Prevalence of Dental Erosion among the Young Regular Swimmers in Kaunas, Lithuania

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ABSTRACT

Objectives: To determine prevalence of dental erosion among competitive swimmers in Kaunas, the second largest city in Lithuania.
Material and Methods: The study was designed as a cross-sectional survey, with a questionnaire and clinical examination protocols. The participants were 12 - 25 year-old swimmers regularly practicing in the swimming pools of Kaunas. Of the total of 132 participants there were 76 (12 - 17 year-old) and 56 (18 - 25 year-old) individuals; in Groups 1 and 2, respectively. Participants were examined for dental erosion, using a portable dental unit equipped with fibre-optic light, compressed air and suction, and standard dental instruments for oral inspection. Lussi index was applied for recording dental erosion. The completed questionnaires focused on the common erosion risk factors were returned by all participants.
Results: Dental erosion was found in 25% of the 12 - 17 year-olds, and in 50% of 18 - 25 years-olds. Mean value of the surfaces with erosion was 6.31 (SD 4.37). All eroded surfaces were evaluated as grade 1. Swimming training duration and the participants' age correlated positively (Kendall correlation, $r = 0.65$, $P < 0.001$), meaning that older swimmers had practiced for longer period. No significant correlation between occurrence of dental erosion and the analyzed risk factors (gastroesophageal reflux disease, frequent vomiting, dry mouth, regular intake of acidic medicines, carbonated drinks) was found in both study groups.
Conclusions: Prevalence of dental erosion of very low degree was high among the regular swimmers in Kaunas, and was significantly related to swimmers' age.

Keywords: tooth erosion; swimming; swimming pools.

Accepted for publication: 13 June 2014
To cite this article:
Zebrauskas A, Birskute R, Maciulskiene V. Prevalence of Dental Erosion among the Young Regular Swimmers in Kaunas, Lithuania.
J Oral Maxillofac Res 2014;5(2):e6
URL: http://www.ejomr.org/JOMR/archives/2014/2/e6/v5n2e6ht.pdf
doi: 10.5037/jomr.2014.5206

INTRODUCTION

Dental erosion is defined as loss of tooth structure by acid dissolution without the involvement of bacteria. It is an increasing problem in today's society, because of the changing lifestyle and nutrition. Numerous reports in literature indicate that the prevalence of dental erosion seems to be rising dramatically in young populations, with varying data from 11 to 100% in different countries [1-3]. The results of the national survey in Iceland showed that the frequency of dental erosion among 15 year-olds doubled when compared to the 12 year-old children [4]. Furthermore, males seem to develop more erosion than females [1].

Pathogenesis mechanism of dental erosion is based on dissociation of hydroxyapatite and on impaired mineralization of the dental hard tissue due to long and frequent effect of acids [5]. For the erosion to progress, the solution pH level has to be below 5.5 for enamel and below 6.0 for dentine [6,7]. A number of external or internal causes can be responsible for the pH drop at tooth surfaces; however development of the erosive process depends on the interplay of different biological, behavioural and chemical factors involved in it. Most often reported risk factors of dental erosion are digestive and eating disorders (GERD, regurgitation, bulimia, anorexia etc.) as well as frequent consumption of acidic drinks and beverages [8]. Occupation and sports can add to development of erosive wear in some patients as well [9]. Amongst those, there might be individuals exposed to acids at the working place (pharmaceutical enterprise, wine tasting etc.) or, individuals engaged in heavy physical activity and using acidic sports drinks to compensate dehydration. A particular group of athletes is people who spend much time in pool water such as swimmers, water polo players and divers. Chlorine compounds are used for disinfection of water in swimming pools. The main disinfection techniques used are gas chlorination or sodium hypochlorite. Chlorine compounds dissolve in water and change the pH level. The water pH level can decrease from 7.4 to 4 over night because of inadequate buffering of HCl when gas chlorination system is used [10]. Chlorine can also be added to pool water as sodium hypochlorite (NaOCl), which has an alkaline pH and, thus, limited erosion potential [11]. A case study by Dawes et al. [12], reported about a complete loss of enamel by acid erosion, particularly from the anterior teeth in a person who swam daily for two weeks in an improperly chlorinated swimming pool. In several epidemiological studies, the prevalence of dental erosion among swimmers varied between 26% to 90% of swim team members [11,13,14].

