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Oral hygiene and gingival health in Flemish pre-school children

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Objectives: *The study aimed to describe oral hygiene habits, oral hygiene status and gingival health in Flemish pre-school children and to explore factors associated with these clinical oral health variables.* ***Methods:*** *Cross-sectional data from 1,071 3-year-old and 1,119 5-year-old children from four geographical areas in Flanders (Belgium) were analysed. Buccal plaque accumulation and gingival health were assessed on six index teeth. Data on oral hygiene and dietary habits, oral health behaviour and socio-demographic variables were obtained through questionnaires.* ***Results:*** *34% of 3-year-olds and 25% of 5-year-olds started brushing before the age of one, 17% of 3-year-olds and 23% of 5-year-olds brushed twice a day. Roughly, 30% of 3-year-olds and 37% of 5-year-olds presented with visible plaque accumulation. In both age groups, only 3 to 4% of children presented with signs of gingival inflammation. Multiple logistic regression models revealed that in both age groups children whose mothers had a college or university degree, had a smaller chance of presenting with visible plaque than children whose mothers had a lower educational level. With gingival health as dependent variable, multiple logistic regression analysis confirmed the major association between bacterial plaque accumulation and the presence of gingivitis. In the oldest age group, children's former exposure to passive smoking was also significantly associated with gingivitis.* ***Conclusion:*** *Parents should be motivated to start brushing at an early age and brush thoroughly in order to maintain good oral health in their off-spring. Special attention should go to children raised by mothers with a lower educational level.*

Key words: Dental plaque, gingival health, gingivitis, oral hygiene, pre-school children, primary dentition.

Introduction

Epidemiological studies revealed that gingivitis of varying severity is nearly universal in children and adolescents and that the prevalence of periodontal disease is relatively uncommon in children (Califano, 2003). Extremely divergent prevalence figures for gingivitis among children have been reported, with rates ranging from 5 to 95% in European and North American populations (Poulsen and Moller, 1972; Hugoson *et al.*, 1981; Hugoson *et al.*, 1995; Carvalho *et al.*, 1998). Methodological dissimilarities between the studies (e.g. selection of the sample, applied gingiva index) may in part be responsible for these differences.

In experimental gingivitis studies in children, it was revealed that gingivitis developed less easily among children than among adults (Matsson, 1978). In the presence of the same amount of plaque, children showed much less exudate and bleeding during probing. Subsequent studies suggested that gingival activity increases gradually from early childhood to adulthood (Matsson and Goldberg, 1985).

In contrast with caries research, the identification and evaluation of risk factors for plaque accumulation and gingivitis in young children has not received much attention yet. Recent studies performed in pre-school children suggested that oral hygiene frequency was not associated with oral hygiene quality (Santos *et al.*, 2007) and that the presence of dental plaque was the strongest indicator for gingivitis (Sayegh *et al.*, 2005; Feldens *et al.*, 2006).

The aim of the present study was to describe oral hygiene habits, oral hygiene status and gingival health in Flemish pre-school children and to explore factors associated with these clinical oral health variables.

Methods

Data for this study were obtained from baseline assessments (September - December 2003) in children of 3 and 5 years old in the Smile for Life (Tandje de Voorste) project, a prospective oral health promotion project in pre-school children.

The children were selected using a technique of stratified cluster sampling without replacement. The target population was divided in three strata, representing the three types of educational system (public, municipal and private schools), taking care of an equal spread on rural and urban regions. The selection was performed in such a way that each child had the same probability of being selected. Whenever a school was selected, all children in the first and/or third pre-school class of the selected school were included. Selecting individual children instead of schools would not have been feasible for ethical, practical and economical reasons. The schools were selected with a probability proportional to their size; this approximates selecting children with equal probability. The samples represented about 30% of the population of interest in the four regions.

The oral health examinations were carried out in a class room by one of eight trained dentist-examiners,

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who participated in two calibration sessions. Parents did not know the exact date of the clinical examination in advance in order to minimise potential bias. Teeth were examined using a mirror with a built-in light source (Mirrorlite™ by Defend® from Medident, Belgium) and a WHO/CPITN type-E screening probe.

The oral hygiene status was evaluated by means of the index described by Alaluusua and Malmivirta (1994). It involves the visual recording of the presence or absence of dental plaque on the buccal surfaces of teeth 55, 52, 72 and 75.

