Stomatologija, Baltic Dental and Maxillofacial Journal, 18: 14-20, 2016

Factors influencing the caries experience of 6 and 12 year old children in Riga, Latvia

Jekaterina Gudkina, Anda Brinkmane, Stephen H. Abrams, Bennett T. Amaechi

SUMMARY

Aim. Authors assessed the influence of drinking tea with sugar, level of cariogenic microflora and use of fluoride toothpaste and tablets on caries experience of 6 and 12 year old children in Riga, Latvia.

Methods. 141 six and 164 twelve year old children were examined clinically and with bitewing radiographs to determine their dmft/DMFT and dmfs/DMFS. Children or their parents responded to questionnaire on number teaspoons of sugar (TS) used per cup of tea, number of cups of tea consumed daily, using fluoride or non-fluoride toothpaste (TP), frequency of toothbrushing, using fluoride tablets or not (ft). Salivary mutans streptococci (MS) and lactobacilli (LB) levels were measured in children with dmft/DMFT>4.0 for age of 6 (73% (n=103)), and for age of 12 (54% (n=88)). Impact of variables in caries status was determined using frequency tables and ANOVA, while proportion differences were tested using chi-square test.

Results. In 6 year olds, statistically significant associations were observed between the salivary microflora (MS, LB) and dt/DT ($p=0.032$; dt=3.71, DT=0.42), use of F-toothpaste ($p=0.020$), and TS ($p<0.001$). In 12 year olds, statistically significant ($p<0.01$) associations were observed between salivary microflora and dt/DT, ds/DS and dmft/DMFT. In both age groups, significant ($p<0.001$) association was demonstrated between dmfs/DMFS and salivary microflora, F-toothpaste and TS.

Conclusions. The present study indicated that the caries development in Latvian children was associated with consumption of sugary tea and use of non-fluoride toothpaste.

Key words: sugar intake, fluoride, salivary cariogenic microflora, dietary habits, caries risk assessment.

INTRODUCTION

Oral hygiene and other preventive measures such as fluoride tablets, varnish, gels or tooth pastes and dietary control make an important contribution to the multifactor caries preventive strategy (1). Sugars are the most important factor in the etiology of caries (1, 2). The intake of sugars more than 4 times a day increases caries risk, and sugar consumption should not exceed 60 g per day for teenagers and adults, and should be less for younger children (2). The popularity of tea drinking in Latvia is considered historical and cultural, and also related to the cold climate both in summer and winter. Fluoride has raised the threshold of the effects of sugar intake on caries, but caries still remains a great problem for disadvantaged individuals in many developed and developing countries (2). Unfortunately, Latvia with its capital Riga has low content of fluoride in natural water. Only several western regions of country have acceptable concentration of fluoride in natural water, but not in the drinking water or water used in food preparation. There is no water fluoridation in the whole of Latvia, making the F-containing toothpaste and chewable F-containing tablets the only sources of fluoride.

The aim of the present study was to investigate the association between caries experience of the 6 and 12 year old children in Riga, Latvia and the number of teaspoons of sugar (ts) used per cup of tea, number of cups of tea consumed daily, use of fluoride toothpaste (TP) and fluoride tablets, frequency of toothbrushing,

[1]*Institute of Stomatology, Riga Stradins University, Riga, Latvia;*
[2]*Quantum Dental Technologies*
[3]*University of Texas Health Science Center, San Antonio, USA*

Jekaterina Gudkina[1] *– M.D., PhD, assist. prof.*
Anda Brinkmane[1] *– M.D., PhD, prof.*
Stephen H. Abrams[2] *– M.D., PhD*
Bennett T. Amaechi[3] *– BDS, MS, PhD, FADI*

Address correspondence to Dr. Jekaterina Gudkina, 20, Str. Dzirciema, Riga, Latvia.
E-mail address: j.gudkina@inbox.lv

and levels of Salivary mutans streptococci (MS) and lactobacilli (LB).

