Caries Increment and Oral Hygiene Changes in 6- and 12-Year-Old Children in Riga, Latvia: A 3-Year Follow-Up Report Using ICDAS II and RADKE Criteria

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Abstract

Objectives The purpose of this study was to investigate the caries increment and oral hygiene changes over a 3-year period and also compare the sensitivity and specificity of Radke's caries assessment method to ICDAS II among 6- and 12-year-old children in Riga, Latvia.

Materials and Methods Thirty-eight 6 and thirty-nine 12-year-old children were examined visually and with bitewing (BW) radiographs for dental caries at baseline and after a 3-year period. Decayed, missing, and filled surfaces (dmfs/DMFS) in all teeth were scored by one calibrated examiner using the Radke's caries scoring criteria. Oral hygiene level was determined using Green-Vermillion index (G-V ind.) at baseline and after 3 years. ICDAS II was used to assess all children only at the 3rd-year time point. The parents of the 6- and 12-year-old children responded to a questionnaire on oral hygiene at baseline and at the 3-year mark.

Statistical Analysis The data were analyzed using *t*-test, Chi-square test, Wilcoxon test (α= 0.05), and sensitivity and specificity tests.

Results The mean (SD) values of G–V ind. and caries experience at baseline/3-year period in 6- versus 12-year-old children were as follows. G-V ind.: 1.14(0.80) /1.48(0.89) [p = 0.4768] versus 0.99(0.45)/1.45(1.22) [p = 0.0337]. DMFS: 0.72(1.02)/ 3.13(3.13) [p = 0.0000] versus 6.79(5.14)/14.79(9.86)[p = 0.0000]; dmfs: 11.26(8.71)/7.74 (4.86) [p = 0.0780] versus 3.57 (2.03)/1.5(0.71)[p = 0.3173].The sensitivity and specificity of Radke to ICDAS II of caries-affected surfaces was: in proximal surfaces–0.57 and 0.98, on occlusal surfaces–0.83 and 0.98, on buccal/lingual surfaces–0.43 and 0.99.

Conclusions The result of the present study suggests that the increased caries experience over a 3-year period among the 6- and 12-year-old children in Riga may be due to the concurrent decreased level of oral hygiene, suggesting that ICDAS II instead of Radke's criteria should be used to detect and monitor dental caries.

Keywords
- caries experience
- oral hygiene
- sensitivity
- specificity
- caries prevalence

Introduction

Dental caries continues to be the most prevalent, expensive, preventable and silent global epidemic in humankind.[1] Traditional epidemiologic surveys only score established cavitated caries in dentine.[1] However, the inclusion of initial lesions in addition to moderate and advanced lesions is becoming more common with the use of screening tools such as the International Caries Detection and Assessment System[1] (https://www.iccms-web.com). The percentage of children with caries

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increased dramatically to 52% when noncavitated enamel lesions were also included.[1] This proportion would increase still further if radiographic information were also available.[1]

This study was designed to investigate the caries increment and oral hygiene changes among 6- and 12-year-old children in Riga, Latvia, over a 3-year period and also compare the sensitivity and specificity of Radke's caries assessment method with ICDAS II in Riga's children initially aged either 6 or 12 years.

Materials and Methods

Sample Size

The study was performed at the RSU Institute of Stomatology, Riga, in a population comprising 6- and 12-year-old children, who were inhabitants of Riga and visited the RSU Institute of Stomatology for dental treatment. There is no water fluoridation in Latvia and its capital Riga. The government sponsors preventive procedures (hygiene instruction, removal of dental plaque or calculus, and application of F-gel or F-varnish) for every child, which is provided by the dentist or the hygienist only once annually; only for 7- and 12-year-old children, these procedures are available twice annually. Thirty-eight children initially aged 6 years and 39 children initially aged 12 years were examined using Radke's criteria. All children were examined at baseline and after 3 years. All patients and their parents volunteered to participate in the study. Informed consent and a study information paper were signed by the parents and their children, which is in accordance with the regulations of the Ethics Committee of the Riga Stradins University (Approval nos. 834 and 967). The sample size was limited by the number of patients of the selected ages who visited the RSU Institute of Stomatology. Subjects were recruited by poster advertisement at the RSU Institute of Stomatology for their primary examination that took place over a two-year period from 2006 to 2008. Recruitment was facilitated by exempting the volunteers from the 2-month appointment waiting period required for regular complete (including radiographic examination) dental checkup. In the 3-year period, all subjects were called to visit a dentist for the regular checkup (including examination with bitewing [BW] radiographs). Additional diagnostic radiographs were taken if they were required to diagnose dental problems. The 3-year visit examination took place over a 1.5-year period from the end of 2009 to the beginning of 2011. The dropout rate was 0%.

