

THE FREQUENCY AND PATTERN OF DENTAL CARIES IN ARCHAEOLOGICAL POPULATIONS FROM ESTONIA

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ABSTRACT

The caries rate is an important indicator of dental health but also provides a lot of information about dietary habits and the lifestyle of past populations. To understand dietary changes, it is important to observe both the primary location and the severity of caries lesions.

In the present study the prevalence, location and severity of caries lesions were recorded on 5,838 teeth of six skeletal populations from Estonia, from the Migration Period (450–600 AD) to the Early Modern Times (18. c.).

Scoring of the presence and location of caries was done visually with the aid of a dental probe in all the observable teeth.

The majority of dental caries appeared at the cemento-enamel junction, or the appositional surfaces in all the groups. The frequency of caries as well as the severity of lesions increased gradually from the Migration Period to the Early Modern Period. No severe caries lesions (to the pulp) were registered in the Migration Period, and in the Early Modern Times 27% of caries lesions were penetrating to the pulp chamber.

These differences in the frequency and the pattern of caries distribution show possible dietary and subsistence differences between groups. The distribution, as well as the overall prevalence of cavities, suggest that in later periods the diet was probably more cariogenic and less abrasive.

Keywords: *dental caries, caries location, Estonia, the Late Iron Age, the Middle Ages, the Modern Times*

INTRODUCTION

Recording dental features in archaeological human remains and using these data to describe lifestyle and health of ancient population has been an important area of investigation throughout much of the history of dental anthropology [6]. In archaeology teeth have a special value – teeth have a strong structure and they preserve better than other parts of the skeleton. Teeth are usually the only preserved part of skeleton that have been in direct contact with the environment. Because of this teeth are susceptible to damage from physical and biological influences not operating on other skeletal elements [16].

Most of the dental diseases observed in archaeological skeletons appear as a result of the exposure of teeth to foodstuffs and the associated material taken into the mouth. The mouth functions primarily as a food processor and the composition of food reflects on the person's teeth condition [10]. Diet and nutrition are major environmental factors in the etiology and the pathogenesis of craniofacial diseases [15]. So the analysis of dental pathologies can be useful in describing health as well as nutritional habits. Alongside the pattern of dental attrition and the analysis of stable isotopes, dental caries epidemiology is one of the most important ways in which the diet of past populations can be reconstructed [4]. Dental caries is probably the most investigated dental pathology and it is also the most common disease among living and ancient populations [10]. It is the consequence of the progressive destruction of calcified dental tissues due to the demineralization caused by the acids produced during the bacterial fermentation of dietary carbohydrates, especially sugars [6, 10]. These microorganisms are housed in plaque, so wherever plaque accumulates caries may develop [3]. Most often caries begins in the fissures of tooth crowns and in the interproximal areas [16]. The frequency of affected individuals or teeth is recorded in almost all the reports on human remains from archaeological sites and this provides valuable source for the reconstruction of dietary habits and the lifestyle for skeletal populations. Past studies have related increases (or decreases) of caries to the diets that are more (or less) heavily dependent on cariogenic food as a result of the decreased (or increased) access to a more varied diet, where proteins and other less-cariogenic products are in the diet, where proteins and other less-cariogenic products predominate [2]. The more detailed registration of caries – the primary location of lesions, the severity of lesions, enables to understand better the relationship between the diet and the dental health.

The aim of this study was to observe dental caries location patterns in different skeletal series from Estonia and to find temporal changes in the prevalence, location and severity of dental caries.

MATERIAL AND METHODS

In the current study 6 skeleton series from Estonia were studied – **1. Lepna** 5th–7th cc. The Migration Period, fragmentary human remains from a possible mortuary house [9]; **2. Jõuga** 11th – 16th cc. Votic graves [7]; **3. Pada** 12th–13th cc. Late Iron Age single underground burials from a stronghold cemetery [13]; **4. Tääksi** 14th–18th cc. village cemetery [12]; **5. Pärnu** 17th–18th cc. town, St. John church cemetery [1]; **6. Hargla** 18th cc. parish cemetery [8] (Figure 1).

