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Relationship between gingivitis severity, caries experience and orthodontic anomalies in 13-15 year-old adolescents in Brno, Czech Republic

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Objectives: The aim of the present cross-sectional study was to assess oral health in adolescents selected from the ELSPAC (European Longitudinal Study of Pregnancy and Childhood) Brno group and complete thus the ELSPAC series of studies on child general health. ***Material and Methods:*** Randomly selected children from the ELSPAC group (n=780) were examined clinically for dental and periodontal status, dental plaque, dental calculus and orthodontic anomalies. The following clinical parameters were assessed: DMFT score and its components, gingival index (GI), plaque index (PI) and calculus index (CSI). GI, PI and CSI were recorded on selected teeth. The presence/absence of orthodontic anomalies and their severity were recorded. ANOVA test for quantitative and χ^2 test for qualitative parameters evaluation were used. ***Results:*** Mean DMFT of the group was 2.82 (SE 0.36), share of caries-free children 25.4%. Mean GI index of the cohort was 0.204 (SE 0.011), grade 0 was found in 36.9% children, grade 1 in 43.0%, and grade 2 in 19.5%. Statistical significant associations ($p<0.05$) were observed in GI and DMFT, GI and DT value, GI and severity of orthodontic anomaly; significant difference was found in GI of caries-free and treated children vs treatment need and in PI value between children with gingivitis vs healthy ones. ***Conclusion:*** The results demonstrated a relatively high caries experience, low level of gingival inflammation and relation between GI and DMFT, particularly in D component, and between GI and orthodontic anomalies.

Key words: *oral health data, DMFT, GI, PI, CSI, gingivitis, caries prevalence, ELSPAC*

Introduction

Oral health is an integral part of the general health of an individual. The first symptoms of many diseases can be frequently found in the oral cavity and diseases of the oral cavity may influence the general health. Dental caries, gingivitis and periodontitis belong to the most common diseases of the oral cavity. During recent decades caries decline has been recorded in most Western countries (Marthaler 2004; Petersen 2003). This tendency has been observed also in countries outside Europe irrespective of background DMFT scores. However, children of immigrants from countries outside Western Europe have generally higher disease levels and may cause increase in caries prevalence (Christensen *et al.*, 2010; Dugmore *et al.;* 2004, Marthaler 2004; Pine *et al.*, 2003). Caries prevalence was also higher in the lower socio-economic strata (Nurelhuda *et al.*, 2009; Thomson *et al.*, 2004). Zaborskis *et al.* (2010) reported that oral health behaviors among young people across Europe, Israel, Canada and USA significantly contributed to the variation in caries experience. The occurrence of gingivitis in children and adolescents has been studied using different indices. In spite of the diversity in the methods used, gingivitis of different severity was frequently found in childhood and adolescence (Rebelo *et al.*, 2009; Thomson *et al.*, 2004) and increased scores with age were recorded. Besides clinical indicators, questionnaires assessing subjectively perceived symptoms have been used to assess oral health and its impact on quality of life (Biazevic *et al.*, 2008; Marshman *et al.*, 2005). Their results suggest that caries and its complications influence quality of life while gingivitis does not (Biazevic *et al.*, 2008). Thomson *et al.* (2004) concluded that oral health in adulthood was determined by the oral health in childhood. Recent epidemiological studies on oral health in the Czech Republic have demonstrated mild decrease in DMFT among children and adolescents (Krejsa *et al.*, 2000). These authors unfortunately did not investigate the occurrence of gingivitis. The general health of children in Brno has been followed in the European Longitudinal Study of Pregnancy and Childhood (ELSPAC) within an extensive European project (Golding, 1989). Although numerous reports on ELSPAC Brno have dealt with various aspects of health of adolescents (Kukla *et al.*, 2008) oral health has not been covered by this international project.

The aim of the present study was to describe and analyse oral health status using the DMFT, GI, PI scores and occurrence of orthodontic anomalies in adolescents selected from the ELSPAC Brno group and include these additional data on oral health in the ELSPAC prospective study.

