Qual Life Res (2011) 20:1699–1706
DOI 10.1007/s11136-011-9897-4

Oral-health-related quality of life in schoolchildren in an endemic fluorosis area of Mexico

F. C. Aguilar-Díaz · M. E. Irigoyen-Camacho · S. A. Borges-Yáñez

Accepted: 16 March 2011 / Published online: 7 April 2011

Abstract
Objective To evaluate the oral-health-related quality of life (OHRQoL) of children living in an endemic hydrofluorosis area.
Methods Schoolchildren aged 8–10 years living in an area with 3.38 ppm F water concentration completed a validated Spanish version of the Child Perceptions Questionnaire ($CPQ_{8–10ESP}$). World Health Organization (WHO) criteria were applied for the diagnosis of dental caries and malocclusion. Additionally, the Thylstrup and Fejerskov Index (TFI) was used for fluorosis diagnosis. $CPQ_{8–10ESP}$ scores and oral health status were analyzed using non-parametric tests and logistic regression models.
Results Two hundred and twelve schoolchildren participated in this study. The mean $CPQ_{8–10ESP}$ score was 12.98 (SD 11.4). General oral health was rated as "poor" in 14.6%, "fair" in 41.5%, "good" in 25.9%, and "very good" in 17.9% of the children. Regarding overall well-being, half (51.6%) of the children perceived that the condition of their mouths disturbs their quality of life (QoL). Children with dental fluorosis (TF >4) had a high $CPQ_{8–10ESP}$ score in all domains ($P < 0.005$). Additionally, children with DMFS + dmfs >5 had higher scores in the oral symptoms, functional limitation, and emotional well-being $CPQ_{8–10ESP}$ domains ($P < 0.05$). Applying a $CPQ_{8–10ESP}$ cutoff point of 32, the OR values for severe malocclusion, caries, and fluorosis were 5.2 ($P = 0.034$), 4.6 ($P = 0.006$), and 5.1 ($P = 0.007$), respectively.
Conclusions Malocclusion, caries, and fluorosis were associated with a negative impact on children's QoL.

Keywords Quality of life · Dental fluorosis · Caries · Malocclusion · Schoolchildren

Abbreviation list

OHRQoL	Oral-health-related quality of life
QoL	Quality of life
$CPQ_{8–10ESP}$	Spanish version of the Child Perceptions Questionnaire $_{8–10}$
OS	Oral symptoms domain
FL	Functional limitation domain
EW	Emotional well-being domain
SW	Social well-being domain
WHO	World Health Organization
DMFS	Decay missing filled surface index
DAI	Dental aesthetic index
TFI	Thylstrup and Fejerskov Index

Introduction

Among the most prevalent diseases are those that affect the mouth, such as dental caries, malocclusion, gingivitis, and

F. C. Aguilar-Díaz (✉)
Department of Dental Public Health, Faculty of Dentistry, National Autonomous University of Mexico, Mexico City, Mexico
e-mail: fatimaguilar@gmail.com

M. E. Irigoyen-Camacho
Department of Health Care, Metropolitan Autonomous University Xochimilco, Calzada del Hueso 1100, Col. Villa Quietud, México, D.F., Mexico
e-mail: meirigo@correo.xoc.uam.mx

S. A. Borges-Yáñez
Department of Dental Public Health, Division of Graduate Studies, Faculty of Dentistry, UNAM, Av. Universidad 3000, Circuito Exterior s/n, Col. Copilco el bajo, Ciudad Universitaria. Del. Coyoacán, CP 04511 Mexico City, Mexico
e-mail: aborges@servidor.unam.mx

dental fluorosis. Those conditions produce discomfort, pain, functional limitation, and emotional problems and affect people's overall well-being. The condition of the oral cavity during childhood probably affects the health and quality of life (QoL) throughout a person's life [1]. Oral-health-related quality of life (OHRQoL) research in children has increased in recent years, mostly in developed countries.

Two of the most common oral disorders studied in this area have been dental caries and malocclusion [2, 3]. Foster et al. [4] found an association between QoL in 11- to 14-year-olds and the presence of malocclusion. Children suffering from hypodontia [5], oligodontia [6], or orofacial disorders [7, 8] experience a deterioration in their QoL, as their condition has a negative impact on their daily activities. Even though the prevalence of dental fluorosis has increased in recent years, few studies have been conducted regarding the relationship between this condition and QoL. Of particular importance is the consideration of the moderate and severe forms of dental fluorosis and its impact on QoL [9].