Oral Examination Procedure

The children were examined in a dental operatory after they were seated in a dental chair with proper lighting. The examination environment, procedure, and sequence employed during normal dental checkup were maintained throughout the study, including protocols for infection control and sterilization.

Caries Diagnostic and Scoring Criteria

Only one calibrated dentist–examiner (JG) was involved in examining the children. A tooth was deemed to be present in the oral cavity when part of its occlusal surface was visible without the need for gingival displacement. The examiner was calibrated on visual examination by a caries detection expert, using the first 15 patients who were not included in the study. Agreement to the set standard was quantified by Kappa analysis.[2] The Kappa[2] scores for intra-examiner and inter-examiner (examiner–calibrator) were 0.81 and 0.87 respectively (any score > 0.70 was considered to be acceptable as adequate agreement). All data was placed in the official dental patient chart.

ICDAS II

Using the two-digit ICDAS II criteria (https://www.iccms-web.com), visual caries assessment was performed on every surface of each tooth on all participants. Visual examination was performed on clean, plaque-free teeth, with careful drying of the lesion/surface to identify early lesions. All examined surfaces were counted as follows: noncavitated lesion (ICDAS 0–2), noncavitated lesion around restorations (ICDAS II (first digit 3–8), cavitated lesion (ICDAS II 3–6), or cavitated lesion around restorations. ICDAS II was measured in both age groups only in the third year of the study, since it was not accepted as the "gold standard" when this study was started but became the gold standard prior to the third year of the study.

Radke's Criteria and Bitewing X-rays

Using Radke's criteria, caries lesions were assessed by visual examination and BW radiography. After the ICDAS II has been performed, teeth were cleaned and made plaque-free before the Radke's criteria were used to rank dental caries. A visual–tactile examination of all teeth was conducted after drying the teeth, ensuring that they were not covered in pools of saliva. A community periodontal probe (WHO probe 550B, LM Dental, Finland) was used to verify the diagnosis for pits and fissures. Caries was diagnosed at the level of dentin involvement, using the WHO methodology and assessment criteria[3] (WHO 1997). Assessment was based on a hierarchical principle that assigned each tooth (and surface) to one of six mutually exclusive categories–sound, decayed, restored, missing due to caries, and missing due to other reasons or absent (unerupted). BW radiographs were used to detect caries on proximal surfaces, and caries was noted when there was a radiolucency in the dentin or caries had broken through the Enamel–Dentin junction (EDJ) but without obvious spread in dentin. With Radke's criteria, radiolucency limited itself only to the enamel (not reaching the EDJ) and was not recorded as carious surface. Caries experience was evaluated using dmft/DMFT and dmfs/DMFS in all participants.

Assessment of Oral Hygiene

Green-Vermillion oral hygiene index (G-V ind.)[4] was used to determine the oral hygiene level in both age groups at baseline and at the 3-year visit mark.

Questionnaire on Oral Hygiene

Identical questionnaires were used to obtain information on oral hygiene at the baseline and at the 3-year period in both age groups. The use of toothpastes (TP) with or without

fluoride (F) was recorded along with the frequency of tooth brushing, as well as the use of F-containing tablets. Questionnaires were administered to both 12-year-old children and parents, if their children were 6 years old, while waiting for their examinations. The parents provided all the responses for their children aged 6 years at the baseline and 3-year visit marks. For the 12-year-old children, questions were answered by themselves but their parents may have helped with the responses at the baseline and the 3-year visit marks.

