# DENTAL WEAR PATTERNS IN LITHUANIAN AND LATVIAN PALEOANTHROPOLOGICAL SAMPLES

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**Abstract**

Numerous researchers have stressed significance of tooth wear scoring for evaluation of earlier nutrition patterns and cultural practices. The aim of this study was to evaluate dental occlusal wear in several representative samples. The hypothesis tested was if transition from foraging subsistence to agriculture and later social stratification indeed was reflected by dental wear changes. According to results, the remarkable changes in nutrition patterns in the Baltic region occurred only in the Iron Age, which does not correspond with "classical" Neolithization model. The next substantial change in dental wear patterns is connected with increased social stratification in Late Medieval period.

Key words: dental wear, nutrition, hunter-gatherers, agriculture, social stratification.

## Introduction

Tooth enamel that covers tooth crown consists of acellular inorganic substances that are being formed before tooth erupts, and is not remodeled during subsequent life. The use of teeth during eating results in the wearing of occlusal surfaces: loss of enamel covering these surfaces that is followed by secondary dentin deposition, when upper and lower teeth come into contact with each other during food mastication. This process, caused by dental abrasion (result of contact between the tooth crown and the food) and dental attrition (caused by direct tooth-to tooth contact) is age-dependent and varies widely between populations (Larsen 1997). Numerous researchers have stressed significance of tooth wear scoring for evaluation of earlier nutrition patterns and cultural practices. Wear severity is related to the characteristics of food and the ways of its preparation. Temporal shifts in teeth wear often indicate dietary changes. The decrease in dental wear was noted among numerous North American Indian populations experiencing transition from foraging to farming subsistence (Walker 1978). The same trends were detected during the Neolithic transition in Portugal (Lubell et al. 1994). Similar tendencies were noted for later periods: there was a marked reduction in the coarseness of foods resulting in dental wear decrease in Britain from about the 17$^{th}$ century (Mays 1998). This phenomenon, explained by general decrease of masticatory load, however, is not universal: extensive use of grinding stones for grain preparation can add small stone or sand particles into consumed foods serving as abrasives. It means that detailed analysis of dental wear patterns could supplement our knowledge about dietary habits in the past, and possible diachronic and social differences could suggest in differences in the mode of life.

As no systematic studies in the Baltics on dental wear patterns were performed, the aim of this study was to evaluate dental occlusal wear in several representative samples. The hypothesis tested was if transition from foraging subsistence to agriculture and later social stratification indeed was reflected by dental wear changes.

## Materials and methods

Analysis was performed on selected archaeological populations, 459 adult individuals in total. All material was organized in four samples, based on different chronology and subsistence: Stone Age, Iron Age, Medieval rural and Medieval nobility. Dates, age structure and quantity of the samples are given in Table 1.

The Stone Age sample is represented by Zvejnieki site. The site is situated in northern Latvia and constitutes one of the largest Stone Age cemeteries in Northern Europe. Excavated by F. Zagorskis in 1964-1978, Zvejnieki includes burials from middle Mesolithic to late Neolithic and Bronze/Iron Age. Only individuals dated middle Mesolithic – late Neolithic and undated individuals, referred as Stone Age were included in the study. As our earlier study (Palubeckaitė and Jankauskas 2006) revealed no statistical differences in dental attrition among different chronological periods of Zvejnieki, all individuals were pooled.

Other samples are composed of Lithuanian archeological material. The Iron Age sample is represented by Obeliai (excavated by V. Urbanavičius in 1979-1982) and Plinkaigalis (excavated by V. Kazakevičius in 1978-1984). Both populations belong to the same Middle Iron Age period in Lithuanian archeological chronology. Absence of the differences in dental wear allowed us to pool all individuals into one sample.