The ingestion of excessive amounts of fluoride during tooth formation causes dental fluorosis, which is characterized by hypomineralization of the tooth structure; there are alterations in the substitution of the organic enamel matrix for minerals (calcium and phosphates). The enamel changes in structure and composition. Slightly and mildly fluorotic enamel is fully functional. Nonetheless, exposure to higher levels of fluoride results in porous, pitted, and discolored enamel, which is more prone to fracture and wear [10]. In the most severe cases, pitting of the enamel occurs, and the pitted areas may connect with one another, thus creating larger areas where enamel is lost [11]. The discoloration produced in the fluorotic enamel and the changes in the shape of the tooth probably lead to negative impacts on OHRQoL; on the other hand, mild forms of this condition may have a positive effect on QoL. Slight or mild dental fluorosis enhances tooth appearance, making the dental enamel looks whiter, and children and adolescents with this degree of fluorosis are more likely to perceive their teeth as attractive or very attractive [12, 13]. Furthermore, mild fluorosis has been associated with improved OHRQoL in Brazilian children [14, 15].

In contrast, the results of other studies where fluorosis severity was high suggested that fluorosis may have a negative effect on OHRQoL when the severity is higher than three according to the Thylstrup and Fejerskov Index (TFI) [16]. In this case, increasing esthetic problems arise [17], which are perceived differently by parents, children, and dentists [18].

Dental fluorosis has been associated with water fluoride concentration above the optimal level. In Mexico, several regions have high water fluoride concentrations [19, 20]. An additional systemic source of fluoride in Mexico derives from fluoridated salt, which is the main dental caries preventive strategy in the country. Before establishing the National Salt Fluoridation Program (NSFP) in Mexico, it was necessary to identify the fluoride concentration of the different drinking water sources. Due to high water fluoride content, five states were excluded from the program; twelve additional states have some municipalities that are excluded from the NSFP, among them the state of San Luis Potosí [21]. In this state, several localities have shown water fluoride levels higher than the optimal (0.8, 2.3, and 2.7 ppm) [22]. In addition, a high prevalence of fluorosis (96%) has been reported in the northern region of the country [23]. Despite this fact, no attempt has been made to evaluate the impact on QoL of dental fluorosis in Mexican children. The objective of this study was to evaluate QoL related to oral health and the general perception of oral health of children living in an endemic hydrofluorosis area in a northern Mexican state (San Luis Potosí).

Methods

This study has a cross-sectional design. The study group was selected from the city of San Luis Potosí, which is the capital of the state of San Luis Potosí, located in the north-central area of Mexico. The city had 730,950 inhabitants in 2005 [24], and this state is ranked 18th according to its gross regional product (6,935 USD/per capita) among the 32 Mexican states [24]. In this region, some water sources naturally contain high amounts of fluoride [22]. The children selected attended a public school in the city of San Luis Potosí and belong to a middle socioeconomic status (SES). Written consent was obtained from the children's parents to allow them to participate in the study. In addition, the children received information about the study's purpose and gave their verbal consent to participate in the study. The ethical guidelines laid out for this study were approved by the Division of Graduate Studies, Dental School, National Autonomous University of Mexico.

Outcome variable

The Spanish version of the Child Perceptions Questionnaire ($CPQ_{8–10ESP}$) was used to assess oral-health-related quality of life (OHRQoL). This index has the advantage of being specific to the evaluation of oral conditions in children of a specific age group (8- to 10-year-olds). The validity and the reliability of this instrument has been reported elsewhere [25]. This instrument consists of 25 questions divided into four domains: (1) oral symptoms (OS), made up of 5 questions (i.e., "Have you had pain in your teeth or mouth in the last 4 weeks?"); (2) functional limitation (FL), made up of 5 questions (i.e., "Have you had any difficulties biting

or chewing food such as an apple, meat or an ear of corn because of your teeth or mouth in the last 4 weeks?"); (3) emotional well-being (EW), made up of 5 questions (i.e., "Have you worried that you are not as good-looking as others because of your teeth or mouth in the past 4 weeks?"); and (4) social well-being (SW), made up of 10 questions (i.e., "Have you tried not to smile or laugh with other children because of your teeth or mouth in the past 4 weeks?") [26]. The responses are recorded on a 5-point Likert scale, from 0 to 4 (0 = never; 1 = once or twice; 2 = sometimes; 3 = often; and 4 = every day or almost every day). The highest possible score is 100 points, so the highest negative impact is 100, and the minimum is 0 (no impact of oral health on quality of life).

Also, the children were asked to rate their oral health ("very good" to "poor") and to indicate how much oral health affects their daily activities ("not at all" to "a lot"). The questionnaire was self-administered and completed in a classroom setting.