Statistical Analysis

Data was analyzed using SPSS software package (IMB SPSS Statistics v.22, RStudio v. 1.0.153 and Excel 2013), with $p < 0.05$ chosen as a level of statistical significance. Statistical analysis was performed by calculating mean values (standard deviations) using *t*-test, chi-square test, Wilcoxon test, and sensitivity and specificity tests.

Results

Assessment of Oral Hygiene

G–V ind. at baseline and after the 3-year period among 6- and 12-year old children are shown in ►**Figs. 1** and **2.** G–V ind. significantly ($p = 0.0337$) increased over the 3-year period among the 12-year-old children but not among the 6-year-old children ($p = 0.4768$).

Examination of the questionnaires revealed the percentage of study subjects using toothpaste and fluoride tablets, the type of toothpaste, frequency of tooth brushing, and whether tooth brushing was supervised or unsupervised among 6- and 12-year-old children at the baseline and 3-year period (►**Table 1**). The concentration of fluoride was not investigated. In a period spanning 3 years, there was no observed improvement in the oral hygiene habits and in the knowledge of the role of fluoride in dental caries prevention in both age groups.

Radke's Caries Examination

With Radke's criteria, there were significant increase in DMFT ($p = 0.0000$), DMFS ($p = 0.0000$), and decrease in dmft ($p = 0.0012$) over the 3-year study period for both the 6- and 12-year-old children (►**Figs. 1** and **2**). However, observed decrease in dmfs within the 3-year study period was not statistically significant for both the 6- ($p = 0.0780$) and 12-year-old children ($p = 0.3173$; ►**Figs. 1** and **2**). All surfaces were examined using dmfs/DMFS but the data are presented separately for proximal, occlusal, and buccal/lingual in both age groups at baseline and at the 3-year period. The mean (SD) values observed with Radke's criteria in 6- versus 12-year-old children were statistically significant, as shown below.

- all surfaces 95.52(8.21)/100.4(9.14) [$p = 0.0073$] versus 118.92 (9.66)/125.23(4.88) [$p = 0.0003$] (►**Figs. 1** and **2**) (e-mail: mrahabi@taibahu.edu.sa)
- all aproximal: 42.68(3.46)/ 44.47(3.93) [$p = 0.015$] versus 52.31(3.91)/54.87(1.99) [$p = 0.0002$];
- all occlusal: 10.16(1.64)/11.11(1.57) [$p = 0.013$] versus 14.26(1.86)/15.49(0.91) [$p = 0.0000$];
- all buccal/lingual:42.68(3.46)/44.47(3.93) [$p = 0.0152$) versus 52.31(3.91)/54.87(1.99) [$p = 0.0002$];

