Community Dental Health (2012) **29,** 33–38
Received 28 November 2009; Accepted 17 September 2010

doi:10.1922/CDH_2619Saerah06

Associated factors of tooth wear among Malaysian 16-year-olds: a case-control study in Kota Bharu, Kelantan

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Objective: To determine the associated factors of tooth wear (TW) among 16-year-old school children. ***Method and Materials:*** A random selection of secondary school children from 8 government secondary schools in Kota Bharu, Kelantan, Malaysia, participated in this case-control study. The Smith and Knight Tooth Wear Index and WHO criteria were used to chart tooth wear and dental caries respectively. Saliva analyses used standards recommended by *GC* Asia Dental. Self-administered questionnaire provided socio-demographic profile of the family, general knowledge of tooth wear, oral hygiene, food and drinks practices and other associated variables for tooth wear. Analysis using multiple logistic regression was performed. ***Results:*** Of the 576 children sampled, 40% of the 460 controls were male as were 57% of the 116 in the case group. Multivariate analysis showed gender, monthly household income, carbonated drinks, caries experience, pool swimming, duration of intake of orange juice and hydration rate and viscosity were significantly associated with wear. ***Conclusion:*** The factors associated with tooth wear were similar to those encountered in other studies. Oral health promotion activities should emphasise those factors which can be changed. The erosive potential of some foods and drinks require further investigation.

Key words: *tooth wear, associated factors, Malaysia, Kota Bharu, Kelantan*

Introduction

Lifelong use of teeth causes wear, i.e. non-carious loss of tooth tissue due to attrition, erosion and abrasion (Ibbetson and Eder, 1999). Such loss is considered as tooth wear (TW) when it exceeds normal wear. Changes in dietary patterns may affect tooth wear leading to problems of sensitivity or discomfort. Data from eastern Malaysia which showed a prevalence of 95% moderate and 41% severe tooth wear among a wide age group of 14-77 years (Milosevic and Lo, 1996) may not reflect tooth wear across Malaysia because the dietary patterns of the ethnic groups studied may be atypical. It is difficult to measure attrition, erosion or abrasion separately therefore this study measured tooth wear in general. Rijkom and colleagues (2002) found prevalences of enamel wear of 3% in 10-13 year-olds and 30% in 15-16 year-olds. The low prevalence in the former group makes it difficult to establish possible etiological factors. Milosevic and colleagues (2004) reported similar prevalence in 14 year-olds and concluded that children aged 12-14 years were too young for the etiological factors to have fully exerted their effects. This led to 16 year-olds being selected for this study. Moreover these groups are not in an examination year in the Malaysian school system reducing barriers to data collection. Therefore we aim to determine the associated factors of tooth wear among 16-year-old school children in Kota Bharu Kelantan, Malaysia.

Methods

Kota Bharu is a town in Kota Bharu District in Kelantan state of Peninsular Malaysia. There are 12 secondary schools: 8 national secondary school, 2 Chinese schools, a boys' college and a school with some boarders. All 8 national schools were surveyed to represent the general population of 16-year-olds in Kota Bharu.

This two-stage study aims to first determine the prevalence of tooth wear and then determine the associated factors of wear. The initial sample size of 756 was calculated using the single proportion formula based on prevalence of wear determined in a pilot study. After determining the tooth wear prevalence of this sample, they were re-sampled for the second stage. The sample size for the second stage was then calculated as 585. Simple random allocation to 117 cases and 468 controls gave a ratio of 1:4 and used all the small number of cases and maintained the sample size. Unfortunately, during the second visit of the study, some children had relocated leaving 116 cases and 460 controls and a retention rate 98.5%.

The Research and Ethics Committee, Universiti Sains Malaysia gave ethical approval. Parents or guardians (hereafter simplified to parents) gave their consent. The Universiti Sains Malaysia short-term grant (304/PPSG/6131406) supported the study.

Children were examined under adequate lighting on school premises using a portable dental chair, disposable plane mouth mirrors, dental probes to remove food debris and periodontal probes to measure depth of worn surfaces when necessary. Teeth were dried using cotton wool rolls. Four surfaces were examined - cervical, buccal, occlusal or incisal and lingual or palatal. Restored or carious surfaces were excluded. Also excluded were children with any serious medical conditions and those

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wearing fixed orthodontic appliances. Teeth were charted for caries experience using World Health Organization (WHO) criteria and tooth wear using Smith and Knight Tooth Wear Index (1984) (Table 1). Children with all tooth surfaces scored zero (TW=0) were categorised as non-case controls and those with at least one surface scored 1 or above (TW) were categorised as cases. SPSS version 11.0 was used for data management and analysis.