Independent variables

Caries experience was assessed using the World Health Organization (WHO) criteria by means of the decayed, missing, and filled surfaces in primary teeth (dmfs) and Decayed, Missing and Filled surfaces in permanent teeth (DMFS) indices. Dental fluorosis was scored according to the Thylstrup and Fejerskov Index (TFI); only upper anterior permanent incisors were evaluated [27]. This index classifies dental fluorosis based on clinical appearance, with scores ranging from 0 to 9. Higher values of the ordinal scale indicate an increase in the severity of fluorosis. The lower levels (1–3) are characterized by color changes in the enamel surface, from fine white lines to irregular cloudy areas on tooth enamel; at level 4, the whole tooth surface shows changes in color (chalky white) and increased opacity, and there is attrition shortly after tooth eruption; at scores of 5–9, in addition to color changes (light yellow to brown), there is loss of tooth structure (pitting and confluent areas of enamel loss).

The dental aesthetic index (DAI) was used to evaluate malocclusion traits. This index is also recommended by WHO, and it was developed to assess the social acceptability of dental esthetics. The index considers ten occlusal traits that include maxillary and mandibular horizontal plane malposition, anterior open bite, upper and lower anterior teeth crowding and irregularities, anteroposterior molar relation, and missing visible teeth. DAI classifies individuals in one of four possible severity categories as follows: no anomaly; low malocclusion; moderate malocclusion; and severe malocclusion [28]. The $CPQ_{8-10ESP}$ questionnaire and clinical examinations were conducted on the same day. All measurements were taken by the same examiner, who was standardized by an experienced public health dentist. The examiner obtained a kappa of 0.87 for the presence of dental caries. For TFI at level 2, the kappa was 0.83, and for the DAI categories, the kappa was 0.91. Oral examination was performed in the classroom. After tooth cleaning, the dentition was inspected using dental mirrors, WHO-probes, and illumination (provided by indirect sunlight and a headlamp), as the index evaluated required. Infection control barriers were used.

For the purpose of verifying the fluoride concentration of the hydrofluorosis area selected, water samples were taken from the well that provides tap water for the selected school area and from bottled water in the 19-l packaging size, which is the least expensive bottled size in Mexico. Water samples were analyzed using a combination fluoride ion-specific electrode. All the water fluoride analyses were duplicated to verify the results. The analysis indicated a concentration of 3.38 ppm of fluoride in the tap water and 0.41 ppm in the bottled water.

Data analysis

Overall mean $CPQ_{8-10ESP}$ scores were compared between groups by oral health status, considering the three oral conditions studied (dental caries, dental fluorosis, and malocclusion), using the Mann–Whitney or Kruskal–Wallis statistical test. Logistic regression models were generated, fitting child's oral health perception, and the backward method was used. For this purpose, one group was composed of those children who perceived their oral health as "excellent or very good," and the other group was composed of those children who perceived their oral health as "fair or poor." In addition, the $CPQ_{8-10ESP}$ score was transformed into a dichotomous variable applying a cutoff point of 32 to obtain groups with "high" and "low" $CPQ_{8-10ESP}$ scores (outcome variable) for the logistic regression analysis. Dental fluorosis and dental caries indices were also dichotomized using as the cutoff value for fluorosis a score of 4 (TFI $\leq$4 and TFI >4) observed on the maxillary anterior teeth; for dental caries, a value of 5 (dmfs + DMFS $\leq$5 and dmfs + DMFS >5) was used. A TFI fluorosis score of higher than four was considered prone to negatively affect the children's OHRQoL, given that the first signs of loss of enamel are shown at this fluorosis stage. Statistical significance tests were set at a level of $P \leq 0.05$. Statistical analysis was carried out with SPSS software (version 13; Chicago, IL).

Results

A total of 234 schoolchildren living in an endemic hydrofluorosis area in San Luis Potosí, Mexico, were invited

to participate in the study. All parents and children accepted. However, 22 children did not complete the questionnaire, or their dental status was not evaluated because they were absent during the examination days. Therefore, the final survey group encompassed 212 children of 8–10 years of age, with a mean age of 8.98 (SD 0.76); 47.2% were boys ($n = 100$) and 52.8% ($n = 112$) girls.

The results showed that 94.8% of the children reported at least one impact on QoL during the preceding 4 weeks: 86.4% of them in the oral symptoms domain; 68.1% in the functional limitation domain; 70.4% in the emotional well-being domain; and 60.6% in the social well-being domain. On the overall scale, the mean score was 12.98 (S.D. 11.4).

The answers to the global oral health question included in the instrument indicated that 14.6% of the children rated their oral health as "poor," 41.6% as "fair," 25.9% as "good," and 17.9% as "very good." To the overall well-being question, half (51.6%) of the children answered that the condition of their mouths interrupted or disturbed their QoL to a different degree as follows: 32.4% of the children reported that their mouth bothered them "a little bit"; 12.6% reported "some"; and 6.6% responded with "a lot"; 48.4% of the children did not perceive a negative impact of oral health on their QoL.