MATERIALS AND METHODS

Size of sample

The study was performed at the Institute of Stomatology, in Riga. The study population comprised of 6 and 12 year old children, inhabitants of Riga, who visited the Institute of Stomatology for dental treatment. The study population comprised of 141 six and 164 twelve year old children. All patients at the aforementioned ages volunteered to participate, with informed consent and study information paper signed by their parents and assent signed by children, in accordance with the regulations of the Ethical Committee of the Riga Stradins University. Thus sample size was limited by the number of patients at the chosen age that visit the institute. The study was approved by the Ethical Committee of the Riga Stradins University (Approval #834 & #967). The study took place over a two year period, from 2006 to 2008. Subjects were recruited by poster advertisement at the Institute of Stomatology.

Oral Examination procedure

The children were examined on a dental chair. A visual-tactile examination of all teeth was conducted using the dental operatory light and without prior drying. The examination environment, procedure and sequence employed during normal dental check-up were maintained throughout the study.

Caries diagnostic and scoring criteria

Only one dentist-examiner (JG) was detecting caries in all patients. The examiner was calibrated on visual 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 (3). The Kappa (3) 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). Caries was detected by visual examination and bitewing radiography. A tooth was deemed to be present when part of it was visible on the occlusal plane without the need for gingival displacement. Caries was diagnosed at the level of dentin using the WHO methodology and assessment criteria (4). 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, missing due to other reasons or absent (unerupted). The rule of thumb was to record a tooth as sound when there was any doubt about the caries status and decay was the overriding diagnosis when present with any other lesion on a tooth or surface. Radiograph was used to diagnose caries on proximal surfaces, and caries was called where there is radiolucency in the dentin or broken EDJ but without obvious spread in dentin. Radiolucency only in the enamel (not reaching the EDJ) was not recorded as caries. Caries experience was evaluated using dmft/DMFT and dmfs/DMFS in both age groups.

Assessment of Oral hygiene and Salivary cariogenic microflora

Salivary mutans streptococci (MS) and lactobacilli (LB) levels were measured in children with dmft/DMFT greater than 4 in both age groups using CRT kit (CRT – bacteria, Ivoclar, Vivadent, Liechtenstein). Green-Vermillion oral hygiene index (G-V index) was used to determine the oral hygiene level in both age groups.

Questionnaire on oral hygiene and dietary habits

Questionnaire was used to obtain information on oral hygiene and dietary habits. Depending on age, children and/or their parents were questioned about snacking habit, intake of chocolates and carbonated soft or sport drinks during the day, number of tea spoons of sugar (TS) per cup of tea, and the number of cups of tea consumed daily. The use of toothpastes (TP) with or without fluoride (F) was recorded along with the frequency of tooth brushing. The use of F-containing tablets was also recorded. Questionnaires were administered while children with their parents were waiting to take the radiograph, so although all questions about oral hygiene and dietary habits were to be answered by children in 12 year olds, their parents may have help with the response. Parents provided all responses for the 6-year olds.

Statistical analysis

Data were analysed using SPSS software package with $p<0.05$ chosen as level of statistical significance. Statistical analysis was performed by calculating mean values (standard deviations) and prevalence of risk factors was assigned by using frequency tables. Relationship between different factors and caries was calculated by using ANOVA analysis, and statistical significance was tested using chi-square test.

RESULTS

Caries experience

Figure 1 showed the caries experience in both age groups. DMFT in 6 and 12 year old children

were 0.5 (0.94) and 4.45 (3.28) respectively, while dmft were 5.75 (3.05) and 2.4 (1.52) respectively. DMFS in 6 and 12 year old children were 0.5 (1.01) and 6.81 (5.99) respectively, while dmfs were 9.95 (7.09) and 4.01 (3.20) respectively.

Oral hygiene

G-V index (SD) was 0.9 (0.58) and 0.99 (0.55) in 6 and 12 year old respectively (Figure1). It was only possible to measure G-V index in 9% (n=11) of 6 year olds, and in 96.34% (n=158) of 12 year olds due to the incomplete eruption of the first molars in the 6 year old population and early extraction/loss of these molars in a small percentage of the 12 year olds. Significant (p=0.001) association was observed between G-V index and dmft/DMFT in 12 year old children.

