

# Child oral health-related quality of life (COHQoL), enamel defects of the first permanent molars and caries experience among children in Western Australia

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Published reports suggest that children with enamel defects, especially where enamel is missing or breaking down, experience considerable discomfort and are generally more fearful of dental treatment. However, children's oral health-related quality of life in relation to enamel defects has not been reported. The aim of this study was to examine the association between oral health-related quality of life among children (COHQoL) with enamel defects of the first permanent molars and deciduous caries experience. **Methods:** Children attending pