Prevalence and severity of tooth wear and risk factors among young adults in Southern Brazil

Prevalência e gravidade do desgaste dentário
e fatores de risco entre adultos jovens no sul do Brasil

Luís Felipe Sá Caye[a], Daiane Cerutti Kopplin[b], Luis Carlos da Fontoura Frasca[c],
Elken Gomes Rivaldo[d], Roger Keller Celeste[c]

ABSTRACT

Introduction: In studies on the prevalence of tooth wear, few publications related to young adults are found. Objectives: To explore the associations of behavioral, medical, and socio-demographic variables with prevalence and severity of tooth wear of the whole dentition, in a sample of young adults, using a modified version of the Tooth Wear Index (TWI). Methods: Sample consisted of 116 university dental students with an average age of 23 years, who answered a questionnaire related to sociodemographic variables, self-perception and health behaviors. In addition, individuals underwent a clinical evaluation of tooth wear by one trained examiner using the TWI modified by Smith and Knight. Logistic regression was carried out at individual level. Results: A total of 9,906 dental surfaces in 116 individuals were examined, 72.27 % dental surfaces had no tooth wear (grade 0), but all individuals had at least one worn surface. Among the individuals, 78,4 % had grade 1 (enamel) as the highest level and 21.6% grade 2 (dentin) as the highest level. The presence of grade 2 tooth wear was mainly prevalent in the following individuals: male; smoker; with bruxism, and among those who reported having undergone orthodontic treatment. Analyzing the relevant factors that affect tooth wear by multiple regression analysis, it was found that smoking (OR 6.67; IC 1.73- 25.76) and bruxism (grinding) (OR 4.05; IC 1.29- 12.7) had the greatest effect on tooth wear. Conclusions: Our results suggest that being male, being a current smoker, having grinding bruxism and having previous orthodontic treatment are associated with tooth wear.

Keywords: Tooth wear. Tooth erosion. Epidemiology. Prevalence. Risk factors.

Luís Felipe Sá Caye *et al.*

RESUMO

Introdução: Nos estudos de prevalência em desgaste dental encontramos poucos trabalhos relacionados com adultos jovens. Objetivos: Explorar a associação de variáveis comportamentais, médicas e sociodemográficas com desgaste dentário em uma amostra de adultos jovens, utilizando uma versão modificada do índice Tooth Wear Index (TWI). Métodos: A amostra foi composta por 116 estudantes universitários de Odontologia, com média de 23.3 anos de idade, que responderam a um questionário relacionado às variáveis sociodemográficas, de autopercepção e comportamentais em saúde. Além disso, esses indivíduos foram submetidos a avaliação clínica do desgaste dental por um examinador treinado usando o TWI modificado por Smith e Knight. Regressão logística foi realizada em nível individual. Resultados: Um total de 9.906 superfícies dentárias em 116 indivíduos foram examinadas, 72,27% das superfícies não apresentavam desgaste dentário (grau 0), mas todos os indivíduos apresentavam pelo menos uma superfície desgastada. Dentre os indivíduos 78,4% apresentaram grau 1 (esmalte) como o nível mais alto e 21,6% grau 2 (dentina) como o mais alto. A presença de desgaste dentário de grau 2 foi principalmente prevalente nos seguintes indivíduos: sexo masculino; fumante; com bruxismo, e entre aqueles que relataram ter realizado tratamento ortodôntico. Analisando os fatores relevantes que afetam o desgaste dentário por análise de regressão múltipla, se verificou que tabagismo (OR = 6,67; IC 1,73-25,76) e bruxismo (OR = 4,05; IC 1,29-12,7) tiveram o maior efeito associado sobre o desgaste dentário. Conclusões: Nossos resultados sugerem que ser do sexo masculino, tabagista, relatar bruxismo e ter realizado tratamento ortodôntico prévio está associado ao desgaste dentário.

Palavras-chave: Desgaste dos dentes. Erosão dentária. Epidemiologia. Prevalência. Fatores de risco.

INTRODUCTION

Human tooth wear is a process that occurs gradually and universally in all individuals, but the degree and pattern are affected by factors such as diet, dentition, jaw musculature, and chewing habits[1]. In an anthropological approach, it has been documented that the stomatognathic system adapts or remodels in response to progressive wear, as well as direct associations between diet patterns and tooth wear[2]. Tooth wear may have physical (abrasion and attrition) and/or chemical (erosion) causes[3]. Although the terms abrasion, attrition, and erosion are often used to denote the loss of tooth structure, they are defined by different mechanisms. While attrition is caused by the wear action of antagonistic teeth, leading to flat lesions with sharp and shiny edges, abrasion is predominantly caused by traumatic oral hygiene habits, and erosion is caused by extrinsic or intrinsic chemical agents, being characterized by loss of tooth morphology and contour, generating concavities, which are generally wider than deep[4]. In addition, variations on how these mechanisms are understood seem to be subtle[5].

It is also well established that levels of tooth wear have a direct linear association with individual's age, with severe tooth wear increasing from 3% at the age of 20 years to 17% at the age of 70 years[6]. Although this relationship tends to increase exponentially, it nevertheless highlights that the general factors related to tooth wear, such as diet and deleterious oral habits, remain relatively constant within a set environment[7].

The aging of the population has emerged as a major demographic trend along with better dental preventive measures. Consequently, this growing segment of individuals has retained functioning natural dentition for longer periods than in previous times[8-10]. Thus, it is expected that the incidence of severe tooth wear will increase considerably in the future, creating the need for a better understanding of the distributions and current causes, considering the habits and eating patterns of contemporary society[11]. Although there are data regarding the prevalence of tooth wear in children and adolescents, data in adults are dispersed, mainly due to the difficulty of recruiting individuals and the lack of a universally accepted index[6]. Hence, the present study aimed to explore the associations of behavioral, medical, and socio-demographic variables with prevalence and severity of tooth wear of the whole dentition, in a sample of young adults, using a modified version of the Tooth Wear Index (TWI)[3].

Materials and methods

Study design

This cross-sectional study includes a convenience sample of 116 young dental students at Universidade Luterana do Brazil (Canoas, Brazil) enrolled in the third, fourth and fifth years. The age range of the individuals is from 18 to 38 years. In selecting the sample, all registered students were eligible and the following excluding criteria were applied at tooth level: lack of integrity of tooth surfaces, having restored teeth due to tooth wear. Missing and decayed teeth, teeth with crowns, orthodontic brackets, and fractures or cracks visible to the naked eye were not considered for evaluation. The assessment of tooth wear was performed between October and December of 2010. Participation in the study was voluntary. Written informed consent was obtained from each subject. This study was approved by the Institutional Review Board of the Universidade Luterana do Brasil (ULBRA/Canoas, RS, protocol # 2011-197H) and has been conducted in full accordance with the World Medical Association Declaration of Helsinki.

Assessment of tooth surface and self-reported questionnaire

Clinical examination was performed by one previously calibrated examiner with a dental mirror and an air-drying device in a dental chair with artificial light. No participant needed dental prophylaxis prior to the examination. A validated modification of the TWI was used to assess tooth wear: 0-Normal (no evidence of wear); 1-Incipient (tooth wear in enamel); 2-Moderate (tooth wear in dentin); 3-Severe (tooth wear in pulp or secondary dentin); 4-Restored (tooth wear leading to restoration); 9-Could not be assessed. The occlusal/incisal, buccal, and lingual/palatal surfaces of all teeth present in the mouth were scored for tooth wear. A self-reported questionnaire included information that might be related to the etiological factors of tooth wear previously published in the literature. The questionnaire also covered details on socio-demographic characteristics and lifestyle factors, as this was prepared for this specific project; it was pre-tested among other students for clarity.