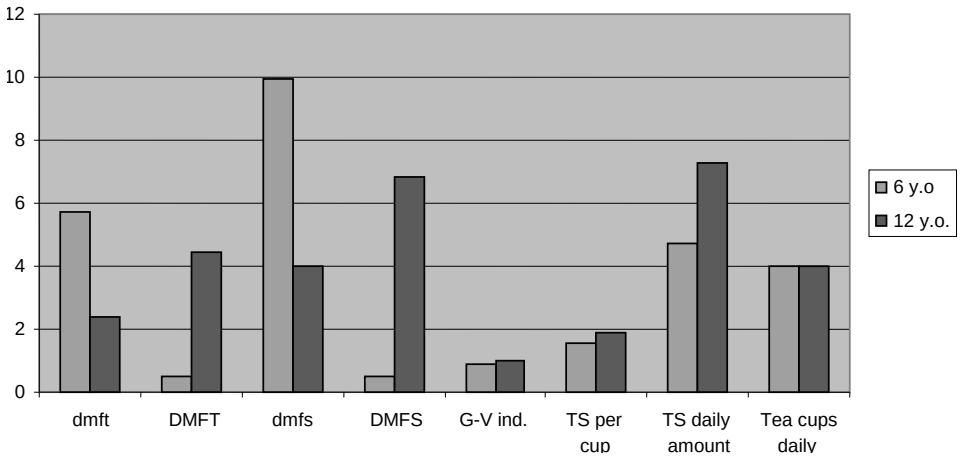

Fig. 1. Mean values of caries experience (dmft/Dmft, dmfs/DMFS), oral hygiene (G-V ind.), tea spoons of sugar per cup (TS per cup) and daily amount (TS daily amount), tea cups daily in 6- and 12- year olds.

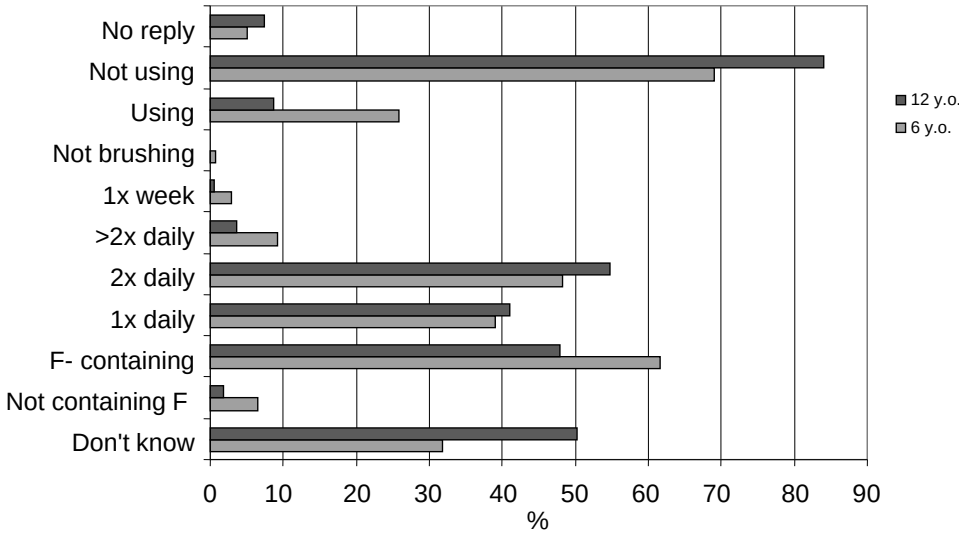

Fig. 2. The use of F-containing tooth paste, tooth brushing frequency and use of F-tablets in 6- and 12-year olds.