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Material and methods

The subjects were 13-15 year old Czechs selected from 5000 Brno and 1500 Znojmo families. Of these families' 6500 children, 900 individuals were invited to participate in the study, randomly chosen by health record codes. Parents of 780 adolescents agreed and signed informed consent to include their children in the study. All participants belonged to the Brno ELSPAC group and were born within a period of one year. They were referred to the Clinics of Stomatology, St. Anne´s University Hospital and Faculty of Medicine, Masaryk University for dental examination using dental mirror and a WHO probe under good lighting. The clinical assessment was carried out by one experienced dentist working at the Paedodontic Department of the Clinics, who had been calibrated in the Division of Oral Epidemiology, Institute of Dental Research, 1st Faculty of Medicine, Charles University, Prague. Clinical parameters assessed were: DMFT (WHO 1997 criteria) score, gingival index (GI), plaque index (PI) and calculus index (CSI). The presence/absence of orthodontic anomalies was assessed using the dental health component of the Index of Orthodontic Treatment Need (IOTN) according to Lunn *et al.* (1993) and coded: ortho 0, no need; ortho 1, borderline need; ortho 2, definite need. The aesthetic component of the IOTN was not evaluated. Children under active orthodontic treatment were excluded from the study. Gingivitis was measured using the modified Löe-Silness GI index described previously (Izakovicova Holla *et al.*, 2008) on teeth 16, 12, 24, 32, 36, 44. This index's 0-3 scale assesses gingivitis on or adjacent to 6 sites (mid-buccal, mesio-buccal, disto-buccal and mid-lingual, mesio-lingual and disto-lingual) of the individual tooth according to the following criteria: 0, a complete absence of visual signs of inflammation; 1, a slight change in color, slight oedema and no bleeding on probing; 2; visual inflammation, redness, edema, glazing and bleeding on pressure; 3, severe inflammation, marked redness, edema, ulceration and tendency to spontaneous bleeding. The presence of plaque and calculus was recorded according to Silness-Löe (PI) and calculus surface index (CSI), respectively, without any disclosing agents as described previously (Izakovicova Holla *et al.*, 2008). The study was approved by the Ethical Committee of Masaryk University with written informed consent obtained from all participants and their parents before inclusion in the study.

The significance of differences between groups in quantitative values (e.g. DMFT index) was determined by ANOVA and Bonferroni correction for multiple comparisons, in qualitative values (e.g. intact – treated – treatment need) the chi-square test was used. Statistica v.8.0 (Statsoft Inc., Tulsa, USA) was used for statistical analysis with the significance level taken as <0.05.

Results

Mean value of DMFT of the cohort (780 adolescents) was 2.82 (range 0–19) and 25.4% (188) were caries free. GI mean value per child was 0.204 (SE=0.011). Healthy gingiva (GI=0) were found in 36.9%, GI=1 in 43.6%, and GI=2 in 19.5% of children. GI of 3 was not detected. The mean value of PI was 0.65 and of CSI, 0.67. Children without orthodontic anomalies (grade 0) formed 54.9% of the group; grade 1, 36.3%; and severe anomalies (grade 2), 8.8%. The relationships between DMFT and its components to mean GI are given in Table 1a-c while the relationship between orthodontic anomalies and GI is presented in Table 1d.

The distribution of GI scores was also assessed according to the highest value for each child and the results presented in Table 2. No differences in gingival index scores were found between caries free and treated children while a significant difference ($p<0.01$) was found in children in need of treatment compared to caries free and treated (Table 2a). A difference in GI scores ($p<0.01$) was found between the group in need of treatment and both the other groups (Table 2a).

No significant difference in GI scores occurred between groups DMFT=1,2 and DMFT=3,4,5 but a significantly lower value in the group DMFT=0 and significantly higher value in the group DMFT>5 were found (Table 2b). GI values also increased with increasing numbers of decayed teeth ($p<0.01$, Table 2c).

No difference in GI scores was found between groups ortho=1 (borderline need) and ortho=2 (definite need), while there was a difference in GI values between the group ortho=0 and both the other groups ($p<0.01$, Table 2d).

Table 1. Dental status of the cohort

	Number of children	*GI - mean/child*	*SE*
[a.] Dental status			
Caries free	188	0.128	0.017
Treated	329	0.150	0.014
Treatment need	263	0.326	0.024
[b.] DMFT index			
DMFT = 0	188	0.128	0.017
DMFT = 1, 2	233	0.192	0.020
DMFT = 3, 4, 5	221	0.216	0.022
DMFT > 5	138	0.308	0.033
[c.] DT component			
DT = 0	517	0.142	0.011
DT = 1, 2	209	0.257	0.022
DT > 2	54	0.591	0.074
[d.] Orthodontic anomalies			
Ortho = 0 (no need)	428	0.145	0.013
Ortho = 1 (borderline need)	283	0.266	0.021
Ortho = 2 (definite need)	69	0.315	0.044

[a] No significant difference between caries free and treated children. Significant difference ($p<0.01$) in children in need of treatment in comparison to caries free and treated.

