SCIENTIFIC ARTICLES & BRIEF COMMUNICATIONS

Oral Health-Related Quality of Life of Children by Dental Caries and Fluorosis Experience

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Abstract

*Objective: To evaluate the oral health-related quality of life (OHRQoL) of children by dental caries and fluorosis status. **Methods:** A random sample of South Australian 8- to 13-year-old children was selected. Caries data were collected from school dental service records to group children by combined deciduous and permanent tooth caries experience. Children were examined for fluorosis using the Thylstrup and Fejerskov (TF) Index to form groups by fluorosis scores on maxillary central incisors. Occlusal traits were recorded using the Dental Aesthetic Index. Children and their parents completed the Child Perception Questionnaire (CPQ) and the Parental Perception Questionnaire (PPQ) and a global rating of oral health (OH). OHRQoL indicators, rating OH as Excellent/Very good, and mean overall CPQ/PPQ scores were compared between groups by fluorosis scores and caries experience. Multivariate models were generated for both OH and CPQ/PPQ indicators. **Results:** Two hundred forty-two children (43.0 percent) had 0 decayed, missing, and filled primary and permanent tooth surface (dmfs/DMFS), while 170 (23.9 percent) had 5+ dmfs/DMFS. The prevalence of TF scores 1, 2, and 3 were 14.5, 9.5, and 1.9 percent, respectively. The proportion of children/parents rating OH as Excellent/Very good was significantly associated with children's caries experience. That proportion increased when fluorosis severity increased from a TF score of 0 to 2, but decreased with a TF of 3. Having low caries experience and better dental appearance were associated with parents' perception of good OH. Having mild fluorosis and more acceptable appearance were significant factors for children's perception of good OH. Caries and malocclusion were associated with lower OHRQoL, while having a TF score of 2 was associated with better OHRQoL in multivariate models for overall CPQ/PPQ scores. **Conclusion:** Caries and less acceptable appearance showed a negative impact, while mild fluorosis had a positive impact on child and parental OHRQoL.*

Key Words: oral health-related quality of life, children, fluorosis, caries

Introduction

Oral diseases and disorders during childhood can have a negative impact on the life of children and their parents. For example, dental caries can lead to toothache, which can be distressful and worrying for the affected children and their parents. Conversely, good oral health can have positive benefits for children and their parents. Children's confidence and self-esteem can be enhanced by the appearance of their teeth, reflecting the children's and their parents' perception of the shape and color of teeth and their occlusion. Importantly, positive aspects of oral health can vary considerably in their magnitude, even among people who have no oral diseases or disorders.

Oral disease and disorders are measured in population studies using clinical measures recorded by dental clinicians during oral examinations such as the decayed, missing, and filled index for caries or the Thylstrup and Fejerskov (TF) Index for fluorosis. These indices indicate the presence and severity of an oral condition. However, perceptions of oral health and positive or negative impacts of oral health status on the quality of life must necessarily be reported by the people who experience those conditions. In the case of children, perceptions and impacts also may be reported by parents.

While fluorides provide a protective benefit against dental caries, fluoride consumed in greater amounts in early childhood can have the adverse effect of causing dental fluorosis, a developmental disorder of dental enamel. There exists, therefore, the potential for a clinical trade-off in oral health with differing levels and timing of exposure to fluorides. Further, variation in the presence and severity of caries and fluorosis may be associated with a consequent trade-off in the impact of those clinical conditions on the oral health-related quality of life (OHRQoL) of children. On the one hand, there is potential for exposure to fluorides to reduce caries experience, and therefore to reduce negative impacts of dental caries on OHRQoL. Conversely, there is potential for excessive exposure to fluorides to cause dental fluorosis, which may change the appearance of teeth and cause negative impacts on OHRQoL.

This study's objective was to evaluate the association of dental caries and fluorosis with children's global self-rating of oral health and multi-item measures of OHRQoL reported by the children themselves and their parents.

Methods

Study Sample. The study sample was nested in a larger population-based study of the South Australian (SA) school dental service (SDS) population. The SA SDS population comprises 89 percent of the state's primary school population. The parent study targeted children aged 5 to 15 years using a multistage, stratified random sample selection. All participants of the parent study who were 8 to 13 years of age in 2002-03 from metropolitan, fluoridated Adelaide and three other regional nonfluoridated towns in South Australia were selected for the further study of OHRQoL among children. The study design and data collection methods have been detailed elsewhere (1-4). Ethical approval was received from the University of Adelaide Human Research Ethics Committee. Informed parental consent was sought for access to caries experience data from SDS clinical records and the separate examination for fluorosis experience.