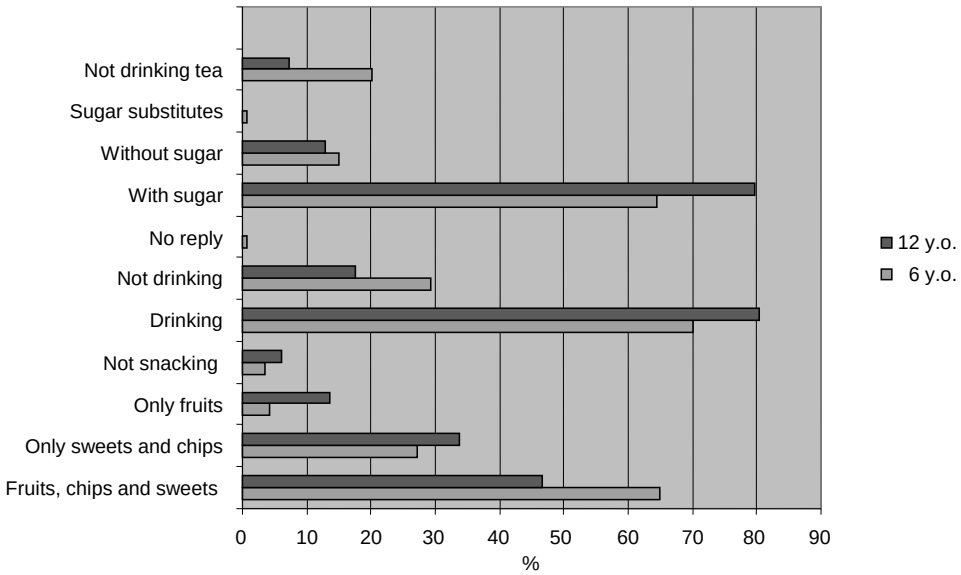

Fig. 3. Snacking habits and soft drinks consumption in 6-and 12-year olds.

Salivary Cariogenic Microflora

Salivary cariogenic microflora level was measured only in 73% (n=103) of 6 and 54% (n=88) of 12 year olds since it was limited to those with dmft/DMFT>4. Less than 10,000 CFU of MS was observed in 18.3% (n=19) and 23.9% (n=21) of 6 and 12 year olds respectively. Greater than 10000 CFU of MS was observed in 81.7% (n=85) and 76.1% (n=67) of 6 and 12 year olds respectively. For LB, less than 10,000 CFU was observed in 25.2% (n=26) and 29.6% (n=26) of 6 and 12 year olds respectively, and >10000 CFU was observed 74.8% (n=77) and 70.4% (n=62) of 6 and 12 year olds respectively.

In 6 year old children, there was a significant association between the quantity of salivary LB and the mean number of decayed teeth (dt=3.71, DT=0.42, p<0.05) and decayed surfaces (mean ds=5.4, DS=0.4, p=0.024). However, significant association was only demonstrated in 6 year olds between the quantity of salivary MS and the mean number of decayed surfaces (mean ds=5.4, DS=0.4, p=0.032) but not decayed teeth. In 12 year old children there was a significant association between the quantity of salivary LB and the mean number of decayed teeth (dt=1.74, DT=2.59, p=0.001) and decayed surfaces (ds=2.43, DS=3.4, p=0.002). Significant association was also demonstrated in 12 year olds between the quantity of salivary MS and the dmft/DMFT (p=0.001), dmfs/DMFS (p=0.004), G-V index (p=0.025), the mean number of decayed surfaces (mean ds=2.43, DS=3.4, p=0.014) and decayed teeth (dt=1.74, DT=2.59, p=0.001).

The use of F-containing toothpaste

In 6 year old children, significant (p=0.020) association was demonstrated between the number of decayed teeth (mean dt=3.71, DT=0.42) and use of F-toothpaste. Figure 2 showed that 61.59% (n=85) and 47.83% (n=77) of 6 and 12 year olds respectively used fluoride toothpaste, while 6.5% (n=9) and 1.86% (n=3) of 6 and 12 year olds respectively used non-fluoride toothpaste. 31.88% (n=44) and 50.31% (n=81) of 6 and 12 year olds respectively could not confirm if their toothpaste contained fluoride or not. Brand of toothpaste and concentration of Fluoride was not investigated.

Tooth brushing frequency

Among the 6 year old children, 39% (n=55), 48.33% (n=68) and 9.22% (n=13) brush their teeth once, twice and more than twice daily respectively, while 2.84% (n=4) brush their teeth once weekly. Among 12 year old children, 41.04% (n=67), 54.67% (n=90) and 3.66% (n=6) brush their teeth once, twice and more than twice daily respectively, while 0.61% (n=1) brush their teeth once weekly. Only 0.71% (n=1) of 6 year olds does not brush at all (Figure 2).

The use of F-containing tablets

While 26% (n=36) and 8.59% (n=14) of 6 and 12 year olds respectively were using F-containing tablets, 69.06% (n=96) and 84.05% (n=137) of 6 and 12 year olds respectively were not using F-containing tablets. There was no response from 5.04% (n=7) and 7.36% (n=13) of 6 and 12 year olds respectively (Figure 2).