Training and calibration were undertaken by the project supervisor (NMI). One examiner (NBS) collected all data. Repeated measures (n=30) were made on 3 occasions to test intra-examiner reproducibility and the resulting Kappa scores (0.85, 0.86, 0.87) were acceptable.

After initial training in use of the GC Asia Saliva kit (2001), assessments were made of hydration rate, viscosity, pH, flow rate of stimulated and unstimulated saliva and buffering capacity. Saliva was collected in the morning at approximately the same time throughout the duration of data collection. Participants were instructed not to eat or drink for one hour before test procedures (Bartlett *et al.*, 1998; Lussi and Schaffner 2000) and were seated upright for saliva collection.

Hydration rate (resting flow rate) was assessed visually by observing saliva production from small salivary glands on the lips. The lower lip was everted and the labial mucosa gently blotted under lighting (Safari Light, Dental Inc, Quebec Canada) to observe saliva droplets appearing from gland orifices. The time from the start of blotting to the first appearance of saliva droplet was taken as saliva hydration rate.

Children sat on a chair in as quiet an environment as possible with heads bent forward for collection of unstimulated saliva. After an initial swallow, they were asked to spit out into a graduated tube every 20 seconds for 5 minutes. The flow rate of saliva was calculated by dividing the volume collected by 5 and categorising as: normal, 0.25-0.35; low 0.1-0.24; or very low, <0.1 ml/min.

Viscosity of resting (unstimulated) saliva was assessed visually by observing the consistency. Sticky frothy saliva indicated high viscosity while clear watery saliva indicated normal viscosity.

Saliva pH was tested by placing a pH test strip into the unstimulated saliva for 10 seconds and comparing the colour with the test chart. pH values were categorised as: highly acidic, 5.0-5.8; moderately acidic, 6.0-6.6; or healthy, 6.8-7.8. However, the pH values were recategorised during the modelling because the first categorisation was not linear in the logit form. The ranges became: 5.0-6.9; 7.0-7.5; and 7.6-7.8.

For stimulated saliva, participants were given a 1-gram piece of unflavored wax to chew for 30 seconds. Saliva produced initially was swallowed, then chewing continued at a regular rate and the saliva was collected and the flow rate calculated as described above. Flow rates were categorised as: normal, >5.0; low, 3.5-5.0; or very low, <3.5 ml/.

The buffering capacity of saliva was tested using the stimulated saliva. A fresh buffer test strip was placed onto an absorbent tissue with the test side up (3 tests on a pad). A pipette was used to one drop of saliva from the collection cup onto each test pad. The strip was then turned 90° to soak up excess saliva on the absorbent tissue. After 5 minutes the strips were compared with the chart provided to score the saliva buffering ability. Scores were categorised as: very low, 0-5; low, 6-9; or normal to high, 10-12 points (O'Sullivan and Curzon 2000).

To assess association between the measure of wear and the categorical and continuous variables, simple logistic regression was used followed by multiple logistic regression analysis. Logit transformations were used to test for linearity between numerical factors and the outcome variable. Non-linear variables were then categorised and retested in the model. All possible two-way interactions were tested. Crude and adjusted odds ratios were obtained from simple and multiple logistic regression analyses respectively and both their 95% confidence intervals (CI) and the p-values of likelihood-ratios (LR) obtained. The model was tested for fitness using the Hosmer-Lemeshow

Table 1. Criteria for scoring tooth wear (Smith & Knight, 1984)

Score[a]	*Surface*[b]	*Criteria*
0	B/L/O/I	No loss of enamel surface characteristics
	C	No change in contour
1	B/L/O/I	Loss of enamel characteristics
	C	Minimal loss of contour
2	B/L/O	Loss of enamel exposing dentine for less than 1/3 of the surface
	I	Loss of enamel just exposing dentine
	C	Defect less than 1 mm deep
3	B/L/O	Loss of enamel exposing dentine for more than 1/3 of the surface
	I	Loss of enamel and substantial loss of dentine but not exposing the pulp or secondary dentine
	C	Defect 1-2 mm deep
4	B/L/O	Complete loss of enamel or pulp exposure, or exposure of secondary dentine
	I	Pulp exposure or exposure of secondary dentine
	C	Defect more than 2 mm deep, or pulp exposure or exposure of secondary dentine

[a]In case of doubt the lower score is given
[b]B = Buccal , L = Lingual or palatal, I = Incisal, O = Occlusal, C = Cervical
Missing teeth were scored as M.
Restored surfaces and other unscorable surfaces were scored as R.

goodness-of-fit test. Sensitivity, specificity and correctly classified proportion from classification table, area under the Receiver Operating Characteristic curve were obtained to evaluate model adequacy.