Data Collection and Management. The families of the selected children were approached with a package containing an information letter, a consent form, an age-specific Child Perception Questionnaire for 8- to 10- or 11- to 14-year-old age groups (CPQ_{8-10} or CPQ_{11-14}) and a Parental Perception Questionnaire (PPQ) (5,6). Evaluation of the construct validity and internal consistency of these questionnaires in this general population has been reported elsewhere (3).

Perception of tooth staining and satisfaction of child's tooth color were asked using Likert-type scales. Tooth staining was rated from "Not stained" to "Very badly stained," while response options to the question of satisfaction with tooth color were from "Very attractive" to "Very unattractive." These questions were used to evaluate perception of dental appearance that may be related to fluorosis.

Items of the CPQ and PPQ used Likert-type scales with response options of "Never" = 0; "Once or twice" = 1; "Sometimes" = 2; "Often" = 3; and "Very often" = 4. For the CPQ_{11-14} and PPQ the recall period was 3 months, while for that of the CPQ_{8-10} it was 4 weeks. Items are grouped into four domains: oral symptoms, functional limitations, emotional well-being, and social well-being. Domain and overall OHRQoL scores of CPQ and PPQ were calculated by summing all the responses to items in the domains or in the whole questionnaire. Lower scores indicated better OHRQoL.

The questionnaires also contained a global self-rating question on oral health with Likert-type responses from "Excellent" to "Poor." The proportion of respondents who perceived their (or their child's) oral health as Excellent or Very good was used as a dependent variable in the analysis of self-rated oral health as a further indicator of OHRQoL.

The clinical records of the children's caries experience were collected at the time of their routine dental visits to SA SDS clinics. Clinicians assessed and recorded tooth surface status as sound, filled, or with cavitated caries using a standardized examination manual developed by epidemiologists from the University of Adelaide. Caries experience data were extracted from these clinical records and used to calculate the prevalence of caries and decayed, missing, and filled primary and permanent (dmfs/DMFS) tooth surface index scores. These data were used to categorize children into four groups based on the number of surfaces of either dentition having caries experience: having 0 dmfs/DMFS; 1-2 dmfs/DMFS; 3-4 dmfs/DMFS; or 5+ dmfs/DMFS.

Children were invited to be examined for fluorosis and malocclusion by one of the authors (LGD) at their local SDS clinic. Prior to the fieldwork, the examiner underwent training sessions with epidemiologists who were experienced with clinical indices. Fluorosis was measured using the TF Index (7). Teeth were dried with compressed air and scored for fluorosis. The most severe fluorosis score observed on one or both maxillary incisors was used to categorize children into groups by TF score. The observed TF scores in the study sample ranged from TF 0 to TF 3. Therefore, four corresponding groups were formed based on the TF score on maxillary central incisors: groups with a TF score of 0; TF score of 1; TF score of 2; and TF score of 3.

Occlusal traits were measured using the Dental Aesthetic Index (DAI) (8). The DAI assesses the relative social acceptability of dental appearance using a weighted measure of 10 occlusal traits. The DAI score can theoretically range from 13 (most socially acceptable) to over 100 (least socially acceptable). The DAI score was used to arbitrarily categorize children into having more acceptable dental appearance (DAI score from 13 to 34) and having less acceptable dental appearance (DAI score of 35 and higher) (8).

Analysis. The CPQ and PPQ responses were used to calculate mean domain scores and overall CPQ and PPQ scores. The percentage of respondents who perceived their (or their child's) oral health as Excellent or Very good was used as another indicator of OHRQoL. These two indicators of OHRQoL were compared between children grouped by caries experience, fluorosis scores, and DAI categories in a bivariate analysis. The three clinical indicators were included as independent variables in multivariate models for the OHRQoL indicators together with other controlling socioeconomic indicators, such as sex, age, urban/rural residence, parental education, and household income. Linear regression models were generated for overall CPQ and PPQ scores (three models: two for children of two age groups and one for all parents), while logistic regression models were generated for percentage of respondents with perceived Excellent or Very good oral

health (two models: children combined and parents').

Results

From a total of 677 children with fluorosis examination, 654 parents completed the PPQ, while 304 and 334 8- to 10- and 11- to 14-year-old children completed a CPQ, CPQ$_{8-10}$, or CPQ$_{11-14}$, respectively (Table 1). Just less than 30 percent of children had some degree of fluorosis. Of those, most had a TF score of 1 or 2, while 10 children had a TF score of 3 on one or both maxillary central incisors. Caries experience was observed among over half of children, with one-fifth having five or more decayed, missing, or filled deciduous or permanent tooth surfaces. One-fifth of children were found to have less acceptable dental appearance as indicated by their DAI score.