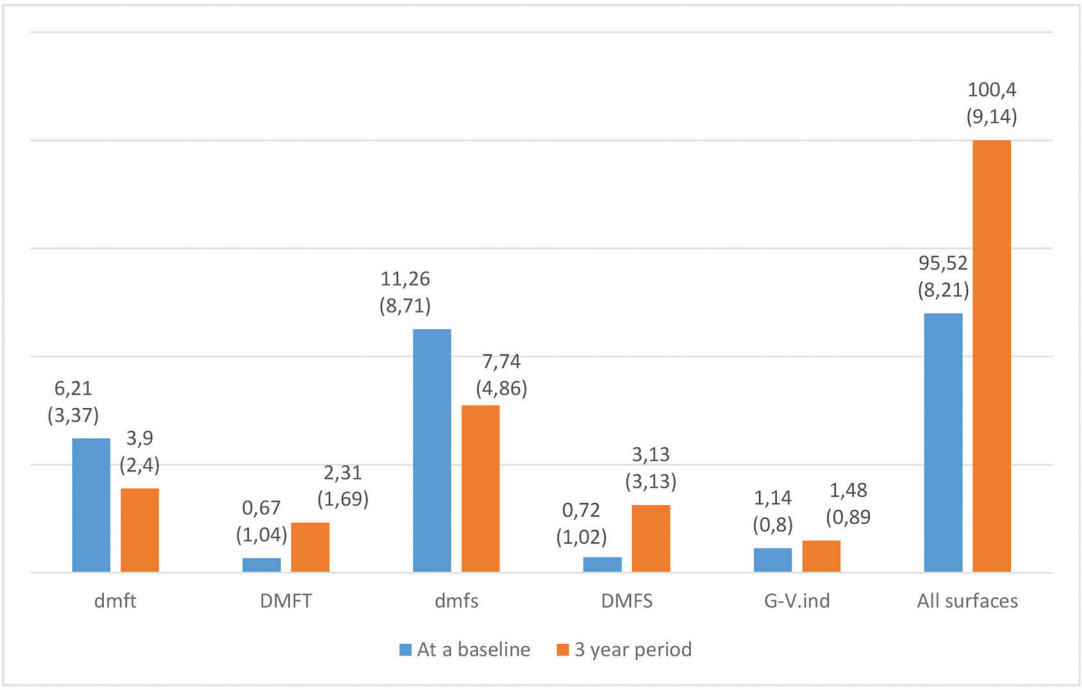

Fig. 1 Mean values of dmft/DMFT, dmfs/DMFS, G-V ind., and all examined surfaces in 6-year-old children over a 3-year period. Green-Vermillion index, G-V ind.

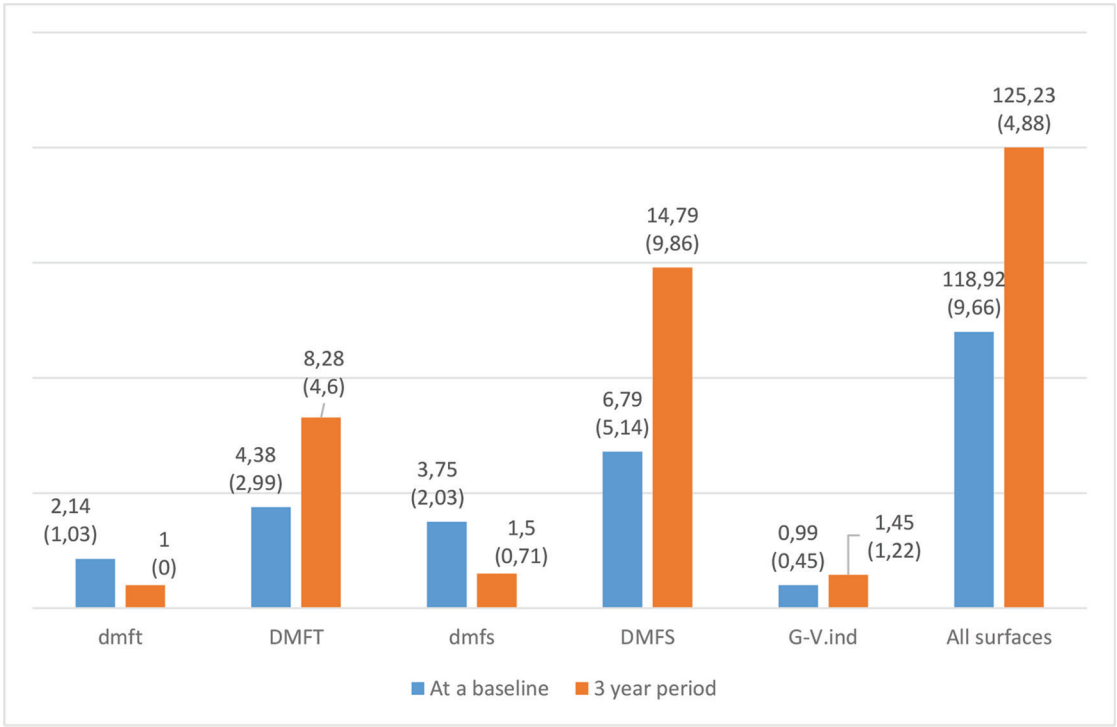

Fig. 2 Mean values of dmft/DMFT, dmfs/DMFS, G-V index and all examined surfaces in 12-year-old children over a 3-year period. Green-Vermillion index, G-V ind.

- buccal/lingual filled (fs + FS): 0.87(2.35)/1.32(2.12) [p = 0.0264] versus 0.72(1.08)/1.79(2.11) [p = 0.0008].