Statistical analysis

The prevalence of tooth wear in dentin, at individual level, is presented in tables according to four groups of covariates: a) socio-demographic and self-perception, b) medical conditions, c) health behavior, and d) dental factors. The comparison of prevalence between categories of covariates was tested with chi-square test or Fisher's exact test when there was violation of assumptions.

Multivariate analyses were carried out using logistic regression at individual level. Due to the large number of covariates in relation to sample size and possible collinearity, it was adopted a two-step analytical strategy. Firstly, running a multiple regression within each block of covariates, then selecting those variables with a $p < 0.20$ for the final multiple regression. In the socio-demographic block only sex remained significant ($p = 0.07$); in the medical conditions no variable remained significant (all presented $p > 0.40$); in the health behavior block only smoking remained significant ($p < 0.01$); and in the dental variables block pain ($p=0.09$), previous orthodontic treatment ($p = 0.12$), and bruxism ($p < 0.01$) were selected. Model fit was assessed with GOF test (Hosmer-Lemeshow Goodness of Fit test). Preliminary subgroup analysis showed no difference in carrying out analysis stratified by surfaces (occlusal and buccal). All analyses were performed using the Stata package for statistical analysis (version 13.1, STATACORP, 2009).

Results

The final sample comprised 32.7% of men, 93.9% of white individual and mean age of 23.3 years (standard deviation = ±3.3). A total of 9,906 dental surfaces, from 116 voluntary students were examined. At individual level, 100% of the subjects presented at least one surface with tooth wear grade 1 or higher (enamel), and 21.6% with grade 2 or higher (dentine) and there was no individual with grade 3 or higher (pulp). At surface level, 72.3% of them did not present tooth wear (grade 0), 25.7% presented tooth wear involving enamel (grade 1), 0.8% showed tooth wear on dentin level (grade 2), 0.04% had been restored due to enamel wear (grade 4), and 1.3% of surfaces could not be assessed (grade 9). No severe lesions involving secondary dentin or pulp exposure were detected. The presence of grade 2 tooth wear or higher was mainly prevalent among males on occlusal/incisal surfaces ($p = 0.04$) (Table 1); smokers ($p = 0.01$) on occlusal/incisal surfaces ($p = 0.01$) and on total surfaces ($p = 0.002$) (Table 3); among persons with bruxism, on occlusal/incisal surfaces ($p = 0.001$) and on total surfaces ($p = 0.004$); and among those who reported having had orthodontic treatment, on total surfaces ($p = 0.04$) (Table 4). General medical conditions in Table 2, like bulimia, gastric reflux, xerostomy and use of medicines were not associated with tooth wear ($p > 0.05$).

Tables

Table 1: Prevalence of individuals with tooth wear according to socio-demographic and self-perception factors among dental students (n = 116).

| | Tooth wear in dentin | | | | | | |
| | Facial/Lingual surfaces | | Occlusal/incisal | | Total | | |
	%	p value	%	p value	%	p value	N
Total	5.2		18.1		21.6		116
Sex							
Man	7.9	0.39	28.9	0.04	31.6	0.90	38
Woman	3.9		12.8		16.7		78
Age							
18-19	0.0	0.71	14.3	0.45	14.3	0.38	7
20-24	5.3		21.1		23.7		76
25-29	4.0		8.0		12.0		25
≥30	12.5		25.0		37.5		8
Race							
Black	0.0	1.00	0.0	1.00	0.0	0.80	4
White	5.5		19.3		22.9		109
Yellow or Indian	0.0		0.0		0.0		3

Table 2: Prevalence of individuals with tooth wear according to self-reported medical conditions among dental students (n = 116).