Figure 1 presents the proportion of respondents who perceived their (child's) tooth as Slightly, Badly, or Very badly stained and who perceived their (child's) tooth color as Attractive or Very attractive. Children who had a TF score of 1 were less likely to perceive their tooth color as stained compared with children who had no fluorosis, i.e., a TF score of 0, and compared with children who had higher TF scores (Chi-square, $P < 0.05$). Those children who had a TF score of 1 were more likely to perceive their tooth color as Attractive or Very attractive compared with children who had no fluorosis in the bivariate comparison (Chi-square, $P < 0.05$), while there was a similarity between children who had no fluorosis or had a TF score of 2 or 3. There were no significant differences in parental response regarding their perception of their child's tooth staining and tooth attractiveness according to TF scores. However, there was a trend of increasing proportion of parents reporting tooth stain associated with higher TF scores.
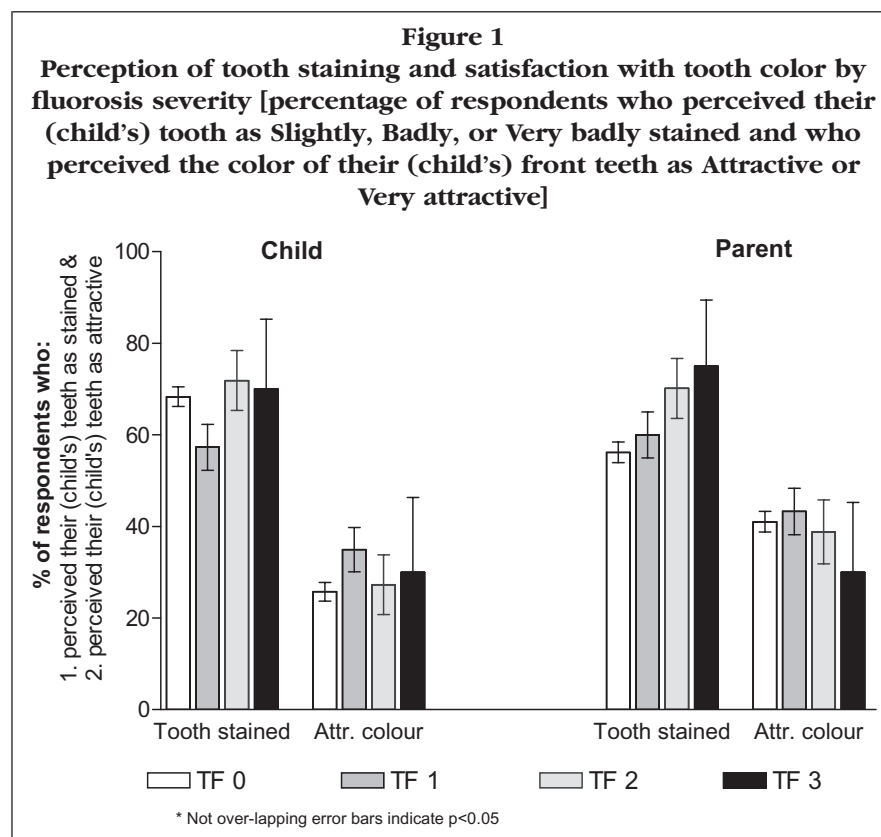
Mean domain scores and overall CPQ and PPQ scores are presented for groups by caries experience, fluorosis severity, or DAI score (Table 2). As expected, the highest mean values were recorded for the domain

Table 1
Percent of Children and Parents with Complete Data Grouped by Dental Caries, Fluorosis, and Dental Aesthetic Index (DAI) Categories

	CPQ$_{(8-10)}$	CPQ$_{(11-14)}$	PPQ
Responses (n)	304	334	654
Fluorosis severity (%)			
TF 0	72.3	69.8	71.5
TF 1	18.6	15.0	16.5
TF 2	8.4	12.6	10.2
TF 3	0.7	2.6	1.9
Caries experience (%)			
0 dmfs/DMFS	39.2	47.0	43.0
1-2 dmfs/DMFS	18.0	24.9	21.5
3-4 dmfs/DMFS	11.7	12.6	12.2
5+ dmfs/DMFS	31.0	15.6	23.3
DAI categories (%)			
Acceptable occlusion (DAI ≤ 34)	70.6	79.8	76.1
Less acceptable occlusion (DAI = 35+)	29.4	20.2	23.9

Some children and parents had incomplete questionnaire data and were excluded from the analysis.
CPQ$_{(8-10)}$, Child Perception Questionnaire for 8-10 years old; CPQ$_{(11-14)}$, Child Perception Questionnaire for 11-14 years old; PPQ, Parental Perception Questionnaire; dmfs/DMFS, decayed, missing, and filled primary and permanent tooth surface.