Data on dietary habits were captured using a food frequency questionnaire listing 17 drinks, fruits and foods available in the local market and selected based on a literature search and considered by expert opinions to suit local children. All dietary items were analysed as separate entities to capture the significance of each variable in tooth wear.

Results

This case-control study involved 576 Malay nationals, all school children between October 2004 and February 2005 with a response rate of 98.5%. Table 2 shows the socio-demographic profile of the children. The percentage of males and females in the control group was 40% but 57% in the case group. The distribution by parental education was similar for these two groups. Most parents were self-employed with median income of RM800 (1st quartile RM 300, 3rd RM 1,300) in both groups.

Table 2. Some socio-demographic characteristics of subjects

	Controls (n=460)		*Cases (n=116)*	
Characteristic	*n*	*(%)*	*n*	*%*
Gender				
Male	186	(40.4)	66	(56.9)
Female	274	(59.6)	50	(43.1)
Parental Education				
University	56	(12.2)	19	(16.4)
Vocational college	294	(63.9)	71	(61.2)
Primary or None	110	(23.9)	26	(22.4)
Parental Occupation				
Not working	7	(1.5)	3	(2.6)
Self- employed	204	(44.3)	56	(48.2)
Private	72	(15.7)	19	(16.4)
Government	177	(38.5)	38	(32.8)

About 44% of children in the control group but only 25% of cases had watery saliva (Table 3). The mean hydration rates were 35s (sd 15) and 40s (14) in control and case groups respectively. The pH values of unstimulated and stimulated saliva were similar in both groups. The median buffering capacities were 9.0 and 10.5 for control and case groups respectively.

Data on dietary habits identified only the duration of orange juice consumption and the intake of carbonated sports drinks as being associated with tooth wear (Table 4). Some 68% consumed sports drinks but only 8% drank two or more per day.

Discussion

The Smith and Knight Tooth Wear Index (1984) was used to compare results with other studies. Previous studies showed males were more susceptible than females (Dugmore and Rock, 2004; Oginni and Olusile, 2002). Our study confirmed that males had 2.2 times (95% CI: 1.35-3.55) the odds of developing tooth wear compared to females (Table 4). This might be due to males having a heavier or higher bite force (Van de Glass *et al.*, 1996) and higher consumption of soft drinks (Harnack *et al.*, 1996).

Three measures of socio-economic status (SES) were considered: parental education, parental occupation and household income. Only household income showed significant association with low income being related to tooth wear. Children of poor income group were at 5.1 times the odds of developing TW compared to those in the highest income group. Income may be related to educational level which could in turn influence behaviour, however, there was no association between educational level and tooth wear. Alternative classifications of SES have been used such as the area-based Townsend index (Bardsley *et al.*, 2004), Jarman score (Milosevic *et al.*, 1994) and ACORN classification (Al-Dlaigan *et al.*, 2001).

The most studied factor in tooth wear is diet (Lussi and Schaffner, 2000). In this study, data on dietary habits identified intake of carbonated sports drinks and dura-

Table 3. Distribution of saliva variables among control and case groups

Variable	*Control group (n=460)*						*Cases group (n=116)*					
	n	*(%)*	*mean*	*(sd)*	*median*	*(IQR)*	*n*	*(%)*	*mean*	*(sd)*	*median*	*(IQR)*
Viscosity												
Sticky, frothy	21	(4.6)					12	(10.3)				
Frothy bubbly	239	(51.9)					75	(64.7)				
Watery, clear	200	(43.5)					29	(25.0)				
Hydration rate (s)			35.4	(14.66)					40.1	(13.71)		
Salivary pH					7.0	(0.6)					7.1	(0.6)
Flow rate (ml/min)												
Unstimulated					0.7	(0.5)					0.7	(0.4)
Stimulated					1.4	(1.0)					1.4	(1.2)
Buffering capacity					9.0	(4.0)					10.5	(4.0)