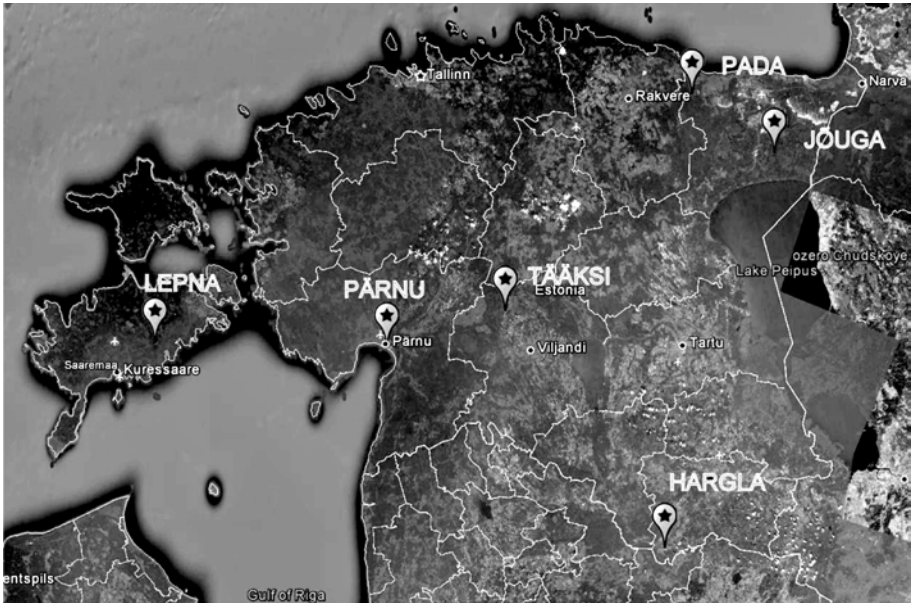


Figure 1. Location of studied skeleton samples.

The analysed individuals were over 15 years of age. In the case of the Lepna fragmentary material only the fully developed teeth with clear signs of attrition were analysed.

The skeleton series had a very different level of preservation. In the Pada group the skeletons were very well preserved and the mean number of the observed teeth per individual was **23.1**. In the case of Hargla only **11.6** teeth per individual were observed (Table 1).

Probably in the Lepna group this number was even smaller as the bones were scattered and highly fragmentary. However, in all the groups the most numerous were molars followed by premolars (Figure 2). A total of 5,838 teeth were observed (Table 1).

Table 1. Number of observed teeth in the group and the number of observed teeth per individual.

	Number of observed teeth	Number of teeth per individual
Lepna 5.–7. cc (possible mortuary house)	203	–
Jõuga 11.–16. cc (votive graves)	2040	15.7
Pada 12.–13. cc (stronghold cemetery)	1878	23.1
Tääksi 14.–18. cc (village cemetery)	877	19.9
Pärnu 17.–18. cc (town cemetery)	612	12.3
Hargla 18. cc (parish cemetery)	228	11.6
Total	5838	

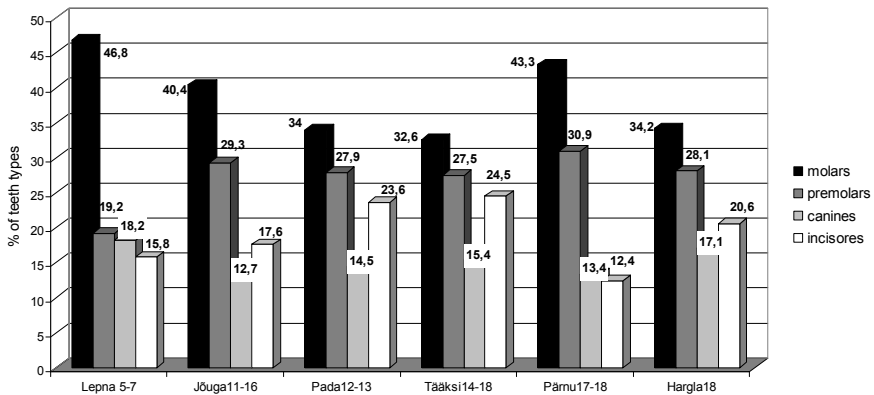


Figure 2. Percentage of different tooth types among the observed teeth.

All the teeth in the skeleton series were divided into the younger (from individual in *juvenilis & adultus*) and the older (from individual in *maturus & senilis*) age group to find out if there were differences in the age distribution between skeletal series (Figure 3). The incidence of caries increases with age [4, 6], in the archaeological skeleton series as well as in the living populations.