	Tooth wear in dentin						
	Facial/Lingual surfaces		Occlusal/incisal		Total		
	%	p value	%	p value	%	p value	N
Total	5.2		18.1		21.6		116
Xerostomy							
Yes	0.0	1.00	0.0	1.00	0.0	1.00	2
No	5.3		18.4		21.9		114
Gastric reflux							
Yes	11.1	0.39	11.1	1.00	11.1	0.68	9
No	4.7		18.7		22.4		107
Bulimia							
Yes	0.0	1.00	0.0	1.00	0.0	1.00	1
No	5.2		18.3		21.7		115
Use of medication							
Yes	8.0	0.60	16.0	1.00	20.0	1.00	25
No	4.4		18.7		21.9		91

Table 3: Prevalence of tooth wear according to health behavior factors among dental students (n = 116).

	Tooth wear in dentin						
	Facial/Lingual surfaces		Occlusal/incisal		Total		
	%	p value	%	p value	%	p value	N
Total	5.2		18.1		21.6		116
Alcohol consumption							
None	6.7	0.64	6.7	0.09	10.0	0.12	30
At least once	4.7		22.1		25.6		86
Smoking							
Yes	11.8	0.21	41.2	0.01	52.9	<0.01	17
No/former smoker	4.0		14.1		16.2		99
Acidic foods and drinks consumed							
No every day	6.3	0.69	15.6	0.47	21.9	1.00	64
Every day	3.9		21.2		21.2		52
Tooth brushing frequency							
≤ 3 times/day	4.3	0.31	15.9	0.27	20.2	0.56	94
> 3 times/day	9.1		27.3		27.3		22

Table 4: Prevalence of individuals with tooth wear according to self-reported dental factors in dental students (n = 116).

	Facial/Lingual surfaces		Occlusal/incisal		Total		
	%	p value	%	p value	%	p value	N
	5.2		18.1		21.6		116
Had tooth whitening							
Yes	8.1	0.08	18.9	0.80	24.3	0.48	74
No	0		16.7		16.7		42
Received orthodontic treatment							
Yes	6	0.67	21.7	0.18	26.5	0.04	83
No	3		9.1		9.1		33
Received occlusal adjustment							
Yes	16.7	0.11	16.7	1.00	25	0.72	12
No	3.9		18.3		21.1		104
Visit to the dentist frequency							
< 1 time/year	0	1.00	13.3	1.00	13.3	0.51	15
≥ 1 time/year	5.9		18.8		22.8		101
Bruxism							
No	4.9	0.46	9.8	<0.01	13.1	<0.01	61
Yes, clenching teeth	8.6		14.3		20		35
Yes, grinding teeth	0		50		50		20
Pain							
No	20	0.39	40	0.68	60	0.42	5
Tooth pain	0		21.7		21.7		23
Facial muscle pain	0		14.3		14.3		7
Ear region pain	6.5		16.9		20.8		77
Tooth, facial muscle, and ear pain	0		0		0		4
Self-perception of oral health							
Very good	5	1.00	20	0.27	25	0.3	40
Good	5.6		15.5		18.3		71
Regular	0		40		40		5
Self-perception of tooth wear							
Yes	6.4	0.68	20.6	0.47	25.4	0.36	63
No	3.8		15.1		16.9		53

Table 4: (Cont.)

	Tooth wear in dentin						
	Facial/Lingual surfaces		Occlusal/incisal		Total		
	%	p value	%	p value	%	p value	N
	5.2		18.1		21.6		116
Had tooth whitening							
Yes	8.1	0.08	18.9	0.80	24.3	0.48	74
No	0.0		16.7		16.7		42
Received orthodontic treatment							
Yes	6.0	0.67	21.7	0.18	26.5	0.04	83
No	3.0		9.1		9.1		33
Received occlusal adjustment							
Yes	16.7	0.11	16.7	1.00	25.0	0.72	12
No	3.9		18.3		21.1		104
Visit to the dentist frequency							
<1 time/year	0.0	1.00	13.3	1.00	13.3	0.51	15
≥1 time/year	5.9		18.8		22.8		101
Bruxism							
No	4.9	0.46	9.8	<0.01	13.1	<0.01	61
Yes, clenching teeth	8.6		14.3		20.0		35
Yes, grinding teeth	0.0		50.0		50.0		20
Pain							
No	20.0	0.39	40.0	0.68	60.0	0.42	5
Tooth pain	0.0		21.7		21.7		23
Facial muscle pain	0.0		14.3		14.3		7
Ear region pain	6.5		16.9		20.8		77
Tooth, facial muscle, and ear pain	0.0		0.0		0.0		4