Figure 1
Perception of tooth staining and satisfaction with tooth color by fluorosis severity [percentage of respondents who perceived their (child's) tooth as Slightly, Badly, or Very badly stained and who perceived the color of their (child's) front teeth as Attractive or Very attractive]

of oral symptoms, followed by functional limitations, then emotional and social well-being. There was no consistent pattern of domain or overall scores for caries or fluorosis among children 8 to 10 years old. However, those children who had a TF score of 1 or 2 reported nonsignificantly fewer oral symptoms and functional limitations. Children 8 to 10 years old who had less acceptable dental appearance reported significantly

Table 2
Mean Domain Scores and Overall Scale Score for Oral Health-Related Quality of Life (OHRQoL) Reported by Children and Their Parents by Caries and Fluorosis Status

	Oral symptoms	Functional limitations	Emotional well-being	Social well-being	Overall scale
Child's responses (8-10 years old)					
Caries					
0 dmfs/DMFS	5.5 (3.0)	1.9 (2.2)	1.2 (1.8)	1.2 (1.8)	10.8 (7.9)
1-2 dmfs/DMFS	5.0 (3.3)	1.6 (2.2)	1.0 (1.7)	1.0 (1.7)	9.2 (7.4)
3-4 dmfs/DMFS	5.7 (3.4)	2.2 (3.3)	2.0 (3.0)	2.0 (3.0)	12.4 (11.1)
5+ dmfs/DMFS	5.0 (3.2)	1.9 (2.8)	1.4 (2.7)	1.4 (2.7)	10.2 (8.4)
Fluorosis score					
TF 0	5.3 (3.3)	2.0 (2.5)	2.0 (3.1)	1.2 (2.1)	10.4 (8.0)
TF 1	5.5 (2.6)	1.8 (2.8)	2.1 (3.6)	1.3 (2.6)	10.7 (9.4)
TF 2	4.4 (3.1)	1.5 (2.2)	2.7 (3.0)	1.5 (2.0)	10.1 (8.6)
TF 3	7.9 (4.4)	3.8 (4.2)	–	3.9 (3.9)	15.7 (12.2)
DAI categories					
DAI ≤ 34	5.1 (3.2)	1.8 (2.4)	1.7 (2.6)*	1.0 (1.9)*	9.6 (7.3)*
DAI = 35+	5.7 (3.0)	2.2 (2.9)	2.9 (4.2)	1.9 (2.8)	12.6 (10.1)
Child's responses (11-14 years old)					
Caries					
0 dmfs/DMFS	5.0 (3.5)	2.8 (3.8)	2.5 (4.8)	1.6 (3.9)	11.8 (13.6)
1-2 dmfs/DMFS	5.2 (3.5)	3.7 (4.3)	3.1 (4.8)	2.6 (4.3)	14.5 (14.5)
3-4 dmfs/DMFS	5.5 (4.2)	3.3 (3.4)	3.9 (5.4)	2.7 (3.9)	15.4 (14.5)
5+ dmfs/DMFS	5.9 (3.2)	3.8 (4.2)	2.7 (3.7)	1.6 (2.1)	14.0 (10.3)
Fluorosis score					
TF 0	5.9 (3.6)**	3.7 (4.2)*	3.3 (5.1)*	2.2 (4.1)*	15.1 (14.4)**
TF 1	4.3 (3.1)	2.2 (3.1)	1.6 (2.9)	1.2 (1.7)	9.2 (7.5)
TF 2	3.4 (2.6)	1.3 (2.0)	1.3 (2.4)	0.6 (1.3)	6.4 (6.5)
TF 3	3.9 (1.3)	3.6 (3.0)	3.5 (3.8)	1.3 (1.9)	12.3 (6.5)
DAI categories					
DAI ≤ 34	5.3 (3.6)	3.0 (3.8)	2.8 (4.7)	2.0 (3.9)	13.0 (13.9)
DAI = 35+	5.1 (3.2)	3.7 (4.0)	3.3 (4.5)	1.7 (2.7)	13.8 (10.0)
Parent's responses					
Caries					
0 dmfs/DMFS	4.3 (3.0)*	2.7 (3.9)	2.2 (4.2)	1.5 (3.6)	10.7 (12.2)
1-2 dmfs/DMFS	4.4 (2.9)	2.9 (3.9)	2.5 (4.6)	1.7 (3.7)	11.4 (12.0)
3-4 dmfs/DMFS	5.2 (3.5)	2.5 (3.0)	2.7 (3.6)	1.7 (3.3)	12.1 (11.2)
5+ dmfs/DMFS	5.4 (3.2)	3.2 (4.0)	2.9 (4.6)	2.1 (4.1)	13.6 (12.9)
Fluorosis score					
TF 0	5.1 (3.2)**	3.2 (4.1)*	2.8 (4.4)*	2.0 (4.1)*	13.1 (12.8)**
TF 1	4.4 (2.6)	2.4 (3.1)	1.6 (3.2)	1.0 (2.3)	9.3 (7.9)
TF 2	3.1 (2.4)	1.5 (2.4)	1.4 (2.5)	0.6 (1.4)	6.6 (6.2)
TF 3	4.9 (2.5)	2.5 (3.6)	2.5 (3.7)	2.2 (3.9)	12.1 (11.7)
DAI categories					
DAI ≤ 34	4.7 (3.1)	2.7 (3.6)	2.3 (4.1)	1.6 (3.8)	11.4 (12.2)
DAI = 35+	4.8 (3.0)	3.4 (4.4)	3.1 (4.5)	2.0 (3.7)	13.2 (12.0)