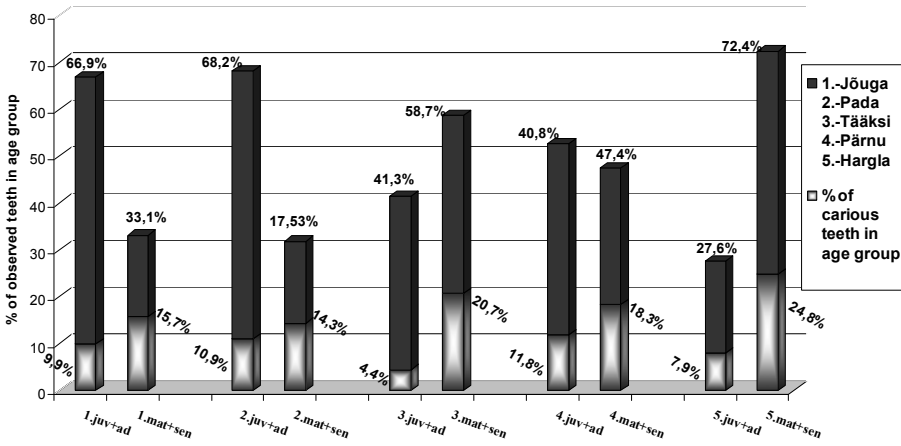


Figure 3. Percent of teeth from younger (juvenilis+ adultus) and older (maturus+ senilis) individuals in observed groups and caries incidence in age groups.

The occurrence of caries was registered in all the teeth and the incidence was calculated per different tooth types (molars, premolars, canines, incisors).

The primary location and the severity of caries were also registered. The primary location of caries was defined as: occlusive, root surface, neck or crown approximal, or undetectable (strong caries, the primary location was not possible to determine, caries had reached at least to dentine). All the teeth were observed *in situ* and with naked eye.

RESULTS

The total incidence of caries was the lowest (6.89%) in the earliest sample of Lepna (5.–7. cc.) and the highest (20.17%) in the latest Hargla (18. c.) group (Table 2). The occurrence of caries increased over time. Among different tooth types molars were most frequently affected in all the studied groups (Table 2). Differences between groups did not depend on whether all the teeth or only molars were observed. The only exception was the difference between the Hargla and the Pärnu/Tääksi groups: when all the teeth were observed, the incidence of caries was the same in both groups, but on molars the difference was statistically significant.

Table 2. Number of observed teeth and the occurrence of dental caries.

	Total teeth			molars			premolars			canines			incisors		
	N	caries		N	caries		N	caries		N	caries		N	caries	
		n	%		n	%		n	%		n	%		n	%
Lepna 5–7cc	203	14	6.9	95	10	10.5	39	3	7.7	37	1	3.7	32	0	0
Jõuga 11–16	2040	241	11.8	827	154	18.6	596	59	9.9	259	12	4.6	358	16	4.5
Pada 12–13	1878	228	12.1	639	129	20.2	525	58	11.0	270	16	5.9	444	25	5.6
Tääksi 14–18	877	129	14.7	282	67	23.7	238	33	13.9	133	14	10.5	224	14	6.2
Pärnu 16–18	612	91	14.9	265	64	24.2	189	18	9.5	82	6	7.3	76	3	3.9
Hargla 18c	228	46	20.2	78	26	33.3	64	12	18.8	39	3	7.7	47	5	10.6

Prehistoric groups differed statistically significantly from historical groups (Table 3). No differences between the groups from the same time period were established. The groups from distinct time periods differed statistically significantly (Mann-Whitney U-test). E. g Jõuga from the end of the Iron Age had less carious teeth than Tääksi, Pärnu or Hargla from the Late Medieval and the Early Modern Times, but did not differ from the Pada group which dates back to the end of the Iron Age.

Table 3. Statistically significant differences in occurrence of caries between groups.

	Total teeth			Statistically significant differences between groups					
	N	caries		Mann-Whitney U-test ($p \leq 0,05$) – *					
		n	%	Lepna	Jõuga	Pada	Tääksi	Pärnu	Hargla
Lepna 5–7cc	203	14	6.9	X			*	*	*
Jõuga 11–16	2040	241	11.8		X		*	*	*
Pada 12–13	1878	228	12.1			X			*
Tääksi 14–18	877	129	14.7				X		*
Pärnu 16–18	612	91	14.9	*	*			X	
Hargla 18c	228	46	20.2	*	*	*	*		X

Caries occurred more often among older individuals in all the observed groups (Figure 3). Statistically significant differences (Mann-Whitney U-test) between younger and older adults were established in the Hargla and the Tääksi groups.