The condition of the gingiva was scored dichotomously based on visual inspection (i.e. no probing was performed). The absence of gingivitis was recorded when the gingiva was normal and without clinical signs of inflammation (discoloration, bleeding after probing, swelling). The recording involved the same teeth and surfaces as those that were scored for plaque.

Caries experience was recorded using the criteria proposed by the British Association for the Study of Community Dentistry (BASCD) (Pitts *et al.*, 1997). Caries experience was recorded at the level of initial disease (d1 level), but for the present report data are analysed at the level of cavitation (d3 level). No radiographs were taken.

Data on oral health behaviour, socio-demographic variables and parental smoking behaviour were obtained through structured questionnaires, completed by the parents. The evaluated independent variables were: gender, home situation (i.e. child living with both parents, one parent or others), educational level of mother and father, age at start brushing, help with brushing, brushing frequency, use of a nursing bottle, application of sweet on pacifier, in between meals, in between drinks, drinks at night, snacks at night and family smoking status (i.e. child raised by parents or others who smoked at home, who quit smoking or who never smoked). The socio-economic status of the child was evaluated based on the reported educational level of the mother and the father. Distinction was made between parents who did not continue educational training after primary and/or secondary school ("Primary & secondary school") and parents who received education at the level of college or at university level ("College or University").

Clinical data were entered in a database using the Dental Survey Plus Program (Providence software). Questionnaire data were entered twice (by two different persons) using Excel (Microsoft); Excel Compare(tm) Version 2.0.3 (http://www.formulasoft.com/) was used to check correspondence between the two databases. All inconsistencies between both files were checked with the original questionnaires until two identical files were obtained. Clinical and questionnaire data were merged into SAS®-data files (version 8.2).

Simple and multiple logistic regression analyses were performed for all studied covariates with plaque score and gingival health as outcome variable, expressed as a binary outcome, i.e. "child presented without visible plaque accumulation/gingivitis on any of the reference teeth" versus "child presented with visible dental plaque accumulation/gingivitis on at least one reference tooth". In order to test the association between gingivitis and caries experience in a child (i.e. $d_3mft>0$), fisher exact tests were performed.

For all statistical tests, a significance level of α=5% was considered.

Results

The studied samples comprised 1,071 and 1,119 children born in 2000 and 1998 respectively, from four distinct geographical areas in Flanders (Belgium) (Table 1).

According to the parents' answers to the questionnaires, 34% of 3-year-olds and 25% of 5-year-olds started brushing their teeth before the age of one, as is recommended by the dental profession (Table 2). The majority of children (i.e. 44% of 3-year-olds and 32% of 5-year-olds) started brushing between their first and second birthday. Parents of the youngest age group admitted that one percent of children had not started brushing yet. Most of the children brushed only once a day (i.e. 54% of 3-year-olds and 57% of 5-year-olds); in 30% of 3-year-olds and 20% of 5-year-olds, teeth were not brushed on a daily basis. Half of the parents of 3-year-olds reported that they assisted their child brushing every day; in the older age group the respective percentage was 34%. Six percent of the youngest and 16% of the oldest age group never received any help with tooth brushing.

About 30% of 3-year-olds and 37% of 5-year-olds presented with visible plaque accumulation (Table 1). In 7% of children of both age groups, dental plaque was visible on all scored primary teeth. In both groups, dental plaque accumulation was less frequently observed on mandibular teeth.

The simple logistic regression analyses revealed no significant gender differences in oral hygiene status. In the 3-year-olds a significant positive association was found between age and the presence of dental plaque (OR: 2.47, 95%CI: 1.40-4.34). In the youngest age group, children not living with both parents had a higher chance of presenting with visible plaque accumulation (OR: 1.76, 95%CI: 1.04-2.98). If mothers had received a college or university degree, 3 year old children were less likely to present with visible plaque on their primary teeth (OR: 0.57, 95%CI:0.42-0.77). Children who received less than once a week help with tooth brushing had a 1.64 (95%CI: 1.07-2.53) higher odds of exhibiting dental plaque, compared to those who were more frequently assisted with brushing. In addition, it was revealed that 3 year old children who consumed in between meals sugar-containing drinks more than once a day, had a 1.45 (95%CI: 1.00-2.10) higher odds and that 3 year old children who consumed sugar-containing drinks every night, had a 2.16 (95%CI: 1.09-4.27) higher odds of presenting with visible plaque on the four index teeth. In both age groups, significant differences in the presence of visible plaque accumulation were found between the four regions where children were examined.