Values are expressed as mean (standard deviation).
Analysis of variance, * $P < 0.05$; ** $P < 0.001$.
dmfs/DMFS, decayed, missing, and filled primary and permanent tooth surface; TF, Thylstrup and Fejerskov Index; DAI, Dental Aesthetic Index.
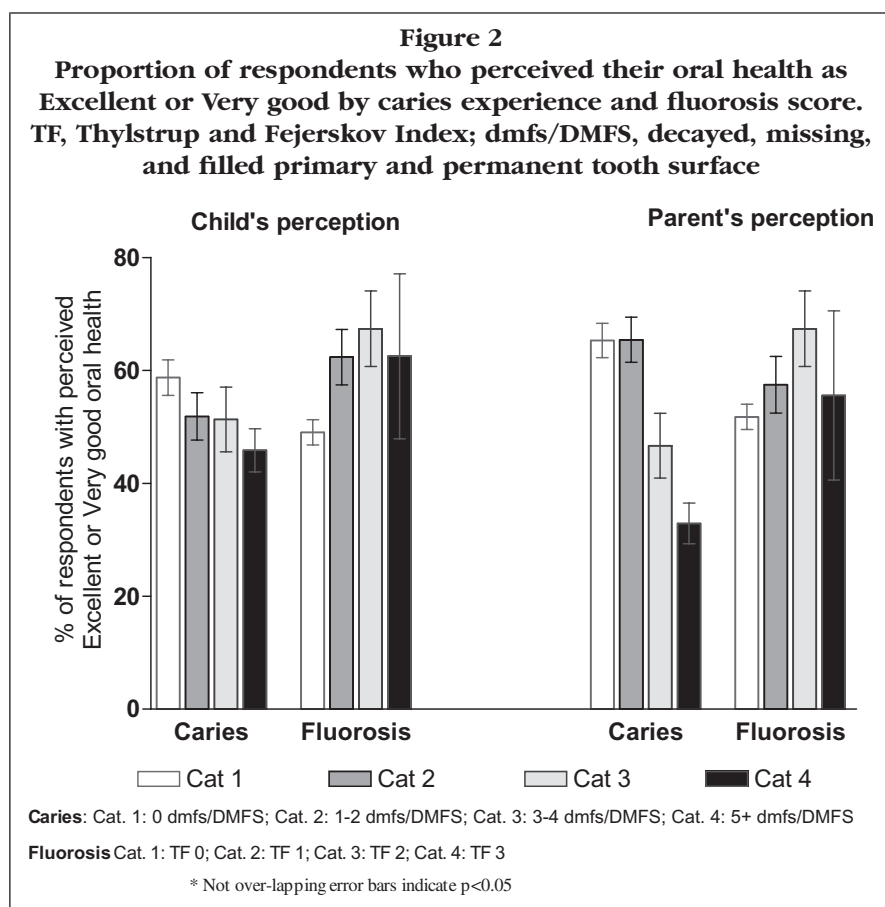
poorer emotional well-being and social well-being.