Swimming is a popular sport activity in Lithuania. Thus, the purpose of the present study was to estimate the prevalence of dental erosion among the different age groups of regular swimmers; and to analyze correlation of dental erosion with their sport regimen and other potential risk factors of erosive tooth wear.

MATERIAL AND METHODS

The study population consisted of 12 - 25 year-old participants practicing swimming regularly in the swimming pools of Kaunas, Lithuania. In total, there are 5 swimming pools in Kaunas (Kaunas swimming school with 3 swimming pools, Lithuanian Sports University - 1 swimming pool and Kaunas Center sport school - 1 swimming pool). All swimmers of the selected age, who practice in Kaunas swimming pools, were invited to take part in the study. However, 50 swimmers of Kaunas Center sport school, and 12 swimmers from Kaunas swimming school and Lithuanian Sports University were not interested to participate. Participation was voluntary. The participants were informed about the purposes of the study and the informed consent was obtained. The parents' approvals for the participants under age of 18 were obtained as well. The Bioethics Committee at Lithuanian University of Health Sciences provided ethical approval for the study (BEC-OF-321, BEC-OF-322). The data were collected during May and June of 2013.

Of the total of 194 of 12 - 25 year-old regular swimmers in Kaunas, 132 agreed to participate in the study. The participants were divided in two groups according to their age: 12 - 17 year-olds (Group 1) and 18 - 25 year-olds (Group 2). There were 76 swimmers (50 males, 26 females) in Group 1, and 56 swimmers (34 males, 22 females) in Group 2, respectively. All participants went through a clinical dental examination at the premises of the swimming pools, using a portable dental unit equipped with fibre-optic operation light, compressed air and a suction device (Dentronic, Aarhus, Denmark), and standard dental instruments for oral inspection (dental mirror and dental explorer). The occlusal, facial and labial surfaces of all teeth were examined for dental erosion, using Lussi index [15] (Table 1). The clinical examinations were performed by one examiner. The intra-examiner reliability was tested by repeating the examinations of 20 participants (10% of the study

Table 1. Clinical criteria for assessment of dental erosion by Lussi [15]

	Facial surfaces	Occlusal/oral surfaces
0	No erosion. Surface with a smooth, silky glazed appearance, absence of developmental ridges possible	No erosion. Surface with a smooth, silky-glazed appearance. Absence of developmental ridges possible
1	Loss of surface enamel. Intact enamel found cervical to the lesion concavity in enamel, the width of which clearly exceeding its depth, thus, distinguishing it from toothbrush abrasion, undulating borders of the lesions are possible dentine is not involved	Slight erosion, rounded cusps, edges of restorations rising above the level of adjacent tooth surface, grooves on occlusal aspects. Loss of surface enamel. Dentine is not involved
2	Involvement of dentine for less than one-half of the tooth surface	Severe erosion, more pronounced signs than grade 1. Dentine is involved
3	Involvement of dentine for more than one-half of the tooth surface	

population), within the 2 days interval between the examinations. Cohen's Kappa was calculated at 0.91 representing good agreement for reproducibility of erosion.

All participants responded to an anonymous questionnaire related to the most common risk factors of dental erosion. The questionnaire was adopted from previous studies [16,17]. The questions in the questionnaire covered background information about the respondent's age and gender as well as about training time and hours spent per week in a swimming pool (one hour was considered as one training); feeling of dental hypersensitivity; bruxism and other related disorders and symptoms (GERD, increased acidity of the stomach, frequent vomiting, dry mouth); regular intake of acidic medicines such as vitamin C and acetylsalicylic acid; carbonated soft drinks and sport drinks consumption.

The quality of water in the pools was estimated based on the data provided by the pool workers (water monitoring is performed twice a day). The parameters of water quality varied between the set limits of water pH 7 - 7.5, and chlorine concentration 0.5 - 2 mg/l.

Statistical analysis

The data were analyzed by means of SPSS software (SPSS 20.0 for Windows). The sample size calculation was based on Paniotto formula that resulted in the minimum of 130 individuals to participate in the survey. The data were described using mean (M) values, standard deviation (SD), 95% confidence intervals (CI). The distribution and qualitative variables were compared by Chi-square (χ^2) test. Depending on the sample size, Fisher's exact test (for small samples) and asymptomatic χ^2 were applied. Correlation of quantitative variables was assessed by Kendall and Spearman correlation analyses. Prognostic values of the selected risk factors expressed as odds ratios (OR) and confidence intervals (95 % CI), were estimated by means of univariate binary logistic regression analysis.