Table 1 presents the oral examination results, showing that only 8% of the children did not show clinical evidence of dental fluorosis in the upper anterior incisors and more than 10% of the children presented fluorosis in a category higher than 4 for these teeth. More than 60% of the children showed no or only a slight level of malocclusion according to the DAI. Caries prevalence (DMFS + dmfs $\geq$1) was 75.9, and 74.1% of the children showed one or more untreated caries lesions. The mean dental caries index (DMFS + dmfs) was 4.1 (SD 4.6) [dmfs 2.8 (SD 3.6); DMFS 1.3 (SD 1.9)]. Dental caries (dmfs + DMFS) experience was not associated with fluorosis status in the anterior teeth, and the caries index was 4.18 (SD 4.7) in children with TF $\leq$4 and 4.90 (SD 4.96) in those with a higher TF index ($P = 0.82$).

When comparing total $CPQ_{8–10ESP}$ and each domain score by malocclusion status, no significant differences ($P > 0.05$) were detected (Table 2). On the other hand, children who were classified as having fluorosis scores greater than four reported higher impacts on their QoL. These differences were statistically significant in all domains (Table 2). Considering the dental caries experience of the children, there was a significant association between the mean $CPQ_{8–10}$ score and the oral symptoms, functional limitation, and emotional well-being domains. The scores in these three domains were higher in those children with more than five damaged dental surfaces, indicating deterioration in the QoL in the children more severely affected by this condition (Table 2).

General perception of oral health ("very good," "good," "fair," or "poor") showed that children with higher fluorosis severity were more likely (OR = 3.22, CI (1.19,8.75), $P = 0.025$) to assess their general oral health as "fair" or "poor," as compared with those showing lower fluorosis levels.

Table 3 shows the results of the multiple logistic regression analysis, which was performed by dichotomizing the total $CPQ_{8–10ESP}$ score. The cutoff score was 32 (children with $CPQ_{8–10ESP} > 32$ encompassed 10% of the group studied). The three dental conditions included in the model (malocclusion, dental caries, and dental fluorosis) were statistically significant; the model was adjusted by age and sex. Children with a fluorosis level higher than 4 (TF >4) were more likely to have a high $CPQ_{8–10ESP}$ score (OR = 5.1, $P = 0.007$). Furthermore, children with

Table 1 Distribution of the dental fluorosis, malocclusion, and dental caries scores of the 212 Mexican schoolchildren

Upper anterior teeth fluorosis degree TFI[a]			Malocclusion DAI[b]			Dental caries DMFS[c]		
	n	(%)		*n*	(%)		*n*	(%)
0	17	8.0	No anomaly	65	30.7	Decayed $\geq$ 1[d]	157	74.1
1	26	12.3	Low	73	34.4	Missing $\geq$ 1[e]	11	5.2
2	41	19.3	Moderate	35	16.5	Filled $\geq$ 1[f]	49	23.1
3	67	31.6	Severe	39	18.4	DMFS $\geq$ 1	161	75.9
4	38	17.9					Mean	SD
5	14	6.6				Decayed[d]	2.80	3.1
6	6	2.8				Missing[e]	0.32	1.4
7	2	0.9				Filled[f]	0.93	2.4
8	1	0.5				DMFS	4.10	4.6

[a] *TFI* Thylstrup and Fejerskov Index anterior teeth, [b] *DAI* dental aesthetic index

[c] *DMFS* (DMFS + dmfs), [d] Decayed (DS + ds), [e] Missing (MS + ms), [f] Filled (Fs + fs)

Table 2 Mean $CPQ_{8-10ESP}$ score by clinical status in a group of Mexican schoolchildren

	DMFS[a]	Median	Mean	P^d	Fluorosis[b]	Median	Mean	P^d	DAI[c] category	Median	Mean	$P^{d,c}$
$CPQ_{8-10ESP}$	DMFS ≤5	9	11.65	0.089	TFI ≤4	9	11.66	<0.001	No anomaly	9	11.5	0.811
									Low	10	13.14	
									Moderate	9	12.35	
	DMFS >5	10	14.87		TFI >4	19.5	21.42		Severe	10.5	14.24	
Oral symptoms	DMFS ≤5	3	3.84	0.041	TFI ≤4	3	3.90	0.004	No anomaly	4	4.24	0.892
									Low	4	4.07	
									Moderate	3	4.21	
	DMFS >5	5	4.77		TFI >4	7	6.27		Severe	3	4.08	
Functional limitation	DMFS ≤5	1	2.29	0.047	TFI ≤4	1	2.34	0.005	No anomaly	1	2.29	0.927
									Low	2	2.64	
									Moderate	1	2.41	
	DMFS >5	3	3.09		TFI >4	3.5	4.38		Severe	1.5	2.55	
Emotional well-being	DMFS ≤5	2	2.62	0.037	TFI ≤4	2	2.74	<0.001	No anomaly	2	2.52	0.539
									Low	3	3.19	
									Moderate	2	2.88	
	DMFS >5	2	3.71		TFI >4	6	5.12		Severe	2	3.45	
Social well-being	DMFS ≤5	1	2.95	0.632	TFI ≤4	1	2.72	<0.001	No anomaly	0.5	2.10	0.120
									Low	2	3.34	
									Moderate	1	2.85	
	DMFS >5	1	3.30		TFI >4	4	5.65		Severe	1	4.16	