[b] No significant difference between groups DMFT = 1,2 and DMFT = 3,4,5. Significantly lower value in the group DMFT = 0, significantly higher value in the group DMFT > 5 ($p<0.01$).

[c] Significant difference ($p<0.01$) between groups

[d] No significant difference between groups ortho=1 and ortho=2. Significant difference ($p<0.01$) between the group ortho=0 and both the other groups.

Table 2. Gingival health according to the child's highest GI score by DMFT and IOTN scores

	Number of children	*Percentage of children*		
		GI = 0	*GI = 1*	*GI = 2*
[a]GI/ treatment need				
Caries free	188	47.9	40.4	11.7
Treated	329	41.0	42.9	16.1
Treatment need	263	24.0	46.8	29.3
[b]GI/ DMFT				
DMFT = 0	188	47.9	40.4	11.7
DMFT = 1, 2	233	37.8	44.2	18.0
DFMT = 3, 4, 5	221	32.6	48.0	19.5
DMFT > 5	138	27.5	39.9	32.6
[c]GI/ DT				
D = 0	517	43.5	42.0	14.5
D = 1, 2	209	27.3	49.3	23.4
D > 2	54	11.1	37.0	51.9
[d]GI/ orthodontic anomaly severity				
Ortho = 0 (no need)	428	45.3	40.7	14.0
Ortho = 1 (borderline need)	283	26.9	48.4	24.7
Ortho = 2 (definite need)	69	26.1	42.0	31.9

[a] No significant difference between caries free and treated children. Significant difference ($p<0.01$) between the group at need of treatment and both the other groups.

[b] Significant difference ($p<0.05$) between groups DMFT 3,4,5 and DMFT > 5. Significant difference ($p<0.01$) between groups DMFT = 0 and/or DMFT = 1,2 versus DMFT > 5. No significant difference between other groups (DMFT = 0 versus DMFT = 1,2)

[c] Significant difference ($p<0.01$) between groups

[d] No significant difference between groups ortho = 1 and ortho = 2. Significant difference ($p<0.01$) between group ortho = 0 and both other groups.

Table 3. Plaque and calculus indices

Plaque Index	*n*	*PI mean*	*PI sd*	*PI 25% quartile*	*PI median*	*PI 75% quartile*
Healthy gingiva	287	0.233	0.589	0	0	0
Gingivitis	489	0.902	1.095	0	1	1
Calculus Index	*n*	*CSI mean*	*CSI sd*	*CSI 25% quartile*	*CSI median*	*CSI 75% quartile*
Healthy gingiva	287	0.667	2.754	0	0	0
Gingivitis	493	0.682	2.780	0	0	0

Significant difference ($p<0.05$) in mean values of PI index (but not of CSI index) between both groups.

The results indicate a difference in PI values between adolescents with and without gingivitis ($p<0.05$) (Table 3). No significant difference was found in CS index.

Discussion

The European Longitudinal Study of Pregnancy and Childhood (ELSPAC) has monitored developmental and health changes throughout childhood and adolescence. Numerous reports on ELSPAC Brno have dealt with various aspects of health (Kukla *et al.*, 2008) however, oral health was not included in this prospective study so far. The present study was performed within the ELSPAC Brno group with the aim to gather and analyse data on oral health in the selected group of adolescents and complete thus information on child general health.