Multivariable logistic regression analyses, with all covariates under investigation included in the model (according to 'the epidemiological approach'), revealed that in both age groups children whose mothers had a college or university degree, had a smaller chance (OR: 0.60, 95%CI: 0.39-0.94 in 3-year-olds and OR: 0.62, 95%CI: 0.41-0.93 in 5-year-olds) of presenting with visible plaque accumulation than children whose moth-

Table 1. Sample characteristics.

	3-year-olds	*5-year-olds*
Number of examined children	1071	1119
Girls (%)	47.0	48.9
Mean age (SD)	3.3 (0.3)	5.3 (0.3)
Presence of visible plaque (%)	29.5	37.0
Signs of gingival inflammation (%)	3.1	4.3

SD: standard deviation

Table 2. Oral hygiene habits

	3-year-olds (%)	*5-year-olds (%)*
Age at start brushing		
1 yr or younger	334/974 (34)	256/1004 (25)
More than 1 yr	430/974 (44)	321/1004 (32)
More than 2 yr	165/974 (17)	244/1004 (24)
More than 3 yr		128/1004 (13)
More than 4 yr		28/1004 (3)
Not yet started	14/974 (1)	2/1004 (0)
Brushing frequency		
More than once a day	161/974 (17)	230/998 (23)
Daily	524/974 (54)	572/998 (57)
At least once a week, but not daily	249/974 (26)	180/998 (18)
Less than once a week	29/974 (3)	15/998 (2)
Never	11/974 (1)	1/998 (0)
Help with brushing		
Daily	494/973 (51)	339/1006 (34)
More than once a week	339/973 (35)	358/1006 (36)
Less than once a week	84/973 (9)	153/1006 (15)
Never	58/973 (6)	156/1006 (16)

ers had a lower educational level (Table 3). In addition, significant regional differences were observed.

Only 3% of 3-year-olds and 4.3% of 5-year-olds presented with signs of gingival inflammation on any of the index teeth, indicating that most children presented with good gingival health (Table 1).

In both age groups, no significant gender differences in gingival health were observed. The variable with the strongest association with presence of gingivitis was dental plaque. More 5-year-old children who were reported to brush their teeth less than once a day, presented with signs of gingivitis on the index teeth (OR: 3.42, 95%CI:1.07-10.94). If mothers had received a college or university degree, 5-year-old children were less likely to present with gingivitis (OR: 0.49, 95%CI: 0.26-0.92). In both age groups, significant regional differences were observed in the presence of gingivitis.

The multiple logistic regression model (table 4) with gingival health as outcome variable confirmed the major association between bacterial plaque accumulation and the presence of gingivitis (OR: 28.35 95%CI: 5.46-147.24 in 3-year-olds and OR: 86.82 95%CI: 10.00-754.13 in 5-year-olds). In the oldest age group, children's former exposure to passive smoking, was also significantly associated with gingivitis (0R:4.41, 95%CI: 1.11-17.48).

93% of 3-year-olds presented without visible signs of caries experience. A $d_3$mft-score between 1 and 4 was seen in 6.1% of the children; 0.8% presented with a $d_3$mft-score of 5 or higher. In the oldest age groups, 69% presented without any sign of caries experience (at the d_3-level). A $d_3$mft-score between 1 and 4 was seen in 23.6%, a score of 5 and higher was recorded in 7.2 % of 5-year-olds.

Fisher's exact tests revealed in 3- as well as in 5-year-olds a significant positive association between the presence of signs of gingivitis and caries experience in a child ($P<0.001$ in 3-year-olds and $P=0.003$ in 5-year-olds), indicating that children presenting with clinical signs of gingival inflammation were more likely to present with signs of visible caries experience.