[a] DMFS = (DMFS + dmfs), [b] *TFI* Thylstrup & Fejerskov Index anterior teeth, [c] *DAI* dental aesthetic index, [d] *P* value obtained by the Mann–Whitney test, $CPQ_{8-10ESP}$ higher values indicate poorer OHRQoL

Table 3 Multiple logistic regression model for the $CPQ_{8-10ESP}$ score and selected oral conditions

Clinical variables	OR	95% confidence interval		*P*
DMFS[a]				
≤5	1	–	–	–
>5	4.6	(1.5)	(13.7)	0.006
Fluorosis[b]				
TFI ≤4	1	–	–	–
TFI >4	5.1	(1.5)	(16.9)	0.007
DAI[c]				
No anomaly	1	–	–	–
Low	1.4	(0.33)	(6.70)	0.603
Moderate	3.6	(0.74)	(17.4)	0.111
Severe	5.2	(1.13)	(24.1)	0.034
Sex				
Boys	1	–	–	–
Girls	1.6	(0.58)	(4.5)	0.346
Age	0.78	(0.41)	(1.4)	0.451

Outcome variable: $CPQ_{8-10ESP}$ score dichotomized using a cutoff point of 32. *OR* odds ratios

[a] *DMFS* (DMFS + dmfs). [b] *TFI* Thylstrup & Fejerskov Index anterior teeth. [c] *DAI* dental aesthetic index

DMFS + dmfs >5 were more likely to have a higher $CPQ_{8-10ESP}$ score (OR = 4.6, $P = 0.006$) than children with lower caries indices, and children with severe malocclusion were also more likely (OR = 5.2, $P = 0.034$) to have a $CPQ_{8-10ESP}$ score higher than those showing less severe levels of malocclusion. Sex ($P = 0.346$) and age ($P = 0.451$) were not statistically significant.

Discussion

The study examined the OHRQoL of children living in an endemic hydrofluorosis area in a northern Mexican state. Most of the children examined perceived that their oral condition had an impact on their QoL. The presence of severe malocclusion, high number of teeth affected by dental caries, and high fluorosis scores in this group of children was associated with high $CPQ_{8-10ESP}$ score, indicating the negative impact of these conditions on the children's QoL. The mean $CPQ_{8-10ESP}$ score found in the children was 12.98 (SD 11.4). Canadian children experienced a higher impact (mean CPQ_{8-10} 18.7; SD 12.6) [26] than the Mexican children studied. Brazilian children also

showed a higher impact (mean $CPQ_{8–10}$ 14.77; SD 3.8) [29]. These differences could be attributed to the oral health condition of the children or different perceptions of OHRQoL in distinct cultural settings, or to both factors.

The prevalence of fluorosis in anterior teeth found in the Mexican children was 91.7%; this percentage was comparable with those reported in other studies in different areas of endemic fluorosis in Mexico. For instance, a study carried out in the same state as this study, San Luis Potosí, also detected a high prevalence of fluorosis. In fact, some cases of severe fluorosis in the primary dentition were observed [30]. Furthermore, another study of children also located in the northern part of the country identified a high prevalence of fluorosis (96.5%) in the anterior teeth [23].

For the children involved in the present study, establishing their total exposure to fluoride during tooth formation is difficult. The water samples analyzed showed a large difference in the amount of fluoride present in the tap water (3.38 ppm), as compared with the bottled water samples (0.41 ppm). Mexico is the second largest market of bottled water in the world, second only to the United States, consuming 18,000 million liters annually [31]. A study of Latino children indicated that the parents believe that tap water would "make them sick," so drinking bottled water is considered to be safer [32]. To verify the use of bottled water in the children studied, a subgroup of parents ($n = 119$) filled out a questionnaire providing information on their children's main source of drinking water. The results indicated that 90.2% consumed bottled water. In the case of the community studied, drinking bottled water reduces the risk of dental fluorosis, as compared with drinking tap water. Despite the high consumption of bottled water, dental fluorosis was present in most of the students; however, close to two thirds of the participants showed fluorosis in the mild categories, which would be consistent with the amount of fluoride present in the bottled water. Nonetheless, prior drinking water habits in the children studied were not evaluated. It is possible that during their first years of life, the children drank boiled tap water, which would constitute a risk factor of developing dental fluorosis. Other fluorosis risk factors should be considered rather than focusing only on water fluoride concentration, such as beverages like sodas and juices that may contain considerable amounts of fluoride. A study by Loyola et al. [33] showed that fluoride content in some soft drinks purchased in San Luis Potosí exceeded the limit established by Mexican government regulations [21]. It is also possible that some children ingested fluoridated salt obtained from other localities close to San Luis Potosí City.