To verify the statistical hypotheses, the significance level of 0.05 was chosen.

RESULTS

The total number of study participants was 132. Group 1 comprised 76 individuals of age 12 - 17 years, and Group 2 - 56 individuals of age 18 - 25 years, respectively. Gender distribution was similar in both groups (Table 2). Swimming training duration and the participants' age had significant positive correlation (Kendall correlation analysis, $r = 0.65$, $P < 0.001$), meaning that older participants had attended swimming for a longer period. However, the swimmers in Group 2 spent significantly less hours per week in the swimming pool as compared to the swimmers in Group 1 (Table 2).

A total of 21, 120 dental surfaces of the study participants were examined. Dental erosion was observed in 296 surfaces (1.4% of the total number of surfaces examined). Forty seven participants (35.6%) had at least one eroded tooth surface. The mean value of the surfaces affected by dental erosion in the total study group was 6.31 (4.37). The lesions were distributed mainly on the labial and oral surfaces of the anterior teeth and premolars, no signs of erosion were observed on the molar teeth. All lesions of dental erosion were valuated as grade 1 according to Lussi index [15].

The prevalence of dental erosion was 25% (19 individuals) in Group 1, significantly lower than the estimated 50% (28 individuals) in Group 2.

The prevalence of dental erosion according to swimming training duration and hours spent per week in a swimming pool is shown in Table 3.

The distribution of dental erosion according to gender, did not differ significantly among the females and males, although a tendency of higher prevalence of eroded dental surfaces among the male participants was observed: in 33% (n = 16) of the girls

Table 2. Comparison of the study groups according to gender, swimming training time, and hours spent per week in a swimming pool

	Total (n = 132)	Group 1 (n = 76)	Group 2 (n = 56)	P-value/χ^2; d.f.; P-value
	N (%)	N (%)	N (%)	
Gender				
Male	84 (63.6)	50 (65.8)	34 (60.7)	0.549
Female	48 (36.4)	26 (34.2)	22 (39.3)	
Training duration (years)				
< 5	26 (19.7)	24 (31.6)[b]	2 (3.6)[b]	χ^2 = 69.6; d.f. = 2;
5 - 10	58 (43.9)	47 (61.8)[c]	11 (19.6)[c]	P < 0.001[a]
> 10	48 (36.4)	5 (6.6)[d]	43 (76.8)[d]	[b,c,d]P < 0.001[a]
Hours spent per week in a swimming pool (h)				
< 4	28 (21.3)	11(14.5)[b]	17 (30.4)[b]	χ^2 = 6.353; d.f. = 2;
4 - 6	25 (18.9)	13(17.1)	12 (21.4)	P = 0.042[a]
> 6	79 (59.8)	52 (68.4)[c]	27 (48.2)[c]	[b,c]P < 0.03[a]

[a]Statistically significant, Chi-square test.
χ^2 = Chi-square test; d.f. = degree of freedom.

Table 3. The prevalence of dental erosion according to swimming training duration and hours spent per week in a swimming pool

Groups	Training duration (years)			χ^2; d.f.; P-value
	< 5	5 - 10	> 10	
	N (%)	N (%)	N (%)	
Group 1 (n = 76)	5 (20.8)	13 (27.7)	1 (20)	χ^2 = 0.466; d.f. = 2; P = 0.792
Group 2 (n = 56)	1 (50)	5 (45.5)	22 (51.2)	χ^2 = 0.114; d.f. = 2; P = 0.945
Groups	**Hours spent per week in the swimming pool (h)**			χ^2; d.f.; P-value
	< 4	**4 – 6**	**> 6**	
Group 1 (n = 76)	2 (18.2)	4 (30.8)	13 (25)	χ^2 = 0.503; d.f. = 2; P = 0.777
Group 2 (n = 56)	7 (41.2)	6 (50)	15 (55.6)	χ^2 = 0.863; d.f. = 2; P = 0.65

χ^2 = Chi-square test; d.f. = degree of freedom.

and 37% (n = 31) of the boys (P = 0.68). Respectively, in Group 1: 23% (n = 6) of the girls and 26% (n = 13) of the boys (P = 0.78); in Group 2: 46% (n = 10) of the girls and 53% (n = 18) of the boys (P = 0.58).

Figure 1 shows that some of the well known risk factors of dental erosion were highly prevalent among the study participants: about half of all swimmers indicated drinking carbonated soft drinks daily, and almost one third of the swimmers indicated drinking sport drinks on the daily basis.