IQR, inter-quartile range

Table 4. Factors associated with tooth wear (TW) by logistic regression

Variable	*Crude OR*	*Adjusted Odds Ratio OR*	*(95% CI)*	*Logistic Regression statistic*	*(df)*	*p-value (LR)*
Gender						
Female	1.00	1.00		10.30	(1)	0.001
Male	1.95	2.19	(1.35, 3.55)	10.02[a]		0.001[a]
Monthly household income				9.10	(3)	0.028
5001-15,000 RM	1.00 [b]	1.00				
1001-5000 RM		2.44	(0.49, 12.12)	1.19[a]		0.275[a]
501-1000 RM		4.22	(0.85, 20.98)	3.10[a]		0.078[a]
0-500 RM		5.11	(1.01, 25.79)	3.91[a]		0.048[a]
Carbonated sport drinks:				9.32	(3)	0.025
Did not consumed	1.00	1.00				
Sometimes	1.33	1.36	(0.78, 2.36)	1.19[a]		0.276[a]
1-3x/week	0.99	0.74	(0.36, 1.52)	0.68[a]		0.409[a]
4x/week	2.63	2.89	(1.23, 6.81)	5.89[a]		0.015[a]
Years of drinking orange juices	1.11[b]	1.17	(1.08, 1.28)	16.23	(1)	< 0.001
Hydration of saliva in seconds				17.74	(2)	<0.001
High (0-29)	1.02[b]	1.00				
Normal (30-60)		2.13	(1.30, 3.52)	8.84[a]		0.003[a]
Low (> 60)		9.20	(2.76, 30.69)	13.04[a]		<0.001[a]
Viscosity of saliva				15.49	(2)	<0.001
Watery, clear	1.00	1.00				
Frothy, bubbly	2.16	2.23	(1.33, 3.74)	9.24[a]		0.002[a]
Sticky, frothy	3.94	5.15	(1.99, 13.31)	11.45[a]		0.001[a]
pH of saliva				4.65	(2)	0.098
7.6-7.8	1.40 [b]	1.00				
7.0-7.5		0.72	(0.38, 1.34)	1.10[a]		0.294[a]
5.0-6.9		0.49	(0.25, 0.96)	4.36[a]		0.037[a]
Caries experience				11.30	(2)	0.004
Caries free	1.04[b]	1.00				
DMFS 1-7		1.98	(1.15, 3.41)	6.14[a]		0.013[a]
DMFS 8		2.88	(1.49, 5.57)	9.82[a]		0.002[a]
Pool swimming				6.09	(2)	0.047
Never	1.00	1.00				
1-3 times/week	1.78	1.54	(0.73, 3.24)	1.08[a]		0.259[a]
>3 times/week	2.82	3.17	(1.24, 8.13)	5.78[a]		0.016[a]

Hosmer-Lemeshow goodness of fit: χ^2=7.47, df=8, p value=0.486.
Correctly classified at probability cut-off 0.5=82.8%.
Area under Receiver Operating Characteristic curve = 0.755
[a] Wald statistic and Wald test
[b] Numerical variable during univariate analysis

tion of orange juice consumption as factors associated with TW. Although over 95% of the children consumed carbonated sports drinks in this study, those drinking 2 or more times a day were few compared to UK findings of over 80% regular consumers and 13% with over 22 intakes of cola per week for 14 year-olds who also showed more prevalent tooth wear (Al-Dlaigan *et al.,* 2001). Our results showed that children drinking 4 cans or more of these drinks weekly had 2.9 times odds of developing TW compared to those not drinking any. This value is higher than the 1.2 resulting from consumption of 7 or fewer cans per week among UK 14 year-olds (Milosevic *et al.,* 2004) Since tooth wear is a cumulative effect, the effect in younger children could be less prominent And a study in adults did find a greater risk of tooth erosion (Jarvinen *et al.,*1991). One study among 15-year-olds found only borderline significance (p=0.055) of carbonated beverages as a predictor for tooth wear (Milosevic *et al.,* 1997). Early commencement of carbonated drinks or acidic fruit juices intake may lead to longer duration of tooth surface exposure to acidic environments causing more wear as found in this study. Other studies exploring total duration of intake were not available for comparison.