Differences between the studied groups were similar, whether all the adults were included or the only older age group was studied. The only exceptions were differences between Tääksi and Pada. Caries frequency in all the adults' teeth did not differ but in the teeth of older adults differed statistically significantly. Tääksi had a higher occurrence of caries.

Strong caries reaching to pulp chamber occurred most often in the Hargla Modern Time group.

The frequency of strong caries lesions increased over time as well as the total frequency of caries (Figure 4).

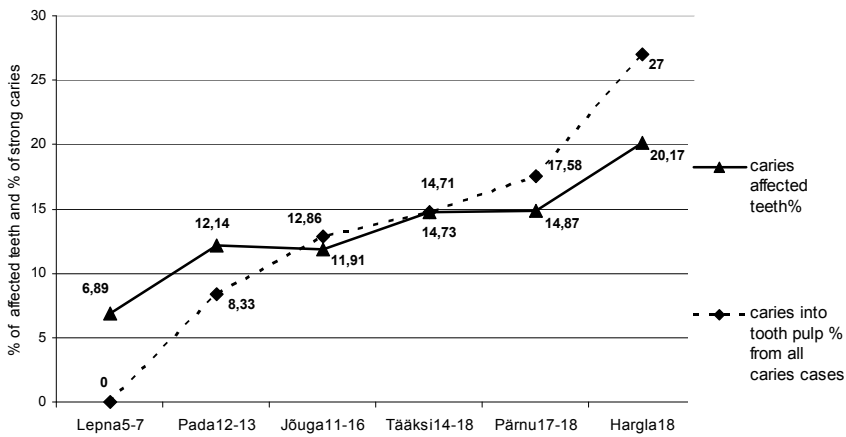


Figure 4. Caries-affected teeth and strong caries into pulp from all the observed caries cases.

In all the series caries was most frequently started from the cemento – enamel junction in mesial or distal surfaces or from the tooth crown contact point between teeth (Figure 5). Caries in the occlusal surface occurred with almost the same frequency in all the groups. Caries in the root surface occurred more frequently in the later groups but in these groups also the number of older individuals was bigger. The lesions which had progressed to the stage of large cavities, involving the underlying dentine or even pulp chamber, occurred more often in later skeleton populations (Tääksi, Pärnu, Hargla).

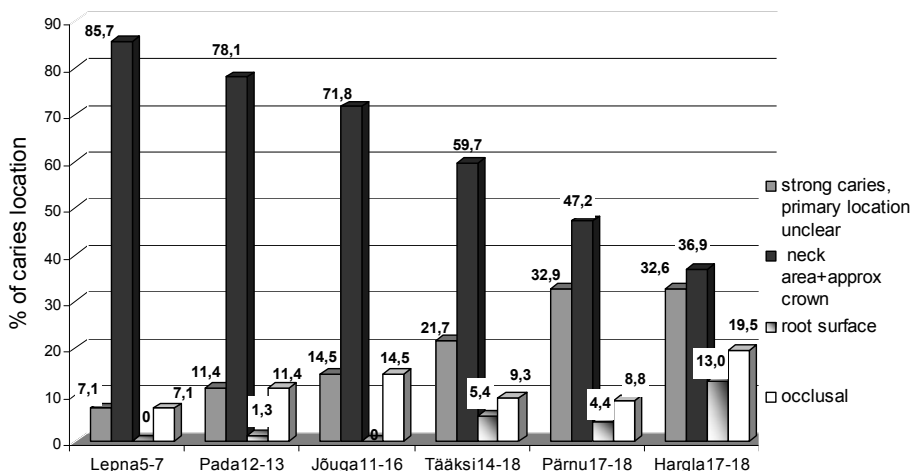


Figure 5. Primary location of caries.

DISCUSSION

There are many factors that influence the formation of dental caries spanning from oral hygiene to hormonal levels, pregnancies and lactation, including the form of food or fluid, the duration of exposure, the nutrient composition, the sequence of eating, the salivary flow, the presence of buffers, and so on. It is not possible to take into account all the factors that influence caries formation in archaeological populations but the diet is considered the most important factor. A dynamic relation exists between the diet and oral health. The diet affects the integrity of the teeth; quantity, pH, and the composition of the saliva; and plaque pH [15]. In the anthropological literature, carious lesions are commonly associated with a high carbohydrate consumption [2]. Studies have confirmed the direct relation between the intake of dietary sugars and dental caries across the life span [11, 15].