Older children who had more caries experience tended to report higher CPQ scores compared with children who had less caries experience (Table 2). However, the difference was not statistically significant. On the other hand, fluorosis was significantly associated with CPQ scores. The domain and overall scores were lowest among children who had a TF score of 2 and highest among children without fluorosis ($P < 0.05$).

The child's caries experience was significantly associated with parental reporting of the oral symptoms domain score (Table 2). The child's fluorosis score was also significantly associated with all four domains as well as overall PPQ score. Parents of children without fluorosis reported higher PPQ scores compared with parents whose child had a TF score of 2 ($P < 0.05$). Parents of children with a TF score of 3 reported higher domain scores compared with parents of children with a lower score for fluorosis.

Figure 2
Proportion of respondents who perceived their oral health as Excellent or Very good by caries experience and fluorosis score. TF, Thylstrup and Fejerskov Index; dmfs/DMFS, decayed, missing, and filled primary and permanent tooth surface

Caries: Cat. 1: 0 dmfs/DMFS; Cat. 2: 1-2 dmfs/DMFS; Cat. 3: 3-4 dmfs/DMFS; Cat. 4: 5+ dmfs/DMFS
Fluorosis Cat. 1: TF 0; Cat. 2: TF 1; Cat. 3: TF 2; Cat. 4: TF 3
* Not over-lapping error bars indicate p<0.05

The association of caries experience and fluorosis score with the proportion of respondents with perceived Excellent or Very good oral health as a further indicator of OHRQoL is presented in Figure 2. There was a gradual decrease in the proportion of those respondents with perceived Excellent or Very good oral health as caries experience increased reported by both child and parent. The difference in child perception was significant between the group without caries and the group with the highest caries experience (Chi-square, pairwise comparison, $P < 0.01$). The difference was also significant and large between caries experience groups in the parental perception of their child's oral health. Children who had a TF score of 1 or 2 were significantly more likely to perceive their oral health as Excellent or Very good compared with children who had no fluorosis (Chi-square, pairwise comparison, $P < 0.05$). A similar association was observed in parental perception. A

significant difference was observed between parents of children with a TF score of 0 and parents of children with a TF score of 2.

The proportion of respondents with perceived Excellent or Very good oral health was also significantly lower among children with a less acceptable dental appearance compared with the group with a more acceptable dental appearance (37 percent versus 51 percent, Chi-square, $P < 0.01$).

Three multivariate linear regression models for overall CPQ and PPQ scores are presented in Table 3. Higher caries experience (having 3-4 surfaces with caries experience) was significantly associated with higher CPQ score reported by 8- to 10-year-old children. Having a TF score of 1 or 2 was associated with significantly lower CPQ score among 11- to 13-year-old children and their parents compared with having no fluorosis experience controlled for other factors. DAI score was also associated with poorer OHRQoL in

the model for younger children and the model for parents.

The association of caries experience and fluorosis score with self-rated oral health was examined in multivariate logistic regression models together with DAI categories and sociodemographic factors (Table 4). Having 5+ tooth surfaces with caries experience was associated with significantly lower odds for parents to perceive their child's oral health as Excellent or Very good compared with the odds for a child with no caries experience. Having a TF score of 2 was associated with significantly higher odds of perceiving Excellent or Very good oral health as reported by children compared with the odds for a child with a fluorosis score of zero. Having a less socially acceptable dental appearance, measured by DAI score, was associated with lower odds for both children and their parents to perceive Excellent or Very good oral health compared with the odds for children with an acceptable dental appearance.

Discussion

This study evaluated the impact of dental caries and fluorosis on the OHRQoL of children. Both oral conditions are associated with the use of fluorides in early life. It is believed that this study is one of only a few to report on the concurrently evaluated impact of dental fluorosis and caries on OHRQoL among children and their parents (9,10). Other studies have examined perception of dental caries and fluorosis by parents only (10-12) or laypersons (13) or from photographs (14,15). The fact that the study sample was drawn from a larger multistaged, stratified random sample of children facilitated extrapolation of the findings to the South Australian child population. A moderately large sample was examined in this study, further increasing the study's power in exploring its aims.