Caries experience was significantly associated with TW. With an increase in caries experience by one surface, the odds of developing TW increased by 4.0% (Table 4). Few studies examine the relationship between tooth wear and dental caries. While Dugmore and Rock (2004) used DMFT score, others (Rijkom *et al.,* 2002; Teo *et al.,* 1997) used DMFS score, which was similar to our study. The results obtained using these two indices may vary. Teo *et al.* (1997) studied children aged 10 years and above and categorised caries as low and high and found less tooth wear in the low caries group. Likewise, in our study, children with low caries and high caries had 2.0 and 2.9 times the odds of developing TW respectively compared to caries free subjects. Although Dugmore and Rock (2004) did not detail caries experience, they similarly support the findings that high caries experience was significantly associated with tooth wear. However, Rijkom and colleagues (2002) found no difference in caries experience among children with or without tooth wear.

Regular pool swimmers risk tooth wear is the pH of the pool water is not regulated. The relationship between swimming habits and tooth wear has not been studied widely but is noted in some case reports (Addy *et al.*, 2000). Gas-chlorinated pools require daily monitoring and adjustment to maintain the recommended pH range of 7.2-8.0 for protection of regular swimmers from dental erosion, particularly those with the habit of squirting water through their teeth while swimming.In our study, swimming was associated with TW with over 3 swims per week giving 3.2 times higher Odds than non-users.

Excessive tooth wear is observed in patients with impaired salivary function (Murray, 1996). Saliva composition varies within and between individuals. Thus standardised saliva sampling is important to achieve valid results. The time of saliva collection is crucial. In most individuals, unstimulated salivary flow reaches the highest peak at about 5pm in the evening and is stimulated by food or drink. In this study, the time for saliva collection was set approximately between 9am and 12noon and participants were instructed not to take any food or drink for one hour before the procedure. Other researchers followed the same protocol (Bartlett *et al.*, 1998; Lussi and Schaffner 2000).

Methods vary for the measurement of salivary hydration and unstimulated flow rate: both are resting flow rates. For salivary hydration the time of the first saliva droplet seen as measured and for unstimulated flow rate the quantity of saliva produced was measured. We found that hydration was significantly associated with TW (Table 4) whereas unstimulated flow rate was not. Like others' studies finding unstimulated flow rate not to be a factor (O'Sullivan and Curzon, 2000) we noticed participants' reluctant to spit into the collecting tube potentially reducing the measured flow rate. At rest, flow rate was measured by hydration. We found that participants with low hydration rate have OR 9.2 of developing TW compared to those with a high rate (Table 4), OR 2.1 for those with a normal hydration rate. Jarvinen *et al.* (1991) found that children with low unstimulated flow rate have OR 5 of developing erosion compared to children with higher flow rates. Direct comparison is complicated by differences in methods and age groups.

Softening of tooth surfaces under acidic conditions leads to increased wear. In this study, mean salivary pH was similar for case and control groups (Table 3). In the logistic regression (Table 4) children with salivary pH in the range 5.0 to 6.9 (mainly in the range 6.0 to 6.9) were apparently at lower risk of toothwear. However this finding is of borderline statistical significance, is counter- intuitive and should be viewed with caution. Other studies revealed slightly higher mean of salivary pH (Jarvinen *et al.*, 1991; Woltgens *et al.* 1985). However, those studies involved adults and salivary pH was not related to tooth wear.

Bicarbonate in saliva determines buffering capacity. While unstimulated saliva has very low levels of bicarbonate, stimulated saliva has bicarbonate levels more than 60 times higher (Edgar and O'Mullane, 1990). In this study, case group have slightly higher mean buffering capacity 10.5 compared to the control's 9.0. However, buffering capacity was not significantly associated with tooth wear in this study nor others (Jarvinen *et al.*, 1991; Woltgens *et al.* 1985).

Conclusion

Factors associated with tooth wear were similar to those in western societies. Significant variables such as consumption of sports drinks, caries experience and pool swimming in chlorinated pools are modifiable. Thus oral health promotion should highlight these findings and encourage changes to reduce tooth wear among children. The erosive potential of some foods and drinks also requires detailed investigation to identify potential harmful effects and inform discussions with producers.

While this study did show salivary hydration and viscosity influenced tooth wear, other studies have a range of findings though with different methods or age groups. Further research may be indicated here.

Acknowledgement

The authors are indebted to Head of Department, School of Medical Sciences and Dean, School of Dental Sciences, Universiti Sains Malaysia for their encouragement and Professor Alexander Milosovic for the tooth wear manual. We thank all heads, health teachers and students from participating schools in Kota Bharu, Kelantan for their cooperation and Dr Pia Trinos and the team from GC Dental Asia, who helped in the training with the GC Saliva Kit.

