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ORIGINAL ARTICLE

Caries experience in the permanent dentition among first- and second-grade schoolchildren in southeastern Estonia

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Abstract

Objective. This study aims to assess the caries experience among first- and second-grade children in the elementary schools of southeastern Estonia. ***Materials and methods.*** A representative sample of 485 children was studied. The mean age of children in the first grade was 7.8 years (SD = 0.35) and in the second grade 8.8 years (0.38). The clinical examinations using ICDAS criteria were completed by four calibrated examiners. The inter- and intra-examiner consistency of the examiners was high (surface and tooth-based kappa >0.9). ***Results.*** The mean caries experience of dentinal caries lesions was 0.8 ($D_{4–6}$MFT) and 1.6 ($D_{4–6}$MFS) among the first graders and 1.1 ($D_{4–6}$MFT) and 1.6 ($D_{4–6}$MFS) among the second graders. The mean caries enamel lesions among the first graders was 1.6 ($D_{1–3}$T) and 2.2 ($D_{1–3}$S) and among the second graders 2.1 and 3.0, respectively. The most affected surfaces were the occlusal surfaces of the lower first molars. The prevalence of sealants was very low—only 2.4% of the first molars were sealed among the first graders and 3.9% among the second graders. There were no statistically significant differences in caries experience or in the provision of restorative treatment between the schools. ***Conclusions.*** Caries experience is high in southeastern Estonia. Preventive programs are urgently needed.

Key Words: *caries experience, children, DMFT, ICDAS code, permanent teeth*

Introduction

The mean caries experience in Estonian children (DMFT 2.7 in 12-year-olds) is close to the average of the other European countries (DMFT 2.6) [1]. The DMFT index is higher than in the Nordic countries, but lower than in the other Baltic States [2,3]. A distinctive feature in Estonia is the inconsistency of the prevalence of caries: it is lower in the western part of the country, where the level of fluorides in the drinking water is high, and higher in southern and southeast Estonia, where the fluoride levels are predominantly below 0.3 mg/L. The connection between caries experience and the fluoride level in drinking water was verified by a study of ground water covering all districts of Estonia [4].

In Estonia, children start school at the age of 7, meaning that they usually already have their first permanent molars and their permanent incisors erupted. Children in the first grade of school have more control over the composition of their diet and the frequency of their eating than they had when in kindergarten. Elementary schooldays are only 4–5 hours long and that period includes one mealtime. Most schools have canteens where children can buy soft drinks and snacks that are predominantly cariogenic. School snacking has been shown to carry great risk of caries development [5,6]. The study carried out in municipal schools in Tartu showed that the percentage of the primary dentition affected by caries in 7-year-old pupils was 83.8% (dmfs 7.7) compared to 62.1% (dmfs 5.3) in Danish children of the same age [7]. Among 12-year-old Estonian children caries prevalence was 69.5% and among 15-year-olds even higher, 81.0%. The mean DMFT in 12-year-old pupils in Tartu was 1.8 and DMFS 2.1 [8]. Dental treatment is state-subsidized for all the children up to the age of 19. Annual oral and dental examinations in kindergartens and at schools are provided by the state. At the same time the examination is voluntary—both

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the child and the parents have the right to refuse treatment. In addition, residents have the right to choose their dentist.

Initial, as yet non-cavitated caries lesions in the permanent dentition, cavitated lesions in primary molars and the combinations of past caries experience variables have been suggested as predictors of caries [9,10]. Caries experience in 5–6-year-old children is known to be a risk factor for caries in their permanent dentition [11]. By comparing caries indicators in permanent teeth in first- and second-grade children, conclusions can be drawn about further caries prognosis and the requirements for treatment and prevention among those age groups [12].

The aim of this study was to examine caries prevalence and experience in the permanent teeth of first- and second-grade schoolchildren in southeastern Estonia.

Materials and methods

The Ethical Committee of the University of Tartu approved the study (166/T-7). The approval of the School Management Authority and school principals was also requested for this study. Written informed consent for oral examination was obtained from the parents/caregivers. The southeastern region of Estonia was chosen for the study as the DMFT index in this region is one of the highest in Estonia.