Table 1. Number of individuals and teeth included in the study

| Age at death \ Sample | Stone Age (7500-2600 BC) | Iron Age (5-6th c.c.) | Medieval rural (15-17th c.c.) | Medieval nobility (16-18th c.c.) | Total |
|---|---|---|---|---|---|
| <25 years | | | | | |
| No. of indiv. | 18 | 49 | 31 | 2 | 100 |
| No. of teeth | 414 | 1325 | 859 | 47 | 2645 |
| 25-35 years | | | | | |
| No. of indiv. | 46 | 52 | 41 | 4 | 143 |
| No. of teeth | 1103 | 1410 | 1065 | 100 | 3678 |
| 35-45 years | | | | | |
| No. of indiv. | 21 | 45 | 34 | 6 | 106 |
| No. of teeth | 464 | 1061 | 770 | 153 | 2448 |
| >45 years | | | | | |
| No. of indiv. | 26 | 52 | 28 | 4 | 110 |
| No. of teeth | 456 | 1079 | 579 | 81 | 2195 |
| Total | | | | | |
| No. of indiv. | 111 | 198 | 134 | 16 | 459 |
| No. of teeth | 2473 | 4875 | 3273 | 381 | 10966 |

The Medieval rural sample consists of Bazorai, Leipalingis and Vink niniai (excavated by E. Svetikas in 1981-1987) and Rukliai (excavated by D. Ribokas in 1989-1998). These burials from eastern and southern Lithuania include medieval rural parish cemeteries. No differences in tooth wear among the four populations were found. The Medieval nobility sample includes inhumations from the Cathedral of Vilnius (excavated by A. Lisanka in 1986-1988). These individuals represent the elite of medieval society.

Dental attrition was recorded on all teeth according to Smith (1984). Results are given in average degree for each tooth category. Because there is generally little left-right discrepancy in dental attrition (Hillson 1996), the two sides were averaged. Taking into account that tooth wear is an age-related phenomenon, all comparisons between the samples were made according to age at death group. Statistical analysis was performed using the SPSS statistical package (ANOVA, Student's T-test procedures).

## Results

Comparison of all samples revealed differences with peculiarities according to tooth category and age at death (Fig. 1-4). The highest average wear of anterior teeth was found in the Stone Age sample, while the lowest anterior teeth wear was characteristic for the Medieval nobility. Individuals of the Iron Age and the Medieval rural samples had similar rates of anterior tooth wear, which was in between and statistically differ both from the Stone Age and the Medieval nobility samples (statistical differences are presented in Table 2). The greatest differences in anterior teeth wear were found among the youngest individuals, however, the same trend persists through all age groups.

Wear of premolars of individuals under 35 years was almost equal in all samples. Among older individuals, the lowest wear of premolars was characteristic for the Medieval nobility. The difference between the latter and the other samples was statistically significant only in 35-45 year age group, yet the same tendency persists in the oldest age group. The greatest difference in molar wear was found in attrition of the first molar. Among the youngest individuals (under 25 years) the lowest degree of molar wear was characteristic for the Stone Age sample. The 35-45 year old individuals of the Stone Age and the Medieval nobility had equal attrition of the first molar, which was statistically lower than the Iron Age or the Medieval rural molar wear. Among older individuals, statistically lower wear of molars was characteristic for the Medieval nobility.

Analysis of age influence on dental wear rates revealed a clear trend of increasing attrition with advancing age at death in the Stone Age, the Iron Age and the Medieval rural samples (Fig. 5-7; Table 3). However, differences were found in anterior versus posterior teeth wear. In the Stone Age sample attrition of anterior teeth was more pronounced compared to molars. This unequal wear was most prominent among individuals under 25 years and persists until 35 years; after 35 years anterior and posterior teeth wear became almost equal. In the Iron Age and the Medieval rural sample the youngest individuals expressed almost equal attrition of anterior and posterior teeth, while after 25 years molar wear became more prominent compared to anterior

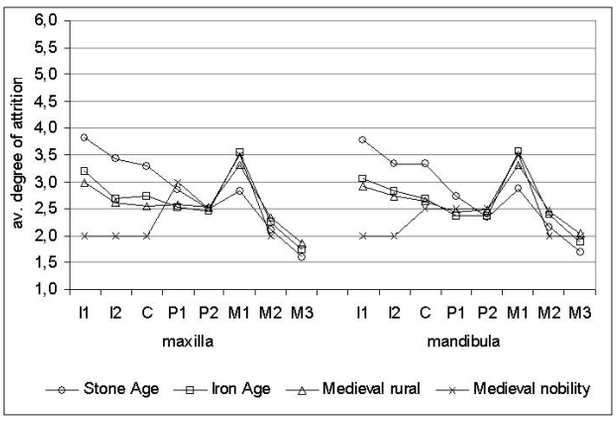


Fig. 1. Dental attrition in the <25 year at death age group.