Dental fluorosis in the most severe forms detected was associated with the highest overall $CPQ_{8–10ESP}$ scores, in the children suffering this condition. Children with TFI >4 had a mean overall $CPQ_{8–10ESP}$ score of 21.42, while children with TFI ≤4 had a mean of 11.66. Accordingly, a study carried out in South Australia detected a $CPQ_{8–10}$ score of approximately 10 in children with TFI <3, while children with TFI = 3 had a mean of 15.7 [12], suggesting a negative impact in the OHRQoL associated with the changes produced by high levels of dental fluorosis. The severity of the fluorosis interferes with children's self-rated oral health. In the Mexican children, the impact was particularly perceived in the emotional and social well-being domains. It appears that they tend to rate their own oral health status based on their anterior teeth's appearance.

Clearly, severe fluorosis can have a negative effect on smile esthetics and produce functional problems [34], affecting self-confidence, causing discomfort, and probably disturbing social roles from a young age. In Uganda, Robinson et al. [9] found that socially noticeable fluorosis was associated with high impacts on QoL. Around the age of 8, children begin to perceive the impact of their ill health on social activities and relationships. Additionally, they start developing a global judgment of self-perception and self-worth [35].

Contrary to the findings of the present study, a number of studies have identified a positive effect of fluorosis on OHRQoL [12, 15, 36]. In Brazil, one study found that most parents of children with fluorosis rated the color of their children's teeth to be esthetically acceptable or even better than normal enamel [37]. However, these studies were conducted on populations with slight or moderate fluorosis, and the authors recognized that higher levels of fluorosis might alter their results. Moreover, Chankanka et al. [38] carried out a literature review and concluded that severe fluorosis had consistently been reported to have negative effects on OHRQoL. For instance, Indian children perceived dental fluorosis as a negative or disadvantageous condition [39].

In spite of the high prevalence of dental fluorosis found in the children studied, the prevalence of dental caries was high. The largest component of the DMFS index was decayed teeth. The caries index was associated with OHRQoL; dental caries had a negative impact on three of the four CPQ domains—emotional well-being, functional limitation, and oral symptoms—in which higher scores were reported. Similar results have already been found in 10- to 14-year-old children in Brazil [40]. Additionally, Foster et al. [4] reported that children with more than four surfaces affected by caries showed poor OHRQoL. Also, a study conducted on 12-year-old children in Uganda found that having dental caries or restorative treatment was associated with higher negative impacts on QoL [9].

The results of the logistic regression model indicated that the presence of severe malocclusion in this group of children disturbed their daily life; those children with severe malocclusion had a less favorable OHRQoL score

than children with no or only a slight level of malocclusion according to the dental aesthetic index. Similar results have been reported in a New Zealand study indicating that children without malocclusion reported significantly less impact on their everyday QoL [4]. In addition, poorer OHRQoL was observed among Australian children who had less acceptable occlusal traits [8].

An advantage of the present study is that it was carried out in a community setting and not in a dental clinic or a hospital dental service. It is expected that the distribution of the oral conditions is less biased than for children recruited through dental services.

Some of the limitations of the present study derived from its cross-sectional design. It would be useful to confirm the findings of this study using a follow-up study design that would allow for the evaluation of the effect of oral conditions on OHRQoL during the children's development. Another limitation was related to the assessment of dental fluorosis, which was carried out by considering only upper anterior teeth. This probably caused an underestimation of dental fluorosis prevalence and severity. However, the esthetic problems derived from fluorosis were not underestimated, since anterior teeth were considered in the oral examination.

More research is needed in order to identify which other factors contribute to explaining the OHRQoL in Mexican children. For example, how much does the parents' perception of and concerns about their children's oral health influence their children's perception? Is children's sense of self-worth associated with the impact of oral health conditions on QoL? What is the impact of dental services on children's perception of their oral health? These and other questions need to be addressed in order to better understand the impact of oral health on children's development and well-being.

Conclusions

Traditionally, oral health needs assessment is determined almost entirely on professional opinion and is based on adverse health (clinical) consequences, but this approach may not be complete. The omission of measures of psychosocial health or OHRQoL produces limitations in the evaluation and treatment of young patients.

Oral diseases affected the QoL of most of the children studied. The findings of this study emphasize that not only caries experience and malocclusion but also dental fluorosis (when moderate or severe) has an adverse effect on children's QoL. While caries experience affects the oral symptoms and functional limitation domains, fluorosis affects particularly the emotional and social well-being domains. The children with these conditions required special attention. Dental fluorosis is irreversible, the treatment of severe fluorosis is expensive and a technical challenge, and tooth destruction due to dental caries requires economic resources that many Mexican families do not have. In addition, a preventive approach is pertinent considering that dental caries lesions are reversible in their early stages, and proven preventive measurements are available. The consumption of elevated doses of fluoride during tooth formation should be avoided in order to prevent moderate and severe dental fluorosis, in light of the disease's consequences on children's well-being.