Discussion

The purpose of the present study was to report on oral hygiene habits, oral hygiene and gingival health status in very young children living in Flanders (Belgium). Data were collected in four distinct geographical areas and should not be considered as representative for all pre-school children living in Flanders. Within each of the four included regions however, the sample was collected

Table 3. Multiple logistic regression models for the presence of dental plaque in 3 and 5-year-olds

Variable	*3-year-olds*				*5-year-olds*			
	*Number of subjects**	*OR*	*95% C.I.*		*Number of subjects**	*OR*	*95% C.I.*	
Gender								
Boys (ref)	494				544			
Girls	424	1.22	0.82	1.81	527	1.10	0.78	1.54
Age	918	1.90	0.87	4.14	1071	1.03	0.54	1.97
Home situation								
Both parents (ref)	744				823			
Other	64	1.24	0.55	2.76	105	1.22	0.69	2.16
Educational level mother								
Primary & Secondary School (ref)	365				392			
College or university	431	**0.60**	**0.39**	**0.94**	528	**0.62**	**0.41**	**0.93**
Educational level father								
Primary & Secondary School (ref)	420				456			
College or university	365	0.88	0.56	1.38	455	1.26	0.85	1.87
Age at start brushing								
1 yr or younger (ref)	276				238			
More than 1 yr	354	1.14	0.72	1.79	299	0.97	0.62	1.52
More than 2 yr	155	0.88	0.48	1.62	377	0.97	0.61	1.53
Help with brushing								
Daily (ref)	399				321			
More than once a week	285	1.35	0.79	2.32	329	1.23	0.81	1.87
Less than once a week	123	1.57	0.77	3.20	290	0.87	0.55	1.37
Brushing frequency								
More than once a day (ref)	135				213			
Daily	429	1.06	0.60	1.90	539	1.26	0.82	1.92
Less than once a day	244	1.79	0.83	3.88	179	1.72	0.95	3.14
Use of a nursing bottle								
No (ref)	439				787			
Yes	316	1.13	0.76	1.68	112	0.94	0.56	1.60
Cleaning a pacifier in the own mouth								
Never (ref)	400				455			
Sometimes or always	360	**0.66**	**0.44**	**0.99**	384	1.01	0.72	1.42
In between meals								
Less than once a day (ref)	148				158			
Daily	374	0.66	0.38	1.15	405	1.04	0.63	1.70
More than once a day	292	0.73	0.41	1.32	378	0.85	0.50	1.43
In between drinks								
Less than once a day (ref)	255				340			
Daily	233	1.16	0.69	1.96	272	0.87	0.57	1.34
More than once a day	327	1.23	0.74	2.05	332	1.05	0.67	1.64
Drinks at night								
None (ref)	780				894			
Daily or more	35	1.41	0.56	3.58	41	1.48	0.64	3.41
Snacks at night								
None (ref)	612				727			
Daily or more	198	1.23	0.78	1.93	205	0.95	0.62	1.46
Family smoking status								
Never (ref)	475				558			
Not anymore	73	0.76	0.35	1.62	92	1.09	0.60	1.97
Yes	256	0.87	0.55	1.38	281	1.42	0.95	2.12
Region								
Waregem (ref)	237				244			
Tielt	256	**0.25**	**0.15**	**0.42**	260	**0.28**	**0.17**	**0.46**
Tielt-Winge	197	**0.14**	**0.08**	**0.25**	297	**0.19**	**0.11**	**0.31**
Berlaar	228	**0.09**	**0.05**	**0.18**	270	**0.18**	**0.12**	**0.29**

Totals less than 1105 in 3-year-olds and 1157 in 5-year-olds are due to missing observations; OR: odds ratio; C.I.: confidence interval; ref: reference; significant results presented in bold.

Table 4. Multiple logistic regression models for the presence of gingivitis in 3 and 5-year-olds