Data collection

The total number of schools in the southeastern region of Estonia in 2008 was 102 and the combined number of first- and second-grade children was 4150 [13]. The sampled schools selected were geographically dispersed around the southeastern region of Estonia and drawn from all elementary schools of this region. The size of school (small, average or large) was taken into account. Sampling was based on the proportional distribution of schools in each county: one urban school (from the major city of the region), four regional center schools, four rural schools and one where kindergarten and elementary school were together.

An invitation to take part in the survey was sent to the management of schools in the stratified sample. If a school declined to participate (one school) or did not respond (10 schools), another school with similar parameters (size, location) from the same region was selected. Reasons for refusal were not requested. When the school agreed to participate in the survey all first and second grade children were involved. The initial number of children would have been 522. The non-participation rate among children was 7.0% (n = 37); 7.8% (n = 22) among boys and 6.3% (n = 15) among girls. According to the teachers, the main reason for not taking part in a study was illness on the day of the examination. The final sample of the first- and second-grade pupils was 485 from 10 different schools (Table I). Of all the schools in this area, 9.8% participated in this study, ending up to 11.7% of all the first and second graders. The mean age was 7.8 years in the first (SD = 0.35) and 8.8 years (SD = 0.38) in the second grade.

No treatment procedures were carried out during the examination. After the examination of their dentition, the children were given a written information sheet for their parents, indicating whether they needed restorative or orthodontic treatment. Those children requiring treatment were advised to visit their family or school dentist.

Dental examination

The clinical dental examinations were organized in January 2008 in the Department of Stomatology of the University of Tartu in four standard dental treatment units. The children were transported by bus from their schools to the examination site. A visual examination was carried out by four trained and calibrated examiners. All the examiners were senior academic staff with long clinical experience. The training and calibration were conducted before the examinations trials by a senior clinical researcher (EH) who had worked in the European Association of Dental Public Health (EADPH) Caries Special Interest Group. He had made a visit to the Dundee Health Services and Research Unit in January 2008, for training in ICDAS II (International Caries Detection and Assessment System) [14]. The computer-based ICDAS training course was then distributed to the other three examiners for individual self-tuition. The ICDAS criteria were discussed together with all examiners and the calibration was arranged during the 2 days prior to the commencement of the study. On the first day, eight children not involved in the study were examined by all

Table I. The number of children by school, grade and gender.

	Grade 1			Grade 2		
School	Girls	Boys	Total	Girls	Boys	Total
Descartes	10	6	16	9	13	22
Nõo	6	6	12	10	22	32
Elva	24	27	51	21	31	52
Võru	24	22	46	19	22	41
Rõngu	9	7	16	5	7	12
Võnnu	8	3	11	4	5	9
Räpina	12	21	33	18	13	31
Melliste	6	3	9	2	4	6
Tõrva	10	19	29	14	14	28
Lähte	—	—	—	13	16	29
Total	109	114	223	115	147	262

the examiners. The findings were discussed and disagreements were resolved by further discussion after re-assessment of the same child. On the second day 25 children were studied twice, by one examiner (SH or RR or JO) and by Examiner 1 (EH). During the study each examiner examined the same 10 children with Examiner 1 and 10 children were examined twice by all four examiners to estimate the inter- and intra-examiner errors. All re-examinations were made on the same day, because the children were brought to Tartu by bus and there were no resources for recall visits. The inter- and intra-examiner consistency (weighted kappa values according to Cicchetti and Allison [15]) was very high (Table II). The examination was arranged by class over 6 consecutive working days. Children were distributed at random among the four examiners. The total number of children examined by the different examiners was 125, 117, 121 and 122.

Immediately before the clinical examination, the children cleaned their teeth for 3 minutes using a soft toothbrush and fluoride toothpaste and they then rinsed their mouths with water. The tooth surfaces were examined after brushing, at first while still wet and then after using compressed air (for 5 s) to gently dry the tooth surface. The carious lesions detected were categorized with the ICDAS II criteria [14]. The advantage of ICDAS over the WHO method [16] is that all incipient caries lesions are also categorized. This method is recommended for use in caries diagnostics, as it provides more thorough information about caries development, including enamel caries lesions which can still potentially remineralize [17]. Such lesions (D_1, D_2 and D_3) and dentinal caries (D_4, D_5 and D_6) were noted separately for each tooth surface. The examination took place primarily visually, using a dental mirror and dental unit light. The WHO probe was used to diagnose and to make a differential diagnosis of the lesions.