As shown in Table 4, the presence of dental erosion was significantly associated with swimmers' age and training duration. The 18 - 25 year-old participants and those who practiced swimming for more than 10 years had 3 times greater risk to develop dental erosion than the younger swimmers (12 - 17 year-olds) and those who practiced swimming less than 10 years.

Among all participants, 17% of the swimmers complained of dental hypersensitivity. There was no significant difference in the prevalence of dental hypersensitivity neither between two study groups nor between females and males. A very weak correlation between the reported dental hypersensitivity and presence of dental erosion (r = 1.124, P = 0.124) was estimated. Only 23% of those who presented with dental erosion, reported about hypersensitivity as well. Of all participants, 13% complained about dental hypersensitivity with no dental erosion recorded.

DISCUSSION

The purpose of the present study was to explore possible correlations of the swimming regimen and the selected risk factors of dental erosion among the regular swimmers in Kaunas, Lithuania. In all swimming pools of Kaunas the sodium hypochlorite disinfection system is used. The results showed that 25% of the 12 - 17 year-old participants had dental erosion, whereas the prevalence of dental erosion amongst the 18 - 25 year-olds was 50%. The prevalence of dental erosion did not correlate with the duration of swimming and time spent per week in pool, in both age groups of the participants. However, it did correlate significantly with the participant's age.

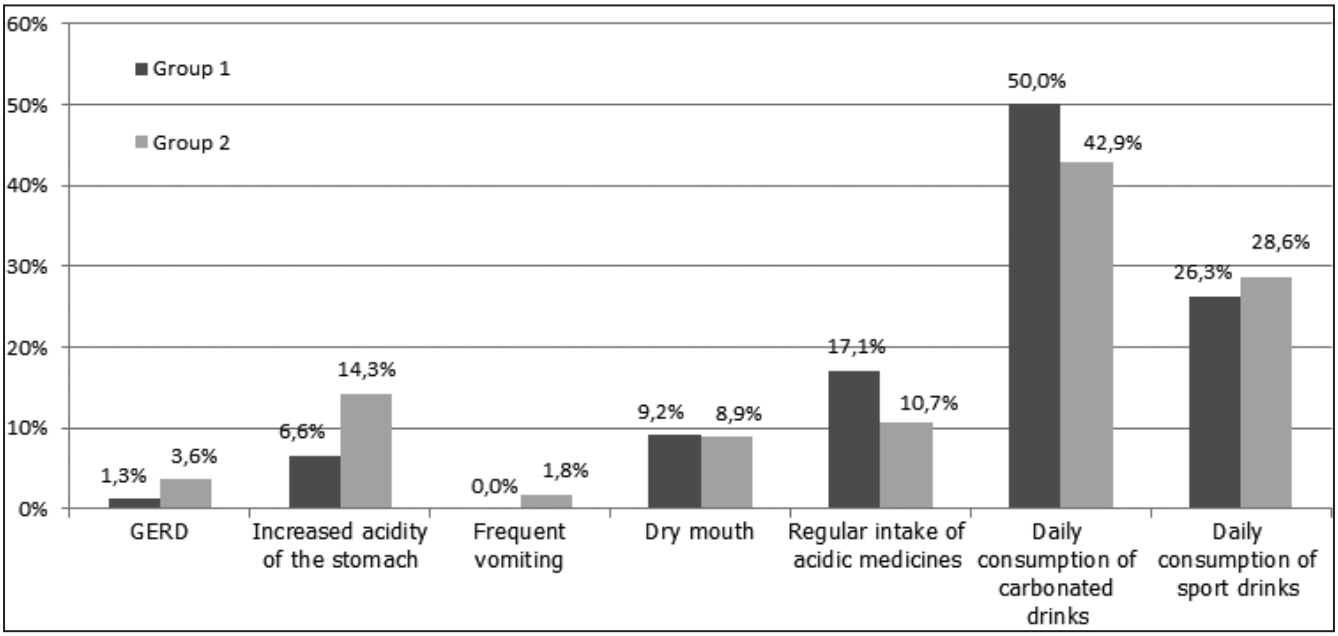

Figure 1. The reported prevalence of the potential risk factors of the erosive dental wear among the study participants.