Results from multiple logistic regression (Table 5) showed that men had OR grinding bruxism OR = 6.50 (IC95%: 1.78-23.75), current smokers OR = 6.67 (IC95%: 1.73-25.76), and = 4.05 (95%CI: 1.29-12.7) more chances of tooth wear than woman. Those with those who received orthodontic treatment OR = 4.50 (IC95%: 1.06-19.24). Residuals from multiple logistic regression had acceptable fit (p = 0.73, Hosmer-Lemeshow GOF-test).

Table 5: Unadjusted and adjusted odds ratio (OR) of having tooth wear at dentin level according to selected variables in multiple logistic regression.

		Unadjusted		Adjusted*	
		OR	(IC95%)	OR	(IC95%)
Sex	Woman	1		1	
	Man	2.31	(0.93-5.72)	4.05	(1.29-12.7)
Bruxism	No	1		1	
	Yes, clenching teeth	1.66	(0.54-5.04)	1.26	(0.35-4.51)
	Yes, grinding teeth	6.63	(2.10-20.91)	6.50	(1.78-23.75)
Smoker	Never/Former	1		1	
	Yes	5.84	(1.96-17.40)	6.67	(1.73-25.76)
Orthodontic treatment	No	1		1	
	Yes	3.61	(1.00-13.01)	4.50	(1.06-19.24)
Facial or dental pain	No	1		1	
	Yes	0.16	(0.02-1.05)	0.21	(0.02-1.98)

* Odds ratio adjusted by all variables in the model (Sex, Bruxism, Smoker, Orthodontic Treatment, and Facial or Dental Pain).

Discussion

In this study, the main risk factors for tooth wear at the dentin level were being male, being a current smoker, having grinding bruxism, and having had previous orthodontic treatment. In analyzing the relevant factors that affect tooth wear by multiple regression analysis, it was found that smoke and bruxism (grinding) had independent and large effects. Despite of smokers having higher rates of bruxism[12,13], these factors could have confounded each other. In a sample of identical twin pairs[13], smoking and bruxism were associated independently of other factors, such as genetic background[14,15]. Bruxism involves local, systemic, psychological, and hereditary causes[16]. About 5–20% of the general population is affected by bruxism, which is related to tooth wear[17]. According to previous studies, individuals with clenching and grinding habits could produce up to four times more tooth wear than individuals deprived of bruxism[18-20]. In addition to these factors, in this study sample, men were up to four times more likely to have tooth wear (OR 4.05; IC95% 1.29- 12.7) than women. Since bite force is a gender-related factor [21], it could be suggested that along with other factors, stronger bite force influences tooth wear.

The present study assessed the prevalence of tooth wear in a sample of young adults, using a modified version[22,23] of the Tooth Wear Index (TWI)[3]. This modification was suggested in order to meet the World Health Organization standard; thus allowing application of the index in comprehensive epidemiological surveys, since it became easier to use while remaining valid for etiological studies[6]. Currently, regarding severity of tooth wear, there is no consensus on which index possesses absolute superiority over any other. However, studies using indices that examine only incisors or first molars (index teeth) may not be able to provide evidence about the distribution and severity of tooth wear in the full dentition[24].