Table II. The intra- and inter-examiner consistency by weighted kappa statistics (according to Cicchetti and Allison [15]).

Examiner	Caries codes by surfaces	Restorations/sealants codes by surfaces
Intra-examiner consistency		
1	0.995	0.999
2	0.990	0.992
3	0.985	0.985
4	0.983	0.988
Inter-examiner consistency		
1 vs 2	0.991	0.996
1 vs 3	0.990	0.989
1 vs 4	0.989	0.998

Data analysis

Data analysis was carried out using the SPSS/PC software package, version 17.0. The numbers of individual ICDAS codes were presented according to the surfaces of the first permanent molars, where the caries lesions were more prevalent than in the incisors. In the further analysis, the teeth surfaces having ICDAS codes 1, 2 and 3 were counted together as enamel caries ($D_{1–3}$) and the teeth surfaces with ICDAS codes 4, 5 and 6 together as dentinal caries ($D_{4–6}$). Caries experience ($D_{4–6}$MFT/$D_{4–6}$MFS) was calculated based on the number of permanent teeth or tooth surfaces with dentinal caries ($D_{4–6}$), treated caries (FT/FS) and/or missing teeth/surfaces (MT/MS) because of caries. The mean numbers of the sealants were counted from the first molars (16, 26, 36 and 46).

The analysis of variance was used to compare the means of different indices according to grade, gender and school. Standard error (SE) was used as a measure of central tendency. The significance was set at $p < 0.05$.

Results

The mean caries prevalence (the proportion of children with $D_{4–6}$MFT >0) in the permanent dentition was 36.2% among the first graders and 48.3% among the second graders. The mean $D_{4–6}$MFT was 0.8 (SE = 0.11) and the mean $D_{4–6}$MFS 1.6 (0.31) among the first graders (Figure 1). The respective figures were 1.1 (0.10) and 1.6 (0.17) among the second graders. There were no statistically significant differences in caries experience between boys and girls. Nor did the mean number of enamel caries lesions ($D_{1–3}$T, $D_{1–3}$S), dentinal caries lesions ($D_{4–6}$T, $D_{4–6}$S) and restorations (FT, FS) differ between boys and girls. The mean number of enamel caries lesions ($D_{1–3}$T and $D_{1–3}$S) and restorations (FT and FS) was significantly lower for the first graders than for the second graders. The mean $D_{1–3}$T for the first graders was 1.6 (0.10) and the mean

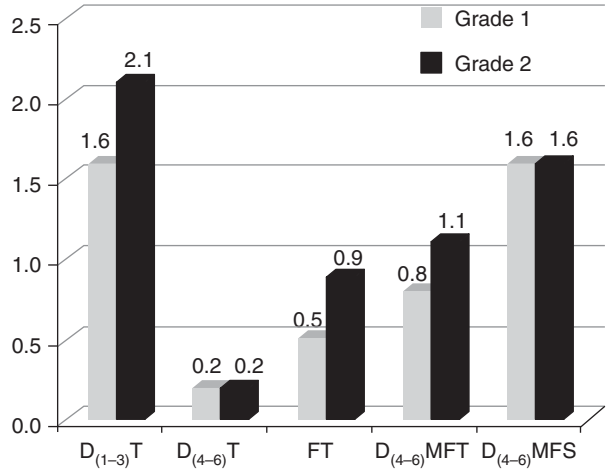

Figure 1. Mean caries indices (enamel and dentine) by grade.

$D_{1–3}S$ 2.2 (0.16) and for the second graders the numbers were 2.1 (0.11) and 3.0 (0.18), respectively. There was no statistically significant difference between the grades in the number of dentinal caries lesions ($D_{4–6}T$ in both groups was 0.2; SE = 0.06/0.03). $D_{4–6}S$ for the first graders was 0.4 (0.12) and among the second graders 0.2 (0.04).

By age 7–8 the first permanent molars and the permanent incisors had erupted. The pre-molars were rarely erupted, except in a few cases where the primary molars had previously been extracted due to complication with caries. The upper permanent incisors had recently erupted and only a few caries lesions limited to enamel ($D_{1–3}$) were found in the whole sample. The lesions were located on the proximal, labial and/or palatal surfaces of all upper incisors. On the lower incisors only two very early caries lesions were detected.