Only among 6-year-old children

- Aproximal decayed (ds + DS): 4.08(3.48)/2.32(2.37) [p = 0.0020]
- Aproximal filled (fs + FS): 4.07(3.48)/2.32(2.37) [p = 0,123]
- Occlusal decayed (ds + DS):1.39(1.72)/0.97(1.67) [p = 0,219]
- Occlusal filled (fs + FS): 2.58(2.38)/3.08(2.77) [p = 0,413]
- Buccal/lingual decayed (ds + DS): 0.95(1.71)/0.31(0.66) [p = 0,60]

Only among 12-year-old children

- Aproximal decayed (ds + DS):1.67(1.87)/3.12(4.17) [p = 0,192]
- Aproximal filled (fs + FS):0.87(1.54)/ 2.18(2.30) [p = 0.0004]
- Occlusal decayed (ds + DS):1.41(1.59)/1.10 (1.23) [p = 0,4693]
- Occlusal filled: 2.34(1.98)/ 4.13(2.90) [p = 0.0000]
- Buccal/lingual decayed (ds + DS): 0.69(1.45)/ 0.26(0.64) [p = 0.0089]

ICDAS II

ICDAS II was established as "a gold standard for caries detection" in 2008, but it was introduced to our study only in the third year, 2009. All surfaces were then examined using Radke's criteria (dmfs/DMFS) and ICDAS II, but the data are presented separately for proximal, occlusal, and buccal/lingual in both age groups only for the third year of the study and not at the baseline. The percentage of "decayed" surfaces (dmfs/DMFS–all cavitated surfaces; ICDAS II–all noncavitated, cavitated, filled noncavitated and filled cavitated surfaces) of each type of surface were calculated in relation to identical type of tooth surfaces (proximal, occlusal, or buccal/lingual). For example, "*decayed*" proximal surface to total number of proximal surfaces, and proximal surface to the total number of all surfaces (proximal, occlusal, and buccal/lingual). In the present study, the term "*caries affected*" surfaces is used when all decayed and filled surfaces were calculated together for DMFS and ICDAS II, as shown in ►**Table 2**. Filled or restored surfaces were included in as a sequel of caries existing previously which has been treated. This was calculated separately for both dmfs/DMFS and ICDAS II.

Sensitivity and Specificity of Radke's Method (dmfs/DMFS) to ICDAS II

Sensitivity and specificity scores of Radke's method (dmfs/DMFS) in comparison to ICDAS II for caries detection were calculated based only on cavitated caries, since Radke's method does not measure noncavitated caries. The sensitivity and specificity of Radke's method to assign caries in relation to ICDAS II (as a gold standard) were compared. The sensitivity of dmfs/DMFS to ICDAS II in approximal surfaces was 0.57 and 0.98; in occlusal, 0.83 and 0.98; and in buccal/lingual, 0.43 and 0.99. The specificity of dmfs/DMFS to ICDAS II in approximal surfaces was 0.57 and 0.98; in occlusal, 0.83 and 0.98; and in buccal/lingual, 0.43 and 0.99.

Table 1 Percentage of study subjects using toothpaste and fluoride tablets, frequency of toothbrushing, the type of toothpaste, and supervised toothbrushing among 6- and 12-year-old children at baseline and over a 3-year period (%/%[n])

Age groups	F toothpaste	Frequency of brushing	The type of F toothpaste	Supervised toothbrushing	The use of F- tablets
6-year-old	with F–60(23)/ 47,83(18) without F–7,89(3)/ 5,26(2) Don't know-31,57(12)/ 47,36(18)	"Once daily"–42(16)/ 52,63(20) "twice daily"–50(19)/ 39,47(15) ''once weekly"– 5,26(2)/0(0) Not brushing at all–2,63(1)/0(0)	"Known"–28,94(11)/ 34,21(13) "Not known"– 71,05(27)/ 65,79(25)	Supervised–55,26(21)/ 34,21 (13) Not supervised– 39,48(15)/ 65,79(25) No response–5,26(2) only at a baseline	Using-3,68(9)/ 7,89(3) Not using–76,32(29)/ 92,11(35) no response– 2,63(1)0(0)
12-year-old	with F– 53,85(21)/ 35,90(14) without F–7,69(3)/7,69(3) Don't know– 2,56(1)/56,41(22)	'Once daily'– 25,64(10)/25,64(10) 'Twice daily'–66,67(26)/ 71,79(28) ''Once weekly'–0(0)/ 2,56(1)	"Know"– 33,33(13)/38, 46(15) "Don't know"– 66,67(26)/61,54(24)		Using–17,95(7)/0(0) Not using– 48,71(19)/100 (n = 39)No response– 7,69(3)/0(0).