The mean value for DMFT in the ELSPAC group Brno was 2.82 (SE 0.36), this seems a relatively high value, but when compared to the data in the country-wide oral health survey of age-matched children conducted in 1998 (Krejsa *et al.*, 2000) it confirms a slow decreasing trend in dental caries prevalence in this country. While dental caries prevalence has decreased in many countries (Marthaler 2004; Petersen 2003) considerable variations in its occurrence between countries, regions within countries, areas within regions and within social and ethnic groups have been reported (Edelstein, 2005; Zaborskis *et al.*, 2010). In the present study, the mean value of GI calculated per tooth was 0.204 (SE 0.011): a very low degree of gingival inflammation. In the cohort, the score GI=0 was found in 36.9% and GI=1 in 43.6%, so 80.5% of ELSPAC children displayed no gingival bleeding. Several studies on the gingivitis occurrence in children and adolescents have used the Community Periodontal Index (CPI) to classify the degree of inflammation. GI 2 corresponds to a certain degree to the CPI 1. These results indicate that for gingivitis, the ELSPAC group has a better level of oral health than children in other countries (Jürgensen & Petersen 2009; Rebelo *et al.*, 2009). Comparison of the data on DMFT, its components and orthodontic anomalies with data on GI also provided interesting results. It is obvious that there is a significant relationship between DMFT and GI especially in the D component, the higher DMFT (D), the higher GI. Similarly, significantly higher GI was found in children with more severe orthodontic anomalies and in children with higher plaque index. Reports on similar findings of mutual associations between DMFT/gingivitis and DMFT/orthodontic anomalies were not found in the literature. However, Rebelo *et al.* (2009) reported that slight gingival inflammation was present in 78.5% and gingival bleeding in 53.3% of adolescents and the group had many teeth with untreated caries but there was no statistical evaluation of their findings. Although gingivitis of different severity and dental caries prevalence in children and adolescents have been a subject of many studies, especially in children with handicap (Lang *et al.*, 2009; Nurelhuda *et al.*, 2009; Thomson *et al.*, 2004), no data on oral health of children has been published within the ELSPAC project in other European countries. Therefore no comparison between our results and those from other studies could be made.

Gingivitis is an inflammatory process of the gingiva induced by a microbial biofilm but individual differences in the host immune response to infection may affect the susceptibility and severity of the disease (Izakovicova Holla *et al.*, 2008). Lang *et al.* (2009) convincingly demonstrated in their longitudinal study that development of periodontitis only occurred in areas of long-standing gingivitis and that gingival inflammation was a risk factor for tooth loss. Thomson *et al.* (2004) concluded that oral health status in adulthood was determined by the oral health status in childhood. Our results demonstrated that persistence of gingivitis may be affected not only by microbial plaque but also by untreated caries or orthodontic anomalies.

Analytical capability of the traditional DMFT index used in the present cross-sectional study for measuring the occurrence of caries is lower than in other studies, which also consider sociodental indicators. The DMFT tool (WHO criteria) for dental caries diagnosis tends to underestimate the need of treatment as small and proximal cavities and/or chronic cavities spreading along dentine-enamel junction without any signs can be overlooked (Nurelhuda *et al.*, 2009).

$D_{1-4}MFS$ index, which enables also the assessment of non cavitated lesions, requires X-ray investigation to confirm the clinical findings. In this study no radiographs could be taken for ethical and practical reasons. In addition, DMFT index does not provide a complex view of the condition and does not evaluate the psychological consequences of the oral conditions. A variety of socio-dental indicators have been developed and used to overcome the normative assessment with contribution from psychology, sociology and economics (Biazevic *et al.*, 2008; Marshman *et al.*, 2005). Some studies use general questionnaires to measure oral health impact; others use specific questionnaires for children. Usage of all kinds of questionnaires needs verification of reliability on a national level. As no similar questionnaire has been verified and tested in this country, simpler methods of investigation were used in this study in agreement with Marthaler´s (2004) statement that dental caries assessment can be done regardless of the socio-economic level. Grade of gingival inflammation was assessed with the GI index. Compared to CPI, the GI index records intensity of gingival inflammation in selected teeth in 3 grades (1–3), 0 reflects clinically healthy gingiva. Severity of gingivitis was expressed as a mean score per a tooth from six examined teeth, which only partly showed an extent of the affected sextants. In the set under study, value 3 did not occur in any of the examined individuals, only grades 1 and 2 were determined. The CPI index has only one value for the assessment of gingivitis (CPI=1, bleeding on probing; CPI=0, clinically health periodontium). For this reason, we considered the use of GI for the assessment of the grade of gingival inflammation more sensitive than the CPI index.

However, the strong point of the study is the fact that all adolescents of the ELSPAC group are of the same age within one year and they have lived under the similar environmental and cultural conditions with the same access to medical and dental treatment.

Conclusion

The results demonstrated slightly better dental health in ELSPAC children probably due to higher socio-economic and cultural homogeneity than an age-matched more diverse child population examined in country-wide surveys. In addition, low levels of gingival inflammation and relationships between GI and DMFT (particularly in the DT component) and between GI and orthodontic anomalies were determined. We hope that our results will motivate the ELSPAC researchers in other countries to include data on oral health into their national programs

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