Our findings showed a prevalence of 27.7%, in terms of tooth level, similar to the percentage described by de Carvalho Sales-Peres et al.[25] also using the TWI. Although that study investigated the prevalence of tooth wear in 12-year-old adolescents, the fact of using full-mouth exam may explain similar results, as well as a difference with another study with a similar sample (prevalence of 13.0%)[26]. Regarding severity, it was found a higher percentage of teeth with a TWI grade 1 (25.6%), while percentages of extensive wear, grades 3 and 4, varied from 0% to 0.4%. From a treatment perspective, the identification of severe levels such as grades 3 and 4 h[27] at tooth level[28-30], comparable with the present study, the percentage of teeth with grade 3 or 4 was higher, proportional with the age of the studied sample: 2% of the total population aged 30 and 70[27].

Along with its strengths, the present study has some limitations. First, the loss of dental structure is not necessarily due to tooth wear, and often the tooth wear patterns do not reflect the etiology indicated. Secondly, the study design was cross-sectional, so caution must be considered in the interpretation causal associations. Nonetheless, it is believed that reverse causation may not be a problem for the main risk factors presented, and further investigation should consider time-related issues. Third, the present results do not represent the general population, as they are based on a convenience sample, and therefore extrapolation of prevalence findings is only possible for similar populations. Finally, self-reported variables are prone to measurement errors, decreasing the magnitude of the associations.

The clinical assessment of tooth wear is often subjective, and the management of tooth wear is difficult. Therefore, screening programs could provide the identification of risk groups for early preventive measures before operative treatment is undertaken. This action could enhance the cost-effectiveness of dental treatment in this regard. Preventive management can reduce or interrupt the progression of pathological tooth wear, using monitoring with models and photographs, restorations of dental tissues lost when necessary, control of the diet, and in some cases can perform the test of salivary flow and buffer capacity, in addition to referral for medical treatment in cases of gastric etiology.

New research should be conducted, seeking uniformity of wear rates used to allow the reliability and comparability of data. In addition, longitudinal studies are needed in the adult population, in order to establish normality parameters and to identify etiologic factors of tooth wear in such population.

Conclusions

Our results suggest that being male, being a current smoker, having grinding bruxism, and having previous orthodontic treatment are associated with tooth wear.

References

1. Wood I, Jawad Z, Paisley C, Brunton P. Non-carious cervical tooth surface loss: a literature review. J Dent. 2008;36(10):759-66.
2. Kaidonis JA. Tooth wear: the view of the anthropologist. Clin Oral Investig. 2008;12 Suppl 1:S21-6.
3. Smith BG, Knight JK. An index for measuring the wear of teeth. Br Dent J. 1984;156(12):435-8.
4. Carvalho TS, Colon P, Ganss C, Huysmans MC, Lussi A, Schlueter N, et al. Consensus report ofthe european federation of conservative dentistry: erosive tooth wear--diagnosis and management. Clin Oral Investig. 2015 Sep;19(7):1557-61.
5. Imfeld T. Dental erosion. Definition, classification and links. Eur J Oral Sci. 1996;104:151-5.

6. Van't Spijker A, Rodriguez JM, Kreulen CM, Bronkhorst EM, Bartlett DW, Creugers NH. Prevalence of tooth wear in adults. Int J Prosthodont. 2009;22(1):35-42.

7. Osborne-Smith KL, Burke FJ, Wilson NH. The aetiology of the non-carious cervical lesion. Int Dent J. 1999;49(3):139-43.

8. Muller F, Naharro M, Carlsson GE. What are the prevalence and incidence of tooth loss in the adult and elderly population in Europe. Clin Oral Implants Res. 2007;18:2-14.

9. Haugen LK. Biological and physiological changes in the ageing individual. Int Dent J. 1992;42(5):339-48; discussion 349-52.

10. Wennstrom A, Ahlqwist M, Stenman U, Bjorkelund C, Hakeberg M. Trends in tooth loss in relation to socio-economic status among Swedish women, aged 38 and 50 years: repeated cross-sectional surveys 1968-2004. BMC Oral Health. 2013;13:63.

11. Liu B, Zhang M, Chen Y, Yao Y. Tooth wear in aging people: an investigation of the prevalence and the influential factors of incisal/occlusal tooth wear in northwest China. BMC Oral Health 2014;14:65.