Table 2 Prevalence of caries based on dmfs (Radke's criteria) versus ICDAS II in 6- and 12-year-old children

	Aproximal surfaces aprox/ total DMFS vs. ICDAS II (%/%[*n*])	Occlusal surfaces occl/ total DMFS vs. ICDAS II (%/%[*n*])	Buccal/lingual surfaces B/L/total DMFS vs. ICDAS II (%/%[*n*])	All caries affected (aprox + occl + b/ll) surfaces to the total number of surfaces DMFS vs. ICDAS II (%/%[*n*])
6-year-old	Decayed–5,21/2,30(88) vs. 45,90/20,36(777) Filled–3,49/1,48(59) versus3,49/1,55(59) caries affected–8,52/ 3,78(147) vs. 49,46/21,91(836) all aprox–44,45(1690)	Decayed–8,77/1,0(37) vs. 25,83 / 2,86(109) Filled-27,73/3,07 (117) vs. 27,48/3,03(116) caries affected- 36,46/4,07(147) vs. 53,31/5,9(225) all occl– 11,09(422)	Decayed–0,71% and /0,31(12) vs. 33,85/15,0(572) Filled–2,95/1,31 (50) vs. 2,78/1,23(47) caries affected– 3,66/1,62(62) vs. 36,63/16,23(619) all B/L–44,45(1690)	All decayed surfaces/all surfaces (*n* = 3802)– 3,6(137) vs. 38,21(1458) all caries affected/all surfaces (*n* = 3802)– 10(363) vs. 44,02(1680)
12-year-old	Decayed–5,7/2,50(122) vs. 55,6/24,34(1189) Filled–4,11/1,80(88) vs. 4,11/1,80(88) caries affected–9,81/ 6,61(210) vs. 59,71/ 26,14 (1277) all aprox–43,81 (2140)	Decayed–7,12/0,88(43) vs. 40,10/4,95(242) Filled–27,5/3,4 (166) vs. 27,5/3,4(166) caries affect- ed–34,6/4,27(209) versus67,6/7,99(408) all occl– 12,37 (*n* = 604)	Decayed–0,46/ 0,21(10) vs. 40,6/ 17,8(868) Filled–3,5/1,53(75) versus3,5/1,53(75) caries affect- ed–3,96/1,74(85) vs. 44,1/19,34(943) all B/L– 43,81(2140)	All decayed surfaces/ all surfaces (*n* = 4884)– 3,6(175) VS. 47,07(2299) all caries affected/ all examined surfaces (*n* = 4884)–10(504) vs. 53(2628).

Notes: Caries affected = Decayed + filled.

Discussion

In spite of the significant reduction in caries prevalence in many parts of the world, dental caries remains a major public health problem affecting people of all ages.[5] Even with regular fluoride use, caries can still develop if caries risk factors are present and are not balanced only by the use of fluoride as a protective factor.[6,7] The present study has shown that mean values of DMFT and DMFS are almost similar at the baseline in both age groups (►**Figs. 1** and **2**) compared with the study conducted between 2006 and 2008 in Riga,[8] but they have significantly increased in both the age groups within the 3-year period. The data from the present study was collected from the smaller population group and compared with both larger populations (141 children of the age of 6 and 164 children of the age of 12) in the other study conducted in Riga.[8] The results of mean DMFT in both age groups, in the present study, could be compared only to the study conducted between 2006 and 2008,[8] because BW radiographs were used in both studies.