Table 4. Univariate binary logistic regression analysis of the prevalence of dental erosion, with respect to the selected risk factors

Risk factors	OR [95 % CI]
Group 2 (18 - 25 year-olds)	3.0 [1.435 - 6.272], P = 0.004[a]
Training duration 5- 10 years Training duration > 10 years	1.5 [0.515 - 4.367], P = 0.457 3.067 [1.048 - 8.974], P = 0.041[a]
Hours spend per week in a swimming pool 4 - 6 hours. Hours spend per week in a swimming pool > 6 hours.	1.407 [0.456 - 4.342], P = 0.552 1.159 [0.463 - 2.901], P = 0.753
Complaints about GERD/ increased acidity of the stomach/frequent vomiting/dry mouth	0.823 [0.339 - 1.999], P = 0.667
Regular intake of acidic medicines (vitamin C, acetylsalicylic acid)	1.065 [0.388 - 2.919], P = 0.903
Daily consumption of sweet, carbonated drinks	0.99 [0.485 - 2.022], P = 0.978
Daily consumption of sport drinks	1.031 [0.464 - 2.29], P = 0.941

[a]Statistically significant, Univariate binary logistic regression analysis.

All lesions of dental erosion were valuated as grade 1 according to Lussi index [15], the same results were found in a similar study by Buczkowska-Radlińska et al. [11].

There are numerous reports in the literature indicating that people who spend a lot of time in a swimming pool such as swimmers, water polo players, divers have an elevated risk to develop dental erosion [10-14,18-21].

However, development of dental erosion was mainly showed in studies performed in gas chlorinated pools [11,12,19,20]. On the contrary, in the countries where sodium hypochlorite disinfection method is used for disinfection of pool water only 0.14% pools had pH level lower than 5.5, which is a critical value with respect to decalcification of dental tissues [6,21].

However, as suggested by Buczkowska-Radlińska et al. [11] low pH of pool water is not exclusively responsible for the dental hydroxyapatite dissolution process, but the concentration of ions with respect to the saturation of dental hydroxyapatite, especially calcium and phosphate, may also be involved. Long-term exposure to the pool water undersaturated with respect to hydroxyapatite could be responsible for erosive damage of dental tissues, particularly in the labial surfaces of teeth. Labial erosions were found more frequently in males, who practiced long swimming sessions and an aggressive style of swimming, involving increased agitation (e.g., when a swimmer is swishing water in the mouth) [11]. Another report [22] suggested that even in properly maintained gas-chlorinated swimming pools basic salivary parameters (salivary flow rate, concentration of minerals in saliva) of the swimmers might be altered thus contributing to enamel dissolution.

Moreover, competitive swimmers often use sport drinks during training time. High intake of sports drinks during exercise, coupled with xerostomia from dehydration, may lead to the possibility of erosive damage to teeth as well [23].

Swimmers also experience physiological decrease of saliva flow because of body's dehydration during training. The effect of sport drinks, possible low swimming pool water pH and undersaturation of hydroxyapatite minerals accumulates and possibly increases the risk of dental erosion.

The small sample size did not allow us to find any significant correlations with other potential risk factors of dental erosion, such as reflux, increased acidity of the stomach, dry mouth, regular intake of acidic medicines (vitamin C, acetylsalicylic acid), or consumption of carbonated beverages and sport drinks. However, the reported prevalence of daily consumption of the soft drinks was high amongst the study participants. Considering the fact that there was no correlation with the swimmer's time (number of hours) spent in swimming pools, it seems that a cumulative effect of various factors, related to the lifestyle of young people, might have occurred. Further research involving larger study samples would be beneficial in order to estimate the severity of dental erosion among different population groups in Lithuania.

CONCLUSIONS

The prevalence of dental erosion of very low degree among the regular swimmers of Kaunas city was high and significantly related with age. Double estimates were found in 18 - 25 year-old swimmers as compared to their 12 - 17 year-old colleagues.

ACKNOWLEDGMENTS AND DISCLOSURE STATEMENTS

The authors would like to thank Irena Nedzelskienė (Lithuanian University of Health Sciences, Faculty of Odontology, Department of Dental and Oral Pathology) for her help in statistical analysis and to the swimming schools and all the participants who participated in this survey.

The authors report no conflicts of interest related to this study.

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To cite this article:
Zebrauskas A, Birskute R, Maciulskiene V. Prevalence of Dental Erosion among the Young Regular Swimmers in Kaunas, Lithuania.
J Oral Maxillofac Res 2014;5(2):e6
URL: http://www.ejomr.org/JOMR/archives/2014/2/e6/v5n2e6ht.pdf
doi: 10.5037/jomr.2014.5206