

[35] SZÉKELY 2018: 170-216.

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