Snacking and drinking habit

Figure 3 depicts the snacking and drinking habit of the children. Among the 6 and 12 year old children respectively, 64.99% (n=91) and 46.64% (n=76) snack with sweets and fruits, 27.15% (n=38) and 33.73% (n=56) snack with sweets only, 4.29% (n=6) and 13.50% (n=22) snack with fruits only, while 3.57% (n=6) and 6.13 % (n=10) do not snack at all.

For the 6 and 12 year old children respectively, 70 % (n=99) and 80.37% (n=133) drink carbonated soft drinks, 29.29% (n=41) and 17.68% (n=29) do not drink carbonated soft drinks. There was no response from 0.71% (n=1) and 1.95% (n=2) of 6 and 12 year olds respectively.

Drinking sugary tea

As shown in figure 4, 64.43% (n=88) and 79.75% (n=130) of 6 and 12 year olds respectively, drink tea with sugar, while 15.11% (n=24) and 12.88% (n=22) of 6 and 12 year olds respectively, drink tea without sugar. 20.14% (n=28) and 7.36% (n=12) of 6 and 12 year olds respectively, do not drink tea.

Teaspoons of Sugar per Cup of Tea

The 6 year old children use a mean of 1.54 (0.6) teaspoons of sugar per cup of tea with a total of 4.7 (3.16) teaspoons per day, while the data are 1.9 (0.6) and 7.3 (4.14) for the 12 year old. The mean number (SD) of cups of tea consumed daily by the 6 and 12 year olds were 3.0 and 4.0 cups respectively, with a mean of 4 cups for both age groups combined. Statistically significant (p<0.001) associations was observed between dmfs/ DMFS and daily sugar intake in 12 year old children.

DISCUSSION

Factors that influence the caries experience of the 6 and 12 year old children in Riga, the capital of Latvia were investigated in the present study. The statistically significant associations observed between the dmfs/DMFS and the number of teaspoons of sugar (TS) used per cup of tea, number of cups of tea consumed daily, the count of cariogenic bacteria (both MS and LB) and the Green-Vermillion oral hygiene index indicate that these are the main factors that determine the caries experience of children in Riga. Thus the result of the present study is in accord with previous studies that reported diets high in sugars to be associated with dental caries (5), which led to consumption of sugar-containing snacks between meals being a key factor in caries risk assessment today (5). This is not surprising since studies has shown that in industrialized countries caries experi-

ence is highest in families of low socio-economic status (6), and the reverse is observed in developing countries where children of high socio-economic status have highest caries rate (6). These variations of different caries rates could be explained in terms of the preventive effects of fluoride and caries promoting role of sugar-containing snacks (6). In socioeconomically developing countries, changing from a traditional to Western-style diet has led to an increase in the consumption of refined and processed food products with high sugar and fat content (5), and this has been associated with increase in dental caries prevalence (7).

The use of fluoride increases the safe level of sugar intake (7). Demineralization occurs every time carbohydrate taken into the mouth with acidogenic bacteria metabolizing it and producing acid as a by-product, but if the fluoride is present in the plaque at the same time, then F will be absorbed by enamel crystals protecting them against being dissolved, also inhibiting bacterial metabolism and promoting process of remineralization (8). The daily use of fluoride-containing dentifrice helps minimize the risk of developing caries and works synergistically with fluoride supplementation (9). Fluoride (F) is thought to be a caries defensive factor (10). Unfortunately, in the present study, the preventive influence of F-containing toothpaste on caries experience was demonstrated only in 6 year olds. Only half of children in both age groups have knowledge of the presence of fluoride in the toothpaste. This was an indication of the parents' lack of knowledge about caries preventive measures and the value of fluoridated tooth pastes. Despite the fact that all of the participants in this study are living in non-fluoridated Riga, the study showed that the majority of children in both age groups were not using F-tablets (Fig. 2). F-tablets or lozenges are thought to be an effective measure to reduce caries development, and can be used as a topical source in children and adults who are not able to brush their teeth with F-containing dentifrice (9). It could be a method of choice in caries control in groups at high caries risk (11) and are considered for use in people living in non-fluoridated areas (9). Results observed in the present study showed large consumption of sugar used with tea cups and daily, unhealthy snacks and also carbonated soft drinks in both age groups in Riga, which turns the balance between preventive and promoting factors on the side of the later.