References

1. Peres, K. G., Peres, M. A., Araujo, C. L., Menezes, A. M., & Hallal, P. C. (2009). Social and dental status along the life course and oral health impacts in adolescents: A population-based birth cohort. *Health Quality Life Outcomes, 22*(7), 95.
2. O'Brien, K., & Wright, J. (2006). The Child Perception Questionnaire is valid for malocclusion in the United Kingdom. *American Journal Orthodontics Dentofacial Orthopedic, 129*(4), 536–540.
3. Martins, M. T., Ferreia, F. M., Oliveira, A. C., Paiva, S. M., Vale, M. P., Allison, O. J., et al. (2009). Preliminary validation of the Brazilian version of the Child Perceptions Questionnaire 8–10. *European Journal Paediatric Dentistry, 10*(3), 135–140.
4. Foster-Page, L. A., Thomson, W. M., Jokovic, A., & Locker, D. (2005). Validation of the Child Perceptions Questionnaire (CPQ11–14). *Journal of Dental Research, 84*(7), 649–652.
5. Wong, A. T., McMillan, A. S., & McGrath, C. (2006). Oral health-related quality of life and severe hypodontia. *Journal Oral Rehabilitation, 33*(12), 869–873.
6. Locker, D., Jokovic, A., Prakash, P., & Tompson, B. (2010). Oral health-related quality of life of children with oligodontia. *International Journal of Paediatric Dentistry, 20*(1), 8–14.
7. Locker, D. (2007). Disparities in oral health-related quality of life in a population of Canadian children. *Community Dentistry and Oral Epidemiology, 35*(5), 348–356.
8. Do, L. G., & Spencer, A. J. (2008). Evaluation of oral health-related quality of life questionnaires in a general child population. *Community Dental Health, 25*(4), 205–210.
9. Robinson, P. G., Nalweyiso, N., Busingye, J., & Whitworth, J. (2005). Subjective impacts of dental caries and fluorosis in rural Uganda children. *Community Dental Health, 22*(4), 231–236.
10. Den Besten, P. K., & Thariani, H. (1992). Biological mechanisms of fluorosis and level and timing of systemic exposure to fluoride with respect to fluorosis. *Journal of Dental Research, 71*(5), 1238–1243.
11. Cutress, T. W., & Suckling, G. W. (1990). Differential diagnosis of dental fluorosis. *Journal Dental Research, 69* Spec No:714–720.
12. Do, L. G., & Spencer, A. (2007). Oral health-related quality of life of children by dental caries and fluorosis experience. *Journal of Public Health Dentistry, Summer, 67*(3), 132–139. doi: 10.1111/j.1752-7325.2007.00036.
13. Hawley, G. M., Ellwood, R. P., & Davies, R. M. (1996). Dental caries, fluorosis and he cosmetic implications of different TF scores in 14-year-old adolescents. *Community Dental Health, 13*(4), 189–192.
14. Peres, K. G., Latorre, M. R., Peres, M. A., Traebert, J., & Panizzi, M. (2003). Impact of dental caries and dental fluorosis on