References

Addy, M., Embery, G., Edgar, W.M. and Orchardson, R. (2000): *Tooth Wear and Sensitivity.* London: Martin Dunitz.

Al-Dlaigan, Y.H., Shaw, L. and Smith, A. (2001): Dental erosion in a group of British 14-year-old school children. Part II: Influence of dietary intake. *British Dental Journal* **190**, 258-261.

Bardsley, P.F., Taylor, S. and Milosevic, A. (2004): Epidemiological studies of tooth wear and dental erosion in 14-year-old children in North West England. Part 1: The relationship with water fluoridation and social deprivation. *British Dental Journal* **197**, 413-416.

Bartlett, D.W., Coward, P.Y., Nikkah, C, and Wilson, R.F. (1998): The prevalence of tooth wear in a cluster sample of adolescent school children and its relationship with potential explanatory factors. *British Dental Journal* **184**, 125-129.

Dugmore, C.R. and Rock, W.P. (2004): A multifactorial analysis of factors associated with dental erosion. *British Dental Journal J* **196**, 283-286.

Edgar, W.M. and O'Mullane, D.M. (1990): *Saliva and Dental Health*. London: British Dental Association.

Freire, M.C.M., Sheiham, A. and Hardy, R. (2001). Adolescents' sense of coherence, oral health status and oral health related behaviours. *Community Dentistry and Oral Epidemiology* **29**, 204-212.

van der Glass, H.W., Lobbezzoo, F., van der Bilt, A. and Bosman, F. (1996): Influence of the thickness of soft tissues overlying human masseter and temporalis muscles on the electromyographic maximal voluntary contraction level. *European Journal of Oral Sciences* **104**, 87-95.

Gudmundsson, K., Kristleifsson, G., Theodors, A. and Holbrook, W.P. (1995): Tooth erosion, gastroesophageal reflux and salivary buffer capacity. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* **79**:185-189.

Harnack, L., Stang, J. and Story, M. (1999). Soft drink consumption amongst US children and adolescents: Nutritional consequences. *Journal of the American Dietetic Association* **99**, 436-441.

Ibbetson, R. and Eder, A. (1999): Tooth surface loss: Editors' introduction. *British Dental Journal* **186**, 60.

Jarvinen, V., Rytomaa, I. and Heinonen, O.P. (1991): Risk factors of Dental erosion. *Journal of Dental Research* **70**, 942-947.

Lussi, A. and Schaffner, M. (2000): Progression of and risk factors for dental erosion and wedge-shaped defects over a 6-year period. *Caries Research* **34**, 182-187.

Milosevic, A. and Lo, M.S.F. (1996): Tooth wear in three ethnic groups in Sabah (Northern Borneo). *International Dental Journal* **46**, 572-578.

Milosevic, A., Bardsley, P.F. and Taylor, S. (2004): Epidemiological studies of tooth wear and dental erosion in 14-year old children in North West England. Part 2: The association of diet and habits. *British Dental Journal* **197**, 479-483.

Milosevic, A., Lennon, M.A. and Fear, S.C. (1997): Risk factors associated with tooth wear in teenagers: a case control study. *Community Dental Health* **14**, 143-147.

Milosevic, A., Young, P.J. and Lennon, M.A. (1994): The prevalence of tooth wear in 14-year-old school children in Liverpool. *Community Dental Health* **11**, 83-86.

Oginni, O. and Olusile, A.O. (2002): The prevalence, aetiology and clinical appearance of tooth wear: the Nigerian experience. *International Dental Journal* **52**, 268-272.

O'Sullivan, E.A. and Curzon, M.E.J. (2000): Salivary factors affecting dental erosion in children. *Caries Research* **34**, 82-87.

Rijkom, H.M.V., Truin, G.J., Frencken, J.E.F.M. and Konig K.G. (2002): Prevalence, distribution and background variables of smooth-bordered tooth wear in teenagers in The Hague, Netherlands. *Caries Research* **36**, 147-154.

Smith, B.G. and Knight, J.K. (1984): Tooth wear index manual, 1984.

Teo, C., Young, W.G., Daley, T.J. and Sauer, H. (1997): Prior fluoridation in childhood affects dental caries and tooth wear in a South East Queensland population. *Australian Dental Journal* **42**, 92-102.

Woltgens, J.H.M., Vingerling, P., de Blieck-Hogervorst, J.M.A. and Bervoets, D-J. (1985): Enamel erosion and saliva. *Clinical Preventive Dentistry* **7**, 8-10.