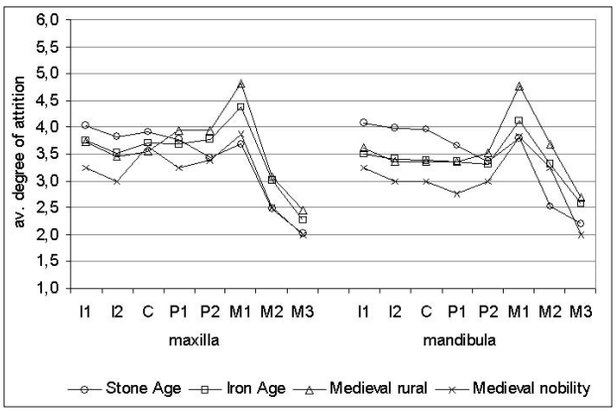


Fig. 2. Dental attrition in the 25-35 year at death age group.

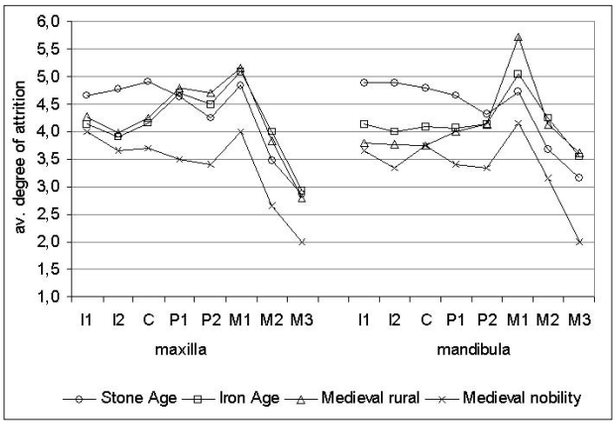


Fig. 3. Dental attrition in the 35-45 year at death age group.

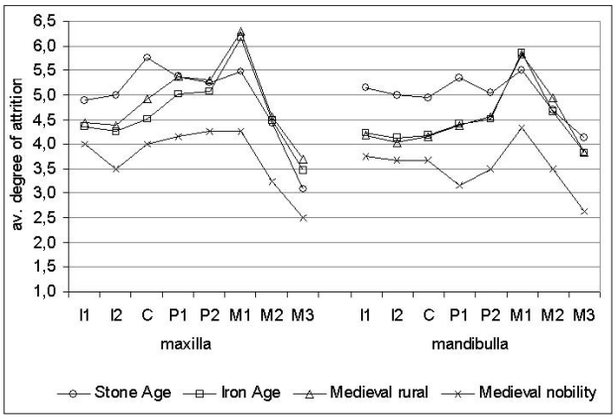


Fig. 4. Dental attrition in the >45 year at death age group.

Table 2. Statistical differences in the average degree of dental attrition among the samples according to age at death group (p – probability of ANOVA test; difference is significant when $p<0.05$)