In analyzing DMFS across both age groups over a period of 3 years, the difference in mean values was 2.41 and 8.0

for 6- and 12-year-old children respectively (►**Figs. 1** and **2**). At the same time, the difference in mean values of the total number of observed surfaces in both groups in the same period was 4.88 and 6.31 for 6- and 12-year-old children respectively (►**Figs. 1** and **2**). In other words, it implies that every second, newly erupted surface of a newly erupted tooth in a 6-year-old, and every newly erupted surface of a 12-year-old is jeopardized by caries development (►**Figs. 1** and **2**) followed by further restoration. This may be attributed to parents' (of the 6-year-old children) and children's (12 years) lack of adequate knowledge of the role of F in caries prevention, as observed from review of the questionnaire data (►**Table 1**). It is worth mentioning that, in Latvia, there is no any preventive dental program which goes about educating and monitoring dental health, and also controlling the regularity of visits of children to the hygienist or dentist. Fluoride (F) is recognized as the main active ingredient in the oral hygiene arsenal which is responsible for the significant decline in caries prevalence.[9-11]

Within the 3-year period of this study, regular toothbrushing twice daily had decreased among 6-year-old children but remained the same among 12-year-old children (►**Table 1**). In the same period, the DMFT/DMFS have doubled in both age groups (►**Figs. 1** and **2**), which suggests that all children in both age groups had poor oral hygiene and inadequate exposure to fluoride. The Cochrane systemic review has found that the simultaneous use of F treatment (mouth rinses, gels, and varnishes) along with F toothpaste results in an enhanced caries reduction compared with the use of F toothpaste alone, irrespective of exposure to water fluoridation.[10] To obtain maximal caries control, it is mandatory to perform daily oral hygiene with F toothpaste and restrict the intake of dietary carbohydrates. In children until the age of 12, appropriate toothbrushing with F toothpaste has to be supervised.[10] In our study, the parental supervision of tooth brushing was reduced in 21% (n = 8) of 6-year-old children over the 3-year period (►**Table 1**.) Poor oral hygiene cannot be compensated by the intensive use of fluorides, as the biofilm removal plays a significant role in caries control together with good dietary habit.[12] Over the 3-year period, there was a statistically significant decrease in oral hygiene level among the 12-year-old population (►**Fig. 2**). At the same time, among the 6-year-old population, statistically significant changes were not achieved in the oral hygiene level, as indicated by the wide difference between the number of 6-year-old children with poor oral hygiene at the baseline (n = 9) and at the 3-year (n = 38) visit mark. This difference could be attributed to the fact that at baseline only 9 children. initially aged 6 years, had all necessary teeth completely erupted to perform G-V ind. (►**Fig. 1**).

The detection of caries is a key element in the monitoring, prevention, and treatment of the disease and also serves as a challenge in dentistry.[13] In our study, we used Radke's caries scoring criteria (dmfs/DMFS indices) to compare our caries experience results with the results of previous Latvian epidemiological studies that used Radke's caries scoring criteria. We also wanted to adopt our study to regular dental checkup procedures in any average dental office in Latvia. The limitations of Radke's caries scoring criteria, today, frequently relates to modern preventive and restorative technology, and may actually be more valid as a measure of treatment received but not measuring the number of teeth at risk. Teeth may be lost or extracted for several reasons other than caries such as periodontal disease in adults, and fractures due to parafunction and as part of orthodontic treatment in teenagers. One can also overestimate caries experience in teeth with the placement of "preventive restorations" or restorations placed to treat cosmetic issues.[14] Comparing one group where caries was recorded across the full disease continuum to one which only recorded caries at cavitation may not be valid (11). Also, Radke's caries scoring criteria data are of little use for estimating treatment needs based on the modern concept of dentistry.[14]

In our study, BW X-rays were performed at the baseline and at the three-year period as part of the dental checkup in both age groups. The number of BW radiographs depended on the eruption of the second permanent molar. When the second permanent molar was present and fully erupted, four BW radiographs were prescribed. Radiographs and visual examination are valid diagnostic tools for the detection of larger lesions but there is a need for more sensitive methods.[15-17]

Based on our study results, the caries prevalence in both age groups was rather high for all type of surfaces when the choice of caries assessment method is the ICDAS II (►**Table 2**). This could be due to the fact that Radke's caries scoring criteria does not include initial stages of caries lesion (►**Table 2**). If the noncavitated lesions are omitted, a very important message about caries prevalence and severity are missing.[18] Notwithstanding all drawbacks of Radke's caries assessment method, it has shown rather high specificity (the ability to detect "healthy surface" i.e., the surface without cavitation to be treated by operative intervention with following restoration) on all types of surfaces examined in our study in both age groups when compared with ICDAS II. However, the sensitivity (the ability to detect "surface with disease" i.e., surface with cavitation) was the highest only for occlusal surfaces in both age groups. Then again, occlusal surfaces constitute only 11.8% (n = 1026), which suggests that the ability to detect only surfaces with cavitation is not appropriate for the major part of all examined surfaces in both age groups.