12-year-old schoolchildren's self-perception of appearance and chewing. *Cadernnos Saude Publica, 19*(1), 323–330.
15. Michel-Crosato, E., Biazevic, M.G., & Crosato, E. (2005). Relationship between dental fluorosis and quality of life: A population based study. *Brazliain Oral Research, Apr-Jun, 19*(2), 150–155. Epub 2005 Sep8.
16. Astrom, A. N., & Mashoto, K. (2002). Determinants of self-rated oral health status among school children in northern Tanzania. *International Journal Paediatric Dentistry, 12*(2), 90–100.
17. Clark, D. C., Hann, H. J., Williamson, M. F., & Berkowitz, J. (1993). Aesthetic concerns of children and parents in relation to different classifications of the Tooth Surface Index of Fluorosis. *Community Dentistry and Oral Epidemiology, 21*(6), 360–364.
18. Shulman, J. D., Maupome, G., Clark, D. C., & Levy, S. M. (2004). Perceptions of desirable tooth color among parents, dentists and children. *Journal of American Dental Association, 135*(5), 595–604.
19. Soto-Rojas, A. E., Urena-Cirett, J. L., & Martínez-Mier, E. A. (2004). A review of prevalence of dental fluorosis in Mexico. *Revista Panamericana de Salud Pública, 15*(1), 9–18.
20. Hurtado, R., & Gardea-Torresdey, J. (2004). Environmental evaluation of fluoride in drinking water at "Los Altos de Jalisco" in the central Mexico region. *Journal of Toxicology and Environmental Health, Part A, 67*(20–22), 1741–1753.
21. Diario Oficial De la Federación. Modificación a la Norma Oficial Mexicana NOM-040.SSA-1993, Productos y servicios. Sal yodada y sal yodada fluorurada. Especificaciones sanitarias.
22. Loyola-Rodríguez, J. P., Pozos-Guillén, A. J., Hernández-Guerrero, J. C., & Hernández-Sierra, J. F. (2000). Fluorosis en dentición temporal en un área con hidrofluorosis endémica. *Salud Pública de México, 42*, 194–200.
23. Barrandey-Orozco, S. E., Cabello-Arreola, M. V., Magaña-Ramírez, J., & Rodríguez-Domínguez, E. (1994). Sal fluorada, riesgo o beneficio para la población de la ciudad de Chihuahua. *Revista de la Asociación Dental Mexicana, 51*(2), 80–89.
24. Censo poblacional. (2005). México: Instituto Nacional de Estadística y Geografía.
25. Aguilar-Díaz, F. C., & Irigoyen-Camacho, M. E. (2010). Validation of the CPQ 8–10ESP in Mexican School children in urban areas. *Medicina Oral Patología Oral Cirugía Bucal*, Aug 15, Ahead of print.
26. Jokovic, A., Locker, D., Tompson, B., & Guyatt, G. (2004). Questionnaire for measuring oral health-related quality of life in eight-to ten-year-old children. *Pediatric Dentistry, 26*(6), 512–518.
27. Thylstrup, A., & Fejerskov, O. (1978). Clinical appearance of dental fluorosis in permanent teeth in relation to histologic changes. *Community Dentistry and Oral Epidemiology, 6*(6), 315–328.
28. World Health Organization. (1997). *Oral health surveys—basic methods* (4th ed.). Geneva: World Health Organization.
29. Martins, M. T., Ferreira, F. M., Oliveira, A. C., Paiva, S. M., Vale, M. P., Allison, P. J., et al. (2009). Preliminary validation of the Brazilian version of the Child Perceptions Questionnaire 8–10. *European Journal of Pediatric Dentistry, 10*(3), 135–140.
30. Rodríguez, J. P., Pozos-Guillén, A. J., Hernández-Guerrero, J. C., & Hernández-Sierra, J. F. (2000). Fluorosis en dentición temporal en un área con hidrofluorosis endémica. *Salud Publica de México, 42*(3), 194–200.
31. Mercado del agua en México. Available form www.latinoamerican-markets.com (visited 2 August 2010).
32. Hobson, W. L., Knochel, M. L., Byington, C. L., Young, P. C., Hoff, C. J., & Buchi, K. F. (2007). Bottled, filtered and tap water use in Latino and Non-Latino children. *Archives of Pediatric & Adolescent Medicine, 161*(5), 457–461.
33. Loyola-Rodríguez, J. P., Pozos-Guillén, A. J., & Hernández-Guerrero, J. C. (1998). Bottled drinks as additional source of fluoride exposition. *Salud Pública de México, 40*, 438–441.
34. Riordan, P. J. (1993). Perceptions of dental fluorosis. *Journal of Dental Research, 72*(9), 1268–1274.
35. Jokovic, A., Locker, D., & Guyatt, G. (2005). What do children's global ratings of oral health and well-being measure? *Community Dentistry and Oral Epidemiology, 33*(3), 205–211.
36. Clark, D. C., Shulman, J. D., Maupome, G., & Levy, S. M. (2006). Changes in dental fluorosis following the cessation of water fluoridation. *Community Dentistry and Oral Epidemiology, 34*(3), 197–204.
37. Barbosa, T. S., Tureli, M. C., & Gavião, M. B. (2009). Validity and reliability of the Child Perceptions Questionnaires applied in Brazilian children. *BMC Oral Health, 9*, 13.
38. Chankanka, O., Levy, S. M., Warren, J. J., & Chalmers, J. M. (2010). A literature review of aesthetic perceptions of dental fluorosis and relationships with psychosocial aspects/oral health-related quality of life. *Community Dentistry and Oral Epidemiology, 38*(2), 97–109.
39. Bhagyajyothi, C. S., & Pushpanjali, K. (2009). Perceptions and concerns about dental fluorosis as assessed by tooth surface index of fluorosis among high school children in an area of endemic fluorosis–Kaiwara. *Oral Health & Preventive Dentistry, 7*(1), 33–38.
40. Piovesan, C., Ferreira-Antunes, J., Saravia-Guedes, R., & Machado-Ardenghi, T. (2010). Impact of socioeconomic and clinical factors on child oral health-related quality of life (COHRQoL). *Quality of Life Research, 19*(9), 1359–1366.