| Tooth \ p | <25 years | 25-35 years | 35-45 years | >45 years |
|---|---|---|---|---|
| Maxilla | | | | |
| I1 | 0.00 | 0.01 | 0.24 | 0.66 |
| I2 | 0.00 | 0.04 | 0.02 | 0.41 |
| C | 0.00 | 0.14 | 0.01 | 0.04 |
| P1 | 0.31 | 0.31 | 0.04 | 0.45 |
| P2 | 0.94 | 0.09 | 0.04 | 0.27 |
| M1 | 0.00 | 0.00 | 0.04 | 0.00 |
| M2 | 0.27 | 0.00 | 0.03 | 0.09 |
| M3 | 0.25 | 0.30 | 0.42 | 0.49 |
| Mandibula | | | | |
| I1 | 0.00 | 0.00 | 0.00 | 0.01 |
| I2 | 0.00 | 0.00 | 0.00 | 0.00 |
| C | 0.00 | 0.00 | 0.00 | 0.00 |
| P1 | 0.27 | 0.03 | 0.00 | 0.00 |
| P2 | 0.82 | 0.57 | 0.04 | 0.14 |
| M1 | 0.01 | 0.00 | 0.02 | 0.05 |
| M2 | 0.23 | 0.00 | 0.02 | 0.05 |
| M3 | 0.19 | 0.05 | 0.04 | 0.04 |

teeth. Individuals of the Medieval nobility sample had similar attrition of anterior and posterior teeth (Fig. 8). Although there was a trend that degree of attrition in nobility slightly increased with age, statistical differences were found only among the youngest versus the oldest individuals.

## Discussion

Our analysis revealed differences in dental wear rates and patterns. Tooth wear was pronounced through all periods, from the Stone Age to the Medieval. However, the Stone Age sample was characterized by prominent attrition of anterior teeth, while the Iron Age sample and the Medieval rural sample revealed pronounced molar wear. The Medieval nobility sample revealed a low average degree of attrition and equal anterior-posterior teeth wear.

Dental wear rates are highly influenced by the consistency and texture of food and by the manner of its preparation (Littleton and Frohlich 1993; Larsen 1997; Mays 1998). Populations, which subsistence is based on hunting and gathering usually expressed heavy dental attrition (Bennike 1985; Larsen 1995; Alexandersen 2003; Eshed et al. 2006; Lieverse et

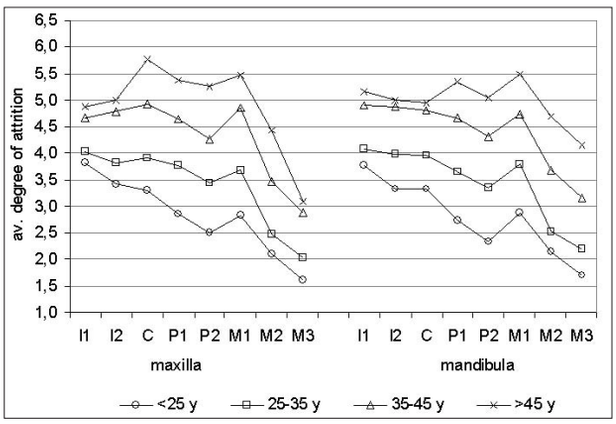


Fig. 5. Age influence on dental attrition in the Stone Age sample.

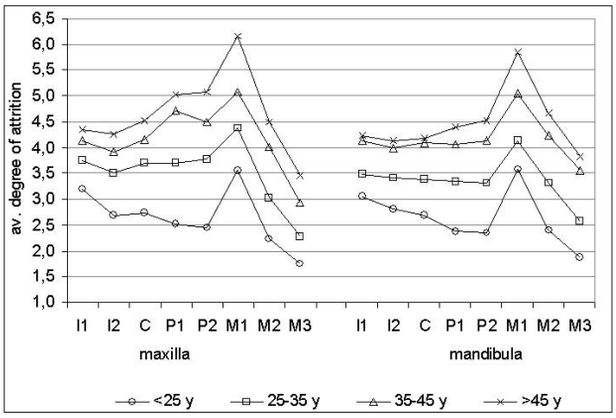


Fig. 6. Age influence on dental attrition in the Iron Age sample.

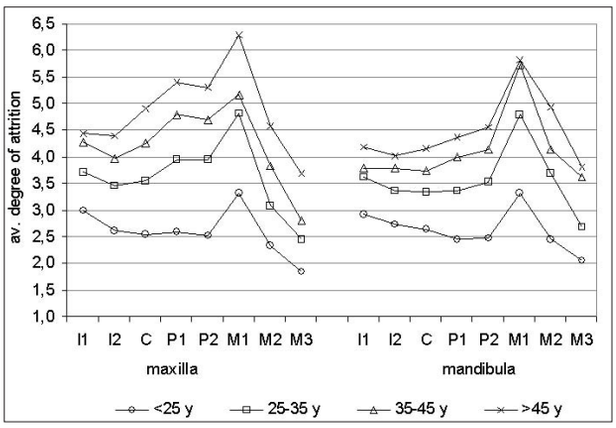


Fig. 7. Age influence on dental attrition in the Medieval rural sample.