The most frequently defective permanent teeth were the first molars. The mean number of each ICDAS code (1–6) in the upper and lower first molars according to tooth surfaces (Table III) indicates the presence of caries mainly on the fissures (occlusal surfaces, buccal fissures of lower and palatal fissures of upper molars). Restorative treatment had been provided in 10.9% of the upper molars (16 and 26) and in 21.0% of the lower ones (36 and 46). These proportions were higher for the second graders at 13.3% and 23.8% than for the first graders, at 7.7% and 16.5%, respectively. There were quite a few sealants, on average only 2.4% of the first molars were sealed among the first graders and 3.9% among the second graders.

There were statistically significant differences in the mean number of enamel and dentinal caries lesions ($D_{1–3}T$, $D_{4–6}T$ and $D_{4–6}S$) between the schools, but the differences in the mean $D_{4–6}MFT$ and the mean $D_{4–6}MFS$ were not significant (Table IV). The mean $D_{1–3}T$ varied between the schools from 0.9–2.2 and the mean $D_{1–3}S$ from 1.2–3.5. The mean $D_{4–6}T$ varied from 0.1–0.9 and the mean $D_{4–6}S$ from 0.1–1.9 (p = 0.001). The mean FT was 0.7 (0.06) and the FS 0.9 (0.08). The mean FT varied between the schools from 0.3–1.2 and the mean FS from 0.3–1.4.

Table III. The mean number of each ICDAS code in upper and lower first molars by tooth surface.

	ICDAS codes						
	0	1	2	3	4	5	6
16/26							
M	98.8	0.3	0.4	0.3	0.0	0.2	0.0
O	63.5	12.5	17.2	4.5	0.8	1.5	0.0
D	100.0	0.0	0.0	0.0	0.0	0.0	0.0
B	98.6	2.2	4.9	0.2	0.0	0.1	0.0
L	84.2	4.8	9.1	1.1	0.3	0.5	0.0
36/46							
M	95.3	0.3	3.7	0.4	0.0	0.2	0.1
O	69.6	7.6	13.7	6.5	1.2	1.1	0.3
D	99.8	0.0	0.0	0.1	0.0	0.0	0.1
B	64.8	9.5	16.5	7.4	0.6	1.0	0.2
L	98.0	0.5	1.4	0.0	0.0	0.0	0.1

Discussion

This is the first descriptive epidemiological dental caries study in Estonia using the ICDAS method. The earlier studies have used the WHO criteria [16] and the enamel caries lesions have not been detected. It is more demanding and time-consuming to determine all six stages of the caries process in enamel and dentine compared to recording the existence of dentinal caries alone. However, early studies have confirmed that use of the ICDAS method is appropriate for caries detection and can be applied quite quickly (3–4 min per child) [18,19]. When lesions are open for inspection, the ICDAS is a more reliable and accurate method than the radiograph for detecting and estimating the depth of the lesion in both primary and permanent teeth [20]. Thus, the ICDAS method is effective when examining large groups of children and the possibility to take dental radiographs routinely is neither ethical nor feasible nor possible, especially during the years of the mixed dentition stage [21].

The high intra- and inter-examiner consistencies in this study were based on the long clinical experience of the examiners and on the careful training and calibration of the examiners. The modern clinical facilities of the dental school made the examinations more reliable than examinations conducted at different schools or in field conditions would have been.

Random sampling for an epidemiologic study is not easy. For the representative sample the stratification

Table IV. Mean $D_{4–6}MFT$ and $D_{4–6}MFS$ indices and their standard errors by schools.

School	*N*	Mean $D_{4–6}MFT$ (SE)	Mean $D_{4–6}MFS$ (SE)
Descartes	38	1.5 (0.45)	2.3 (0.81)
Nõo	44	0.6 (0.16)	1.6 (0.47)
Elva	103	0.9 (0.16)	1.6 (0.49)
Võru	87	1.2 (0.16)	1.9 (0.32)
Rõngu	28	0.9 (0.19)	1.1 (0.32)
Võnnu	20	1.4 (0.41)	2.4 (1.22)
Räpina	64	0.8 (014)	1.1 (0.22)
Melliste	15	1.3 (0.74)	2.5 (1.73)
Tõrva	57	0.8 (0.16)	1.6 (0.42)
Lähte	29	0.7 (0.25)	1.0 (0.37)
Total	485	1.0 (0.07)	1.6 (0.17)

according to the county, the size of the school and the urban–rural ratio was considered important in this study. The random sample was drawn at the beginning. However, it was not mandatory for the school administrators to participate in this study and the schools which refused to participate or did not reply were replaced by other ones. These schools were not randomly selected but were from the same area and had the same size and urban–rural ratio. The non-response by the schools might have caused a bias in the representativeness of the sample. However, the decision not to participate in was by the principals or the management of the school and not by the pupils. Most of the children participated, except the children who were absent from the school on the day of the examination.