In archaeological investigations caries prevalence changes are used as an indicator of changes in the diet and the subsistence strategy [2, 3, 5, 6, 10, 14].

Among the observed groups the **frequency of caries as well as the severity of lesions** increased gradually from the Migration Period to the Early Modern Period. Probably the increase in occurrence is rather caused by changing diets or nutritional habits and not hygiene. Food was probably more cariogenic (more carbohydrates in the diet) in the later periods. Significantly higher incidence of caries in the Early Modern skeletal samples can be explained by refined sugars in the menu.

Caries-affected teeth occurred most often in the **Hargla 18 c. parish cemetery**. Probably using sucrose was common in the everyday menu and the diet was more cariogenic than in the early periods. But the number of older individuals was also highest in the Hargla group and the occurrence of caries increases with age. That is why the total amount of carious teeth might be a little higher than in other groups. More caries in the occlusive surface may be caused by a less abrasive food.

Skeletal populations from **the end of Medieval and Early Modern** (*Tääksi and Pärnu*) had a similar total frequency of caries and the location pattern of caries and the severity of lesions. But the age distribution of two groups was different. Tääksi had more teeth from older adults and older adults had caries frequency higher than in Pärnu. At the same time younger adults in Tääksi had a very low caries incidence; also there were less strong caries cases in Tääksi. But the distribution of caries was similar. Probably in Tääksi, as well as in Pärnu, the diet was rich in carbohydrates but maybe in the Pärnu group there were more sugars in the diet.

Skeletal populations from **the end of the Iron Age** (*Pada and Jõuga*) had a similar total frequency of caries, the location pattern of caries and the severity of lesions. Two groups had also a similar age distribution. It seems that these two archeologically different populations (stronghold underground cemetery and Votic graves) had similar nutritional habits and oral hygiene.

In the **Lepna migration period** the skeletal population caries frequency, the location and the severity differ from all the later period groups. The occurrence of caries is low; it is mainly located in the neck area and is not intensive.

The frequency of **caries on different tooth types** has a similar pattern in all the human groups. Molars are most often affected, then premolars and least affected are front teeth [6].

The same pattern was observed in all the studied groups.

It is suggested that that the best approach is to make comparisons separately for each tooth type [5, 6] but in the current study there was no difference if to compare the incidence of caries in all the teeth or only in molars. Statistically significant differences between the groups were the same in both cases.

The intensity of caries lesions: In most cases caries is a slowly progressive disease, it can take years for surface-visible signs to develop, and the lesions develop irregularly, with faster development interspersed by quiescent phases [4]. In very severe cases, where oral hygiene is very poor and where the diet

is very rich in fermentable carbohydrates, caries cavities evolve very quickly. In addition to the total amount of sugars in the menu the frequency of consumption is also important in the aetiology of caries [11]. Severe lesions into tooth pulp can be caused not only by cariogenic food and bad hygiene but also by frequent eating. The proportion of carious teeth was similar in the Jõuga and the Pada group likewise in the Tääksi and the Pärnu group. But severe lesions occurred more often in the Jõuga and the Pärnu group. Maybe more severe caries lesions were caused by more frequent eating.

Age also affects the frequency of severe caries cases. The proportion of teeth with penetrating caries to the pulp chamber rose gradually with age (Hillson 2001). But in the current case it is hardly the reason for differences between Pada and Jõuga or Tääksi and Pärnu. Jõuga and Pada had a similar age distribution and in the Tääksi group even more teeth were from older adults than in the Pärnu group.

The location of caries lesions: Larsen (1991) has stated that in the lowest caries rate populations the occlusal fissures of first molars are generally affected and when the caries rates rise the occlusal sites in the second molars are involved and, higher still, the approximal sites of the molar crowns are affected. In the current study temporal changes in the frequency of occlusive caries were not established, but the frequency of approximal neck and coronal caries decreased from the Migration Period to the Early Modern.

Dental caries can occur on any surface of a tooth that is exposed to the oral cavity, but not the structures that are retained within the bone. When the root surfaces of teeth are exposed by continuous eruption, or the recession of the gingivae and underlying supporting tissues related to the periodontal disease, caries can develop on the root surface.

The proportion of an individual's teeth affected by coronal or root surface caries rose with age. In the Hargla group the root caries occurred most often and the proportion of teeth from older individuals was also the highest.

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