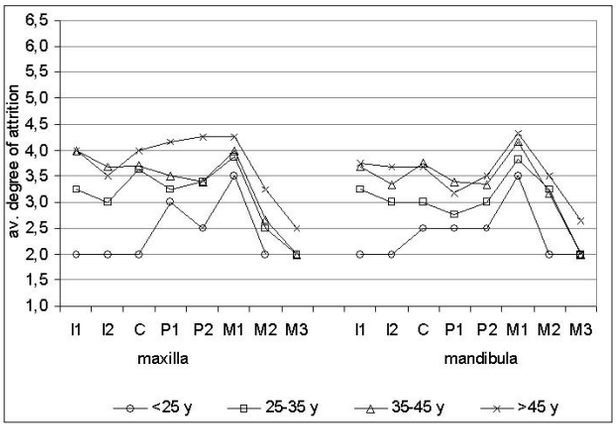


Fig. 8. Age influence on dental attrition in the Medieval nobility sample.

Table 3. Influence of the age at death on the average degree of dental attrition (p – probability of ANOVA test; difference is significant when $p<0.05$)

| p / Tooth | Stone Age | Iron Age | Medieval rural | Medieval nobility |
|---|---|---|---|---|
| Maxilla | | | | |
| I1 | 0.00 | 0.00 | 0.00 | 0.07 |
| I2 | 0.00 | 0.00 | 0.00 | 0.06 |
| C | 0.00 | 0.00 | 0.00 | 0.03 |
| P1 | 0.00 | 0.00 | 0.00 | 0.43 |
| P2 | 0.00 | 0.00 | 0.00 | 0.12 |
| M1 | 0.00 | 0.00 | 0.00 | 0.17 |
| M2 | 0.00 | 0.00 | 0.00 | 0.46 |
| M3 | 0.00 | 0.00 | 0.00 | 0.13 |
| Mandibula | | | | |
| I1 | 0.00 | 0.00 | 0.00 | 0.06 |
| I2 | 0.00 | 0.00 | 0.00 | 0.06 |
| C | 0.00 | 0.00 | 0.00 | 0.08 |
| P1 | 0.00 | 0.00 | 0.00 | 0.37 |
| P2 | 0.00 | 0.00 | 0.00 | 0.52 |
| M1 | 0.00 | 0.00 | 0.00 | 0.24 |
| M2 | 0.00 | 0.00 | 0.00 | 0.06 |
| M3 | 0.00 | 0.00 | 0.00 | 0.05 |

al. 2007). The diet of those people generally consisted of hard textured, fibrous food products that require heavy mastication, e.g. not-well roasted and dried meat and fish, shellfish, nuts, various roots and tuber-crops. In addition, the presence of soil and sand in incompletely clean products also caused severe tooth wear (Bennike 1985; Littleton and Frohlich 1993; Eshed et al. 2006). Such abrasive diet could be a reason of a high dental wear in the Stone Age sample. Stable isotope analysis and zooarhaeological research confirmed that fishing, hunting and gathering were the main subsistence strategies for people from Zvejnieki (Eriksson 2006; Lõugas 2006). Our earlier study of dental status of the Zvejnieki (Palubeckaitė and Jankauskas 2006) revealed no significant differences in dental attrition according to chronological period, suggesting that no dramatical changes in food composition and preparation have occurred during the Stone Age in this region. This corresponds with recent palynological and macrobotanical evidence, which indicates that a shift to agricultural products in the East Baltic region appeared only in the late Neolithic/early Bronze Age (Antanaitis 2001).