Variable	*3-year-olds*				*5-year-olds*			
	*Number of subjects**	*OR*	*95% C.I.*		*Number of subjects**	*OR*	*95% C.I.*	
Gender								
Boys (ref)	494				544			
Girls	425	0.41	0.12	1.46	527	0.54	0.20	1.43
Age	919	0.51	0.04	5.75	1071	1.08	0.15	7.83
Home situation								
Both parents (ref)	746				823			
Other	63	1.57	0.13	19.15	105	0.35	0.05	2.36
Educational level mother								
Primary & Secondary School (ref)	366				392			
College or university	431	2.83	0.69	11.52	528	0.84	0.25	2.86
Educational level father								
Primary & Secondary School (ref)	422				456			
College or university	365	0.40	0.09	1.77	455	0.69	0.20	2.40
Presence of dental plaque								
No (ref)	646				675			
Yes	271	**28.35**	**5.46**	**147.24**	396	**86.82**	**10.00**	**754.13**
Age at start brushing								
1 yr or younger (ref)	276				238			
More than 1 yr	355	0.70	0.21	2.37	299	0.56	0.14	2.24
More than 2 yr	155	0.23	0.02	2.59	377	1.56	0.45	5.45
Help with brushing								
Daily (ref)	401				321			
More than once a week	284	0.57	0.11	2.83	329	0.60	0.17	2.18
Less than once a week	123	1.81	0.20	16.37	290	0.63	0.17	2.42
Brushing frequency								
More than once a day (ref)	136				213			
Daily	428	4.69	0.50	44.38	539	1.95	0.45	8.36
Less than once a day	245	2.35	0.13	41.47	179	2.62	0.41	16.61
Use of a nursing bottle								
No (ref)	439				787			
Yes	316	1.68	0.51	5.52	112	1.66	0.46	6.00
Cleaning a pacifier in the own mouth								
Never (ref)	401				455			
Sometimes or always	360	1.44	0.42	4.96	384	1.94	0.75	5.03
In between meals								
Less than once a day (ref)	148				158			
Daily	375	2.07	0.28	15.16	405	0.41	0.10	1.73
More than once a day	292	3.14	0.37	26.37	378	0.53	0.13	2.24
In between drinks								
Less than once a day (ref)	254				340			
Daily	234	1.49	0.31	7.17	272	0.39	0.08	1.84
More than once a day	328	0.42	0.07	2.34	332	2.21	0.57	8.57
Drinks at night								
None (ref)	781				894			
Daily or more	35	0.92	0.07	12.84	41	2.40	0.43	13.22
Snacks at night								
None (ref)	612				727			
Daily or more	199	0.12	0.01	1.24	205	1.25	0.39	3.93
Family smoking status								
Never (ref)	476				558			
Not anymore	73	1.51	0.14	16.48	92	**4.41**	**1.11**	**17.48**
Yes	256	1.64	0.43	6.20	281	1.18	0.38	3.66
Region								
Waregem (ref)	238				244			
Tielt	257	0.88	0.21	3.66	260	**5.32**	**1.58**	**17.90**
Tielt-Winge	196	0.40	0.06	2.52	297	0.18	0.02	1.96
Berlaar	228	0.51	0.05	5.18	270	0.52	0.12	2.34

Totals less than 1105 in 3-year-olds and 1157 in 5-year-olds are due to missing observations; OR: odds ratio; C.I.: confidence interval; ref: reference; significant results presented in bold.

in such a way that the selected children represented the pre-school children living in that area very well. Since significant differences in oral hygiene habits, oral hygiene and gingival health status between the four regions were observed, the variable "region" was adopted in all multiple regression analyses.

The results described in this study indicate that 30-37% of examined pre-school children presented with visible plaque accumulation whereas only 3-4% of them present with signs of gingival inflammation. These results are not surprising, since it was demonstrated in an experimental gingivitis study that during a 7-day period of no active oral hygiene, young subjects (4-6 years of age) with a fully erupted deciduous dentition formed less plaque than the older subjects, and failed to respond to de novo plaque formation with enhanced signs of gingivitis (Ramberg *et al.*, 1994).

The prevalences described here are much lower than those described in recent reports. In Canoas (Brazil), 99% of pre-school children attending public school nurseries presented with dental plaque and 77% with gingival bleeding (Feldens *et al.*, 2006). Another Brazilian study, performed in a convenience sample, illustrated that 88% of pre-school children presented with dental plaque (Santos *et al.*, 2007). In Jordan, 66% of 4-5 year-old children had signs of gingivitis (Sayegh *et al.*, 2005). In the municipality of Leuven (Flanders) 36-40% of pre-schoolers presented with dental plaque accumulation; sound gingivae were identified at 83% of the recorded sites (Carvalho *et al.*, 1998). The comparison of cited prevalence data should be performed with caution. First of all, in the present study clinical examinations were not performed in a clinical dental setting, but in classrooms with children sitting on a chair and examiners using an illuminated dental mirror. These suboptimal circumstances may have resulted in underscoring. Given the very young age of the children (3-5 years old) and the suboptimal examination circumstances, it was opted to score plaque accumulation and the status of the gingivae only at the buccal sites of four index teeth. It can be speculated that if for example the approximal sites of the posterior teeth and the lingual aspects of the manidbular molars had also been evaluated, higher prevalence scores might have been obtained. In addition, the differences in gingivitis scores may also be attributed to differences in examination criteria. In the present study gingival health was based on visual inspection of the tissues whereas in other studies, gingivitis was recorded after bleeding upon probing (Carvalho *et al.*, 1998; Feldens *et al.*, 2006).