12. Lavigne GL, Lobbezoo F, Rompre PH, Nielsen TA, Montplaisir J. Cigarette smoking as a risk factor or an exacerbating factor for restless legs syndrome and sleep bruxism. Sleep. 1997;20(4):290-3.

13. Rintakoski K, Ahlberg J, Hublin C, Lobbezoo F, Rose RJ, Murtomaa H, et al. Tobacco use and reported bruxism in young adults: a nationwide finnish twin cohort study. Nicotine Tob Res. 2010;12(6):679-83.

14. Hublin C, Kaprio J, Partinen M, Koskenvuo M. Sleep bruxism based on self-report in a nationwide twin cohort. J Sleep Res. 1998;7(1):61-7.

15. Schnoll RA, Johnson TA, Lerman C. Genetics and smoking behavior. Curr Psychiatry Rep. 2007;9(5):349-57.

16. Chisnoiu AM, Picos AM, Popa S, Chisnoiu PD, Lascu L, Picos A, et al. Factors involved in the etiology of temporomandibular disorders - a literature review. Clujul medical (1957). 2015;88(4):473-8.

17. Lobbezoo F, Van Der Zaag J, Naeije M. Bruxism: its multiple causes and its effects on dental implants — an updated review. J Oral Rehabil. 2006;33(4):293-300.

18. Christensen GJ. Treating bruxism and clenching. J Am Dent Assoc. 2000;131(2):233-5.

19. Kontaxopoulou I, Alam S. Risk Assessment for tooth wear. Prim Dent J. 2015;4(3):25-9.

20. Pavone BW. Bruxism and its effect on the natural teeth. J Prosthet Dent. 1985;53(5):692-6.

21. Pigno MA, Hatch JP, Rodrigues-Garcia RC, Sakai S, Rugh JD. Severity, distribution, and correlates of occlusal tooth wear in a sample of Mexican-American and European-American adults. Int J Prosthodont. 2001;14(1):65-70.

22. Al-Dlaigan YH, Shaw L, Smith A. Dental erosion in a group of British 14-year-old, school children. Part I: Prevalence and influence of differing socioeconomic backgrounds. Br Dent J. 2001;190(3):145-9.

23. Dugmore CR, Rock WP. The prevalence of tooth erosion in 12-year-old children. Br Dent J. 2004;196:279-82; discussion 273.

24. Wiegand A, Muller J, Werner C, Attin T. Prevalence of erosive tooth wear and associated risk factors in 2-7-year-old German kindergarten children. Oral Dis. 2006;12(2):117-24.

25. de Carvalho Sales-Peres SH, Goya S, de Araujo JJ, Sales-Peres A, Lauris JR, Buzalaf MA. Prevalence of tooth wear among 12-year-old Brazilian adolescents using a modification of the tooth wear index. Public Health. 2008;122(9):942-8.

26. Peres KG, Armenio MF, Peres MA, Traebert J, De Lacerda JT. Dental erosion in 12-year-old schoolchildren: a cross-sectional study in Southern Brazil. Int J Paediatr Dent. 2005;15(4):249-55.

27. Hugoson A, Bergendal T, Ekfeldt A, Helkimo M. Prevalence and severity of incisal and occlusal tooth wear in an adult Swedish population. Acta Odontol Scand. 1988;46(5):255-65.

28. Borcic J, Anic I, Urek MM, Ferreri S. The prevalence of non-carious cervical lesions in permanent dentition. J Oral Rehabil. 2004;31(2):117-23.

29. Nunn J, Morris J, Pine C, Pitts NB, Bradnock G, Steele J. The condition of teeth in the UK in 1998 and implications for the future. Br Dent J. 2000;189:639-44.

30. Smith BG, Robb ND. The prevalence of toothwear in 1007 dental patients. J Oral Rehabil. 1996;23(4):232-9.