The most conspicuous feature of the Stone Age dental wear was a pronounced attrition of anterior teeth. Such an unequal tooth wear was noticed in some other hunter-gatherer's populations (Alex-

andersen 1988; Littleton and Frohlich 1993; Bonfiglioli et al. 2004; Molleson 2005; Lieverse et al. 2007). Hard texture of food alone cannot explain asymmetry in dental wear. According to authors, it is probably due to implements in activities other than eating. Ethnographical studies of Inuit populations have revealed a similar attrition pattern, which was due to intensive use of teeth as tools, e.g. in softening the skin, holding skin while sewing, making baskets or tightening lines (Merbs 1983). Intensive use of teeth as tools also result in damaged teeth and cause unusual wear facets (Larsen et al. 1998). Such cases of antemortally broken and fractured teeth and specific grooves on occlusal and interproximal dental surfaces were found in Zvejnieki (Palubeckaitė and Jankauskas 2006). Thus, it is reasonable to suggest that extramasticatory activities mentioned above was most responsible for severe anterior dental attrition in the Stone Age sample.

Daily subsistence of people of the Iron Age sample was based on agriculture products (mostly barley, wheat, peas and beans) and husbandry (beef, pork, sheep and goat) (Tautavičius 1996). Comparisons between hunter-gatherers and agriculturalists or populations undergoing agricultural intensification usually revealed a decrease in severity of tooth wear (Littleton and Frohlich, 1993; Larsen 1995, 1997; Eshed et al. 2006; Keenleyside 2008). According to authors, this trend reflects the reduction in consistency, hardness or abrasiveness of food consumed by farmers. Our results did reveal a significant decrease in anterior teeth wear in the Iron Age sample compared to the Stone Age. However, attrition of posterior teeth remained the same or even increased. The similar increase in molar wear was noticed in Danish Iron Age populations (Bennike 1985) and in agriculturalists of Northwest Mexico (Watson 2008). Changes in food processing practices that occurred during intensification of agriculture involved an increase in the use of grinding stones for making flour from cereal grains. It is likely, that increased reliance on the stone-ground flour, which contained a substantial amount of grit (Watson 2008), resulted in fast posterior dental wear in the Iron Age sample. The decreased in attrition of anterior teeth is probably a result of a simultaneous effect of changes in tool making technologies and increased mechanical processing (softening) of dietary products. These changes highly reduced the use of teeth as tools and decreased a role of anterior teeth in the initial preparation of food.

The Medieval rural sample was also characterized by severe molar wear and moderate attrition of anterior teeth. High dental attrition was not an unusual feature in medieval populations (Bennike 1985; Varrela 1991; Alexandersen 2003). The diet of ordinary villagers consisted of agricultural products, mainly dark rye and bran bread, porridges and gruels, which still contained a substantial amount of coarse residues from milling (Moore and Corbet 1973). A high consumption of dried and salted fish and meat during winter seasons and famines and increased reliance on turnips could also promote tooth wear (Česnys and Balčiūnienė 1988; Varrela 1991). Our analysis revealed no differences in tooth wear rates and pattern between the Medieval rural and the Iron Age samples. Thus, it could be supposed that a daily subsistence of medieval peasants did not differ substantially from the people of the Middle Iron Age. The diet still consisted of rough, not refined, coarse products. If there was an improvement in food processing technologies, it did not substantially lowered abrasiveness of the diet.

However, a different situation was found in the Medieval nobility sample. The significantly lower dental wear and only a slight increase in degree of attrition with age indicate a consumption of soft, refined food products. Dental wear differences by social group and rank have been noticed in other past societies (Larsen 1997). Members of the elite had an access to better quality food products, such as fresh meat and fish and white bread from fine wheat flour (Moore and Corbet 1973). This less mechanically demanding and less abrasive diet resulted in a low severity of tooth wear in the upper class individuals.

## Conclusions

Differences found in the degree and pattern of teeth wear reflects differences in the composition and preparation of food among the samples. Heavy tooth wear with pronounced attrition of anterior teeth of the Stone Age sample indicates a consumption of rough, fibrous, hard-textured food products and intensive use of teeth in extramasticatory activities (e.g. softening the skin, making baskets etc.).