Epidemiological research in 1998, in Riga found rather high caries experience, DMFT was 3.9 in 12 year olds and 0.6 in 6 year olds in 1998 (12), but the present study showed DMFT 0.5 in 6 year olds and 4.45 in 12 year olds. Even though we had a smaller study population in both age groups we found a large number of interproximal lesions, causing higher value of mean DMFT than in this previous study (12). The previous research was performed without using bitewing radiographs so it was difficult to detect proximal caries, thus the lower DMFT. However, we use the WHO caries criteria, as opposed to the more recent International Caries Detection and Assessment System (ICDAS-II), in order to enable comparison of our results with studies previously carried out in Latvia. It was not surprising that in the present study the caries experience measured as dmft/DMFT was significantly associated with the G-V index only in 12 year olds. G-V index could be used, for evaluating only completely erupted permanent teeth such as all first molars and upper-lower central incisor. In our study only 11 children at the age of 6 had all necessary teeth completely erupted to use this index. It is important to understand that although the mean values of G-V index in this study is showing rather good level of oral hygiene in 12 year olds , it couldn't completely reflect the complete status of oral hygiene in patients with permanent and mixed dentition. More complicated plaque index should be used to predict future caries development. Significant association of the G-V index in this study was also in accord with scientific evidence that carious process is based on the metabolic activity of the plaque and tooth completely without plaque will not decay (13). Children with good oral hygiene have fewer carious lesions than children with poor oral hygiene (13). Salivary cariogenic microflora was also significantly associated with caries experience in the present study only in 12 year olds, and this can be attributed to the choice of the index we used to evaluate the status of oral hygiene in both age groups.

The high caries experience among the children examined in the present study may also be attributed to the observation that only 50% of the children in both age groups brush their teeth twice daily, which could be compared with similar percentage of school children brushing their teeth more than once a day reported by other recent study in Latvia (14). This inference is considerable since previous studies reported that patient who do not brush their teeth for 23 days developed white spots along the gingival margin, but all lesions were reversible in 30 days when good oral hygiene was maintained together with daily fluoride mouth rinsing (0,2%sodium fluoride) (13), and it is highly recommended to brush teeth twice daily if caries is to be prevented

(10, 13). Other studies have shown that supervised tooth brushing implemented in early childhood with the primary dentition can help in reduction of caries development in permanent dentition providing a long lasting effect (15).

In Latvia, tea sweetened with sugar is a very popular drink. The present study showed that majority of children in both age groups were consuming sugary tea during the day time (Fig. 3). Artificial sweeteners are rarely used when drinking tea. Measuring the sugar intake in teaspoons per cup of tea and cups of tea consumed daily in the present study, gave us the opportunity to advise patients on the importance of reducing either the amount or frequency of sugar intake as a means of improving their oral health. However, from the chemical view point of demineralization, reduction in the number of teaspoons of sugar per cup of tea will not reduce the frequency of pH drop during the demineralization process (13). The number of teaspoons of sugar used per cup in 6 year olds was lower than in 12 year olds, but this resulted in a higher rate of caries in the 6 year old population. It is possible that the primary teeth have a higher susceptibility to caries development than permanent molars. The anatomy and morphology of primary teeth leads to more rapid caries progression (16). Also the type of tea being used should be taken into consideration due to the numerous benefits of tea in relation to caries prevention and control. In addition to fluoride, tea also contains polyphenols as antibacterial and flavanoids (1). Animal studies showed caries reduction with black tea infusions (1), although the sugar intake while drinking the tea was estimated (1). One cup of black tea contains 0.3-0.5 mg of F and if it is used with milk teeth will benefit from the calcium (16). It is best to drink tea without sugar to reduce the risk of dental decay (17).For green tea the plant leaves are steamed and parched immediately after they have picked, but for black tea leaves are left to wither, ferment and oxidize (18). In the final phytochemical balance (18) . Tannic acid, excreted from tannins, can inhibit salivary amylase reducing the cariogenic potential of starch-containing foods and reducing the number of S.mutans in plaque (1).