Oral hygiene behaviour, as reported by the parents, was far from optimal. When data are collected by interviews or questionnaires, limitation in recall should not be overlooked. The parents of the examined children were questioned about the age tooth brushing started at the time their son or daughter was already three or five years old. Reliability concerning reported behaviours may decrease over time (Persson and Carlgren, 1984). In the present study it was also observed that parents of the older age group reported a later age at which tooth brushing was started.

In addition, some parents may have overestimated oral hygiene habits out of motives of social desirability. Thus, some children may have been categorised in the wrong group. Misclassification of 'exposure' usually results in differences between groups being veiled. Moreover, tooth brushing frequency should not be confused with effective plaque removal. Santos *et al* (2007) . also failed to observe any significant associations between oral hygiene frequency and two evaluated biofilm indices and concluded that oral hygiene frequency is not associated to oral hygiene quality. These factors may also explain why the logistic regression analyses revealed only few associations between the evaluated oral hygiene habits and oral hygiene status and gingival health.

Results of the multiple analyses revealed that 3- and 5-year-old children whose mothers had a college or university training, presented with significantly less dental plaque, even after correction of other evaluated possibly confounding factors. This finding concurs with the results of others showing social class to be strongly associated with oral hygiene status (Sayegh *et al.*, 2005; Feldens *et al.*, 2006).

The habit of "cleaning a pacifier in the own mouth" after it had accidently fallen on the ground, is widespread in Flemish families. About half of the parents admit doing so or having done so. This habit may facilitate the transmission of oral bacteria, and more specifically *mutans Streptococci* (Li *et al.*, 2005). Surprisingly, it was observed that 3-year-olds whose parents admitted doing so, had less plaque than their peers. On the other hand, the result should not be overexaggerated as it was only of borderline significance.

Neither the simple nor the multiple logistic regression analyses revealed any significant association between gender and the oral hygiene status or gingival health of the pre-school children. This finding is in agreement with other researchers who also failed to detect any gender effect on gingival health in young children (Sayegh *et al.*, 2005; Spencer *et al.*, 1983), but is in contrast with one of the Brazilian studies where higher plaque indices were obtained in boys (Feldens *et al.*, 2006).

The presence of dental plaque exerted the most pronounced effect on the presence of gingivitis: 3-year-olds who presented with dental plaque accumulation had 28 times the likelihood of having gingivitis, 5-year-olds even 87 times. The results confirm the primary role of plaque in the development of gingivitis and follow the outcome of other investigations (Vanderas *et al.*, 1998; Sayegh *et al.*, 2005; Feldens *et al.*, 2006).

In the oldest age group, gingivitis was also related to children's exposure to passive smoking. Children, who were previously exposed to parental smoking, had a four times higher chance of presenting with signs of gingival inflammation. As for now, it is not completely clear why the effect of children's former exposure is more pronounced than their current exposure to passive smoking.

In a previous study performed in the same data set, it was revealed that the presence of dental plaque accumulation was associated with the presence of dental caries as well as with the severity of disease (Declerck *et al.*, 2008). In the present study a significant positive association between signs of gingivitis and caries in a child was revealed. These results are in agreement with Vanderas *et al*. who found a significant association between interproximal caries lesions and gingivitis in young

children (Vanderas *et al.*, 1998). They speculate that interproximal caries lesions can affect the development of gingivitis either by food impaction and accumulation of plaque and/or by enzymes or cytotoxins produced by bacteria involved in the pathogenesis of caries.

The present investigation showed that there is scope for improvement of the oral hygiene habits among Flemish pre-school children. Since dental plaque acts as a direct causal factor in the pathogenesis of dental caries as well as gingivitis, programmes stressing the importance of better plaque control in young children are needed, especially in less privileged groups.

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