Decreased anterior tooth wear in the Iron Age sample indicates a consumption of more processed, softer food items and decrease in the usage of teeth as tools. However, heavy posterior teeth wear indicates an abrasiveness of the diet, which could be a result of changes in food processing practices, e.g. increase in the use of stone grinds. Similar dental wear rates and patterns in the Medieval rural sample indicate a succession of main dietary traits in the subsistence of peasants.

Low dental attrition in the Medieval nobility sample indicates a greater access of upper class individuals to highly processed refined food of better quality.

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# LIETUVOS IR LATVIJOS SENŲJŲ GYVENTOJŲ DANTŲ NUSIDĖVĖJIMO YPATUMAI

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## Santrauka

Dantų nusidėvėjimą sukelia nuolatinis dantų kramtomųjų paviršių trynimasis kramtant maistą. Nusidėvėjimo laipsnis priklauso nuo keleto veiksnių: individo amžiaus, vartojamo maisto sudėties ir konsistencijos. Pastebėta, kad dantų nusidėvėjimo stiprumo ir (arba) pobūdžio pasikeitimai atspindi žmonių mitybos pokyčius. Daugelis autorių nurodo sumažėjusį dantų nusidėvėjimo laipsnį bendruomenei pereinant nuo medžioklės ir rankiojimo prie žemdirbystės; manoma, kad žemdirbiai valgė minkštesnį, labiau mechaniškai ir termiškai apdorotą maistą. Taip pat pastebėta, kad skiriasi įvairių socialinių grupių dantų nusidėvėjimas. Visgi nusidėvėjimo kitimo tendencijos kiekvienoje populiacijoje savitos. Todėl detalus dantų nusidėvėjimo tyrimas gali padėti geriau suprasti senųjų gyventojų mitybos ypatumus.

Mūsų tikslas buvo ištirti kelių Baltijos regiono senųjų gyventojų grupių dantų kramtomuosius paviršius, siekiant išsiaiškinti, kaip žemdirbystės atsiradimas ir vėliau išryškėję socialiniai skirtumai susiję su dantų nusidėvėjimo ypatumais. Visa tyrimo medžiaga (459 suaugę individai) buvo suskirstyta į keturias grupes, atstovaujančias akmens amžiaus, geležies amžiaus, viduramžių valstiečių ir viduramžių elito bendruomenėms. Lyginant dantų nusidėvėjimą buvo atsižvelgiama į individų amžių mirties metu.

Gauti rezultatai parodė, kad visam akmens amžiaus laikotarpiui būdingas didelis dantų nusidėvėjimas. Tai reiškia, kad to meto gyventojai daugiausia maitinosi kietu, termiškai prastai apdorotu maistu. Ypač ryškus priekinių dantų nusidėvėjimas gali būti siejamas su intensyviu dantų naudojimu vietoj įrankių (išdirbant odas, pinant krepšius, gaminant lankus ir kt.). Žymesni dantų nusidėvėjimo pokyčiai atsiranda tik geležies amžiuje. Sumažėjęs priekinių dantų nusidėvėjimas gali reikšti, kad buvo vartojama daugiau minkštesnio, labiau mechaniškai ir termiškai apdoroto maisto; be to, sumažėjo dantų kaip įrankių reikšmė. Tačiau vis dar ryškus šoninių dantų nusidėvėjimas rodo, kad maiste netrūko abrazyvių dalelių, kurios galėjo atsirasti malant grūdus akmeninėmis girnomis. Viduramžių valstiečių dantų nusidėvėjimas niekuo nesiskyrė nuo geležies amžiaus gyventojų, todėl galime spėti, kad ryškių maisto produktų sudėties ar maisto gaminimo technologijų pokyčių neįvyko. Tuo tarpu viduramžių elito atstovų dantų nusidėvėjimas buvo palyginti nežymus ir beveik nepriklausė nuo individo amžiaus. Tai rodo, kad aukštesnė socialinė padėtis viduramžiais reiškė galimybę maitintis geresnės kokybės maistu.