The very small decrease in pH leads to be an alternative drink to acidic ones. Flavanoids in black and green tea also inhibits the growth of cariogenic bacteria by preventing the adherence and growth of plaque bacteria at the tooth surface (19). To promote overall health and well-being, green tea is a good antioxidant and destroys cancer cells leaving healthy tissues untouched (18). It acts as an antibacterial and antiviral agent (18). Most studies about black tea traditionally have used a method of measuring fluoride that doesn't account for the amount that combines with aluminum, contained in leaves, to form insoluble aluminum fluoride, which is not detected by fluoride electrode (20). Seven brands of store bought tea were tested, steeping each for 5 minutes in deionized water, which contains no fluoride (20). The amount of fluoride in each sample was higher using the diffusing methods than the traditional method (20).

CONCLUSIONS

The present study indicated that the caries development in Latvian children was associated with consumption of sugary tea and use of non-fluoride toothpaste.

DECLARATION OF INTERESTS

All authors declared no conflict of interest. This study was supported by ESF National program "Assistance for doctoral and post doctoral research in medicine".

REFERENCES

1. van Loveren C, Lingström PD. The role of dietary control. In Fejerskov O, Nyvad B, Kidd EAM, editors. Dental Caries: The disease and its clinical management. 3rd ed. Wiley & Sons,Ltd; 2015. P. 133-51.
2. Zero DT. Sugars- The arch criminals? *Caries Res* 2004;38:277-85.
3. Cohen J. A coefficient of agreement of nominal scales. *Psych Bull* 1960;20:37-46.
4. Oral health surveys: Basic methods. 4th ed. Geneva: WHO; 1997.
5. Åstrøm AN, Kiwanuka SN. Examining intention to control preschool children's sugar snacking: a study of carers in Uganda. *Int J Paediatr Dent* 2006; 16:10-18.
6. Welbury RR, Duggal MS, Hosey MT. Paediatric dentistry. 4th ed. Oxford: Oxford University Press; 2012.
7. Moynihan PJ. The role of diet and nutrition in the etiology and prevention of oral diseases. *Bull World Health Organ* 2005;83:694-9.
8. Featherstone JD. The science and practice of caries prevention. *J Am Dent Assoc* 2000;131:887-99.
9. Hellwig E, Lennon AM. Systemic versus topical fluoride. *Caries Res* 2004;38:258-62.
10. Fejerskov O, Cury JA, Tenuta LM, Marinho VC. Fluorides in caries control. In: Fejerskov O, Nyvad B, Kidd EAM, editors. Dental caries: The disease and its clinical management. 3rd ed. Wiley & Sons; 2015. p.245-272.
11. Senakola E, Brinkmane A. Dentistry in Latvia - developments since 1995. *FDI World* 2000; 4: 21-23.
12. Kidd EAM. The Essentials of dental caries. 3rd ed. Oxford: Oxford University Press; 2005.
13. Valsts Veselības Veicināšanas Aģentūra. Latvijas skolēnu paradumu pētījums 2001/2002 / Latvijas Republikas

Veselības Ministrija. Rīga; 2004. P. 16-25.
14. Pine CM, Curnow MMT, Burnside G, Nicholson JA, Roberts AJ. Caries prevalence four years after the end of randomised controlled trial. *Caries Res* 2007;41:431-6.
15. Deery C, Hosey MT, Waterhouse P. Paediatric Cariology. London, Hosey: Quintessence Publ.; 2004.
16. Cabrera C, Artacho R, Gimenez R. Beneficial effects of green tea: a review. *J Am Coll Nutr* 2006;25:79-99.
17. Abd Allah AA, Ibrahium MI, Abd Allah SM, Amin MA.(): Antimicrobial effect of tea and tea with milk beverages on oral Streptococcus mutans and Lactobacilli. *World Appl Sci J* 2012;19:1327-34.
18. Naghma K, Hasan M. Tea olyphenols for health promotion. *Life Sci*;2007; 81:519-33.
19. Chacko SM, Thambi PT, Kuttan R, Nishigaki I. Beneficial effects of green tea: A literature review. *Chin Med* 2010; 5:13.
20. Withford G, Arun A. Black tea fluoride concentrations: Influence of preparatory methods. *J Dental Res* 2010:89 (Spec Iss B):3859.

Received: 11 11 2014
Accepted for publishing: 28 03 2016