CPQ domain scores were collected with a different reference period for the two age groups: 4 weeks for the 8- to 10-year-olds and 3 months for the older group. Therefore, these scores were not directly

Table 3
Linear Regression Models for Overall Child and Parental Perception Scale Score for Oral Health-Related Quality of Life (OHRQoL) against Categories of Caries Experience, Fluorosis, and Dental Aesthetic Index (DAI) Categories

	Child (8-10 years old)		Child (11-14 years old)		Parent	
	Un-std B	P	Un-std B	P	Un-std B	P
Caries experience						
0 dmfs/DMFS	Ref		Ref		Ref	
1-2 dmfs/DMFS	−0.48	NS	2.19	NS	0.21	NS
3-4 dmfs/DMFS	3.36	<0.05	3.28	NS	1.56	NS
5+ dmfs/DMFS	0.58	NS	−0.88	NS	0.37	NS
Fluorosis score						
TF 0	Ref		Ref		Ref	
TF 1	−0.38	NS	−5.93	0.01	−3.28	0.01
TF 2	−0.91	NS	−8.39	<0.01	−5.23	<0.01
TF 3	6.46	NS	−6.09	NS	1.68	NS
DAI categories						
DAI ≤ 34	Ref		Ref		Ref	
DAI: 35+	4.78	<0.001	−0.163	0.94	3.00	0.01

Dependent variable: sum of all OHRQoL items. Higher value indicates poorer OHRQoL. Other variables in the model: age, sex, residential location, parental education, and household income.

Un-std B, unstandardized coefficient; dmfs/DMFS, decayed, missing, and filled primary and permanent tooth surface; NS, not statistically significant; TF, Thylstrup and Fejerskov Index; Ref, reference.

Table 4
Logistic Regression Models for Perceiving Excellent/Very Good Oral Health against Categories of Caries Experience, Fluorosis, and Dental Aesthetic Index (DAI) Categories

	Child's perception		Parent's perception	
	Odds ratio (95% CI)	P	Odds ratio (95% CI)	P
Caries experience				
0 dmfs/DMFS	Ref		Ref	
1-2 dmfs/DMFS	0.73 (0.47-1.15)	NS	1.11 (0.70-1.78)	NS
3-4 dmfs/DMFS	1.01 (0.57-1.77)	NS	0.79 (0.45-1.41)	NS
5+ dmfs/DMFS	0.71 (0.44-1.15)	NS	0.32 (0.19-0.53)	<0.01
Fluorosis score				
TF 0	Ref		Ref	
TF 1	1.38 (0.87-2.19)	NS	1.09 (0.68-1.74)	NS
TF 2	1.87 (1.00-3.48)	<0.05	1.65 (0.85-3.21)	NS
TF 3	1.20 (0.28-5.10)	NS	0.66 (0.15-2.85)	NS
DAI categories				
DAI ≤ 34	Ref		Ref	
DAI: 35+	0.57 (0.38-0.87)	0.01	0.60 (0.39-0.92)	0.02

Dependent variable: global rating of oral health (Excellent or Very good responses versus other responses). Other variables in the model: age, sex, residential location, parental education, and household income.

CI, confidence interval; dmfs/DMFS, decayed, missing, and filled primary and permanent tooth surface; Ref, reference; NS, not statistically significant; TF, Thylstrup and Fejerskov Index.

comparable and were analyzed separately. Doing so reduced the sample size for analyses that involved child domain scores. However, the global rating of oral health was the same for the two groups and hence, was combined in the analysis. Also, 8- to 10-year-old children tended to show lower stability in reporting CPQ scores as evidenced in a convenience sample (6) and in a general population sample (3). Although the questionnaire was designed to suit the language skills of children in this age range, their cognitive skill may lower their ability to fully recall events in the specified time period. This issue may limit the usefulness of domain scores reported by children in this age range.

It must be acknowledged that it was difficult to concurrently evaluate OHRQoL among children with low levels of oral conditions. Children of the age range that was in this study may be less likely to recall events related to caries experience. That was evident even in the convenience sample of patients with a high disease rate (5,16). The other study of general population sample could detect significant difference only among groups with a high level of caries without controlling for fluorosis experience (17). This study examined the association of caries and fluorosis concurrently that might further reduce the ability to detect statistical significance of the association between OHRQoL and caries. Also, caries and fluorosis were used as ordinal variables in the analysis, which may reduce the power of the analysis to detect statistical significance (18). When caries and fluorosis experience were used as continuous constructs, statistical

significance was found (19). However, ordinal grouping of fluorosis experience was used in this report to identify the level of fluorosis severity where fluorosis starts inflicting a negative impact on OHRQoL.