Conclusions

The result of the present study demonstrated that ICDAS II, instead of Radke's criteria, should be used to detect and monitor dental caries. The study further suggests that the increased caries experience within 3 years among the 6- and 12-year-old children in Riga may be due to the concurrent decreased level of oral hygiene.

Conflict of Interest
None declared.

References

1 Pitts NB, Wright JP. Reminova and EAER: Keeping enamel whole through caries remineralization. Adv Dent Res 2018;29(1):48–54
2 Cohen J. A coefficient of agreement of nominal scales. Psychol Bull 1960;20:37–46
3 Alaluusa S, Malmvrita R. Early plaque accumulation-a sign for caries risk in young children. Community Dent Oral Epidemiol 1994;22(5Pt):273–276
4 WHO, Oral Health Surveys: Basic Methods, 4th ed. WHO: Geneva; 1997
5 Al-Akwa AA, Al-Maweri SA. Dental caries prevalence and its association with fluoride level in drinking water in Sana'a, Yemen. Eur J Dent 2018;12(1):15–20
6 Fontana M. Enhancing fluoride: clinical human studies of alternatives or boosters for caries management. Caries Res 2016;50(Suppl 1):22–37
7 Khadri FA, Gopinath VK, Hector MP, Davenport ES. Evaluating the risk factors that link obesity and dental caries in 11-17-year-old school going children in the United Arab Emirates. Eur J Dent 2018;12(2):217–224
8 Gudkina J, Brinkmane A, Abrams SH, Amaechi BT. Factors influencing the caries experience of 6 and 12 year old children in Riga, Latvia. Stomatologija 2016;18(1):14–20
9 Van Loveren C, Toothpastes. 1st ed. Basel: Karger AG; 2013
10 Fejerskov O, Cury JA, Tenuta LM, Marinho VC, Fluorides in caries control. In: Fejerskov O, Nyvad B, Kidd E, eds. Dental Caries: The Disease and Its Clinical Management. Blackwell: Munksgaard; 2015 245–276
11 Idon PI, Enabulele JE. Prevalence, severity, and request for treatment of dental fluorosis among adults in an endemic region of Northern Nigeria. Eur J Dent 2018;12(2):184–190
12 Nyvad B, The role of oral hygiene. In: Fejerskov O, Nyvad B, Kidd E, eds. Dental Caries: The Disease and Its Clinical Management. Blackwell: Munksgaard; 2015 277–285
13 Rodrigues JA, de Oliveira RS, Hug I, Neuhaus K, Lussi A. Performance of experienced dentists in Switzerland after an e-learning program on ICDAS occlusal caries detection. J Dent Educ 2013;77(8):1086–1091
14 Pitts N, Detection, Assessment, Diagnosis and Monitoring of Caries. 1st ed. Basel: Karger AG; 2009 42–47
15 Dove SB. Radiographic diagnosis of dental caries. J Dent Educ 2001;65(10):985–990
16 Rockenbach MI, Veeck EB, da Costa NP, da Costa P. Detection of proximal caries in conventional and digital radiographs: an in vitro study. Stomatologija 2008;10(4):115–120
17 Burt BA, Baelum V, Fejerskov O, The epidemiology of dental caries. In: Fejerskov O, Kidd E, Nyvad B, Baelum V, eds. Dental Caries: The Disease and Its Clinical Management. Blackwell: Munksgaard; 2008:124–145
18 Carvalho JC, Dige I, Machiulskiene V, et al. Occlusal Caries: Biological approach for its diagnosis and management. Caries Res 2016;50(6):527–542