In the further analyses the enamel caries lesions were grouped together, as were the dentinal caries lesions. The results of the mean D_{4-6}MFT and the mean D_{4-6}MFS indices cannot be considered to be equivalent to the results of the other surveys with the WHO methods. However, the feasible differences could be expected to be quite small.

The D_{4-6}MFT index of 7–8-year-old children in southeastern Estonia seemed to be higher than the Estonian average. The caries prevalence and the mean D_{4-6}MFT and D_{4-6}MFS indices are in accordance with the results of the previous studies [7,11]. There was a significant difference between the D_{4-6}MFT of the first and second graders. Among the second graders the untreated caries (D_{4-6}T) and treated caries (FT) contributed fully to the D_{4-6}MFT scores, but the sum of D_{4-6}T and FT left a score of 0.1 for the MT component among the first graders. This obviously reflects a higher prevalence of extractions among the first graders. This probably follows from the more radical treatment approach adopted for first graders than for second graders.

The permanent first molars and incisors had recently erupted. This study shows that the first molars (especially the pits and fissures) are the first affected permanent teeth. In the incisors, there were only a few early caries lesions which were limited to the enamel. The lower permanent incisors were least affected because of the protection of the saliva. The ICDAS code 2 (enamel caries lesion without cavitation, but visible on the wet surface) appeared to be the most common finding. The prevalence of the dentinal caries codes was very low, indicating a high coverage of restorative treatment.

The statistically significant difference in the mean caries scores between the schools might be explained by the differences in the social structure in the area [10,22,23] as well as low fluoride content of the drinking water [24–26]. The mean caries scores were also different in different types of schools (urban/rural schools). The differences between the schools were especially notable in dentinal caries (D_{4-6}T, D_{4-6}S). A remarkably high number of untreated dentinal caries surfaces were detected in the children of a small rural school (Melliste). It could be assumed that in small villages families have a lower socio-economic status [27]. As the classes were small (nine first graders and six second graders), the difference was not statistically significant.

The occurrence of caries on the mesial and in particular on the distal tooth surfaces was very low. Proximal caries lesions usually develop on a later age. This study design did not include dental radiographs (bite-wings) and some proximal lesions on the mesial surfaces of molars might have been undetected by the used visual tactile method.

Most significant difference between the first- and second-grade pupils was in the number of incipient caries lesions (D_{1-3}T, D_{1-3}S), which shows the development of active caries during teeth eruption. There was obvious lower occurrence of early caries lesions (both D_{1-3}T and D_{1-3}S) in children of one school (Descartes). This school is located in the region with high fluoride content in drinking water [4]. Some children at this school had fluorosis, which could prevent or mask early caries lesions. This could explain the surprisingly low number of enamel caries lesions in the children.

Lack of difference in caries experience between boys and girls confirms the findings of several previous studies in Estonia [7,8,11]. A lack of inter-school difference in the amount of fillings (FT, FS) reflects the equal availability of the treatment for children, irrespective of where they live. However, the number of fillings among children in some schools was quite high. Most of them were located in the buccal fissures of the lower molars, which in fact could reflect possible over-treatment (ICDAS code 3, an advanced enamel caries lesions). The significant difference in the number of filled permanent teeth and surfaces (FT, FS) between the first- and the second-grade pupils also indicates high emphasis on restorative treatment. The low prevalence of sealants confirms the need for a change in the treatment strategy towards preventive and minimal invasive approach.

Conclusions

The caries prevalence and experience are high among the children of southeastern Estonia. The results of the study showed statistically significant difference in caries prevalence between the first- and second-grade pupils. The high caries experience corresponded to the results of the previous studies. The age groups of the first- and second-grade pupils are at a critical period for caries development and require well-organized preventive efforts to prevent further caries lesions in the permanent teeth.

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