Recent studies on fluorosis have focused on the effect of fluorosis on the perception of dental appearance. Available evidence suggested that the affected children and others around them could discern changes in tooth color caused by fluorotic lesions (11,20-22). Findings of the present study indicated that the children and their parents perceived tooth staining caused by fluorotic lesions. This perception was more obvious with TF scores of 2 or 3. The explanation may be that a fluorotic lesion defined as a TF score of 1 can be difficult to discern when the tooth is wet. However, still more than half of the children who had a TF score of 1 and their parents perceived a change in the color of their teeth. The popular opinion that fluorosis is discernable only to trained professionals was not supported. It was clear that children and their parents could detect the presence of even these less severe fluorotic lesions.

However, the perception of the presence of a change in tooth color (associated with fluorotic lesions) was not related to a perception of the unattractiveness of teeth. Children with a TF score of 1 were even more likely to perceive their teeth as Attractive or Very attractive compared with children with a TF score of 0 or 2-3. The latter two groups were similar in perceived attractiveness of their teeth. This finding was similar to that reported by other studies (11,22,23). Hawley and coworkers (23) reported that TF scores of 1 or 2 even enhanced the appearance of teeth as perceived by children. This positive perception of tooth color may influence the perception of OHRQoL by the children and their parents. This phenomenon may be explained by the preference for more "whitish" tooth color of deciduous teeth over "yellowish" color of newly erupted permanent teeth during the mixed dentition period.

The findings of this study also indicated that a significant proportion of children who were diagnosed as not having dental fluorosis perceived their teeth as stained or their parents perceived the child's teeth as stained. This is evidence that numerous other conditions contribute to tooth discoloration (24). Although not clinically recorded in this study, those children might have discoloration such as white spot lesions or other intrinsic discolorations. If so, not having fluorosis may not always mean being without tooth discoloration, which may have an impact on the perception of dental appearance and OHRQoL.

Dental caries and fluorosis are two conditions on the opposite sides of the balance of fluoride use. Considering the potential impact of the two conditions on OHRQoL of the population provides an important public health perspective in the use of fluoride in the prevention of caries. Clinical indicators of the two conditions are necessary. However, those indicators may not reflect the impact of the conditions among the general population, where the levels of caries and fluorosis are relatively low. Self-reported perception of oral health by the affected individuals adds substantially to the measurement of the impact of the use of fluoride.

Dental fluorosis and caries have a measurable impact on affected children. This was evident even though the study sample was drawn from the general population. The impact on affected children was reported by both the children themselves and their parents. Caries experience was found to have a negative association with the perception of oral health of children. The association was more pronounced for the parental perception of oral health. This association can be explained as caries can cause pain and discomfort as well as time and financial problems for the family.

Our research has shown that the presence of some fluorosis was associated with a lower caries experience – the other side of the balance of risk

and benefit of fluoride use (19). Similar findings have been reported elsewhere (23,25). Caries experience seemed to have a more pronounced association through a plausible link to oral symptoms and functional limitations. Children and their parents who had mild fluorosis were even better off in perception of oral health when other factors were controlled for in multivariate models. This rather unexpected finding might be explained by the fact that better oral health was often perceived as being without caries. The association of fluorosis with the perception of dental appearance, if any, was outweighed by a feeling of being free from the impact of caries. The findings even suggested some positive association of mild dental fluorosis with perceived OHRQoL. That positive association may be the result of the enhancing effect of mild fluorosis on the perception of attractiveness of tooth color. A follow-up of this study sample is being planned to reevaluate and compare the role of perception of tooth color attractiveness and the role of perception of being caries-free in the impact of fluorosis on OHRQoL.

The findings of this study on the association of caries and mild fluorosis with OHRQoL were similar to that reported by recent studies (9,11,13). Those studies reported no or minimal negative association of mild dental fluorosis with perceived OHRQoL reported by children or laypersons. Those findings were in contrast with reports from populations where fluorosis severity was high (26). Fluorosis may have a negative association with OHRQoL when the severity score is from a TF score of 3 and higher. Given the prevalence of TF score 3 in this population of less than 2 percent, this finding was similar to the estimated proportion of children with esthetically objectionable fluorosis, which affected some 2 percent of the US children population (27).

To summarize, fluorosis was often discernable by the affected children and, to a lesser extent, by their parents. However, this study

indicated that mild fluorosis did not have a negative association on the perception of dental appearance, self-rated oral health, or child or parent perceptions of OHRQoL (measured by the four domains and overall scale score and self-rated oral health) in this child population. The current level of fluorosis experience in the South Australian child population was not expected to have a major negative influence on the quality of life of children, at least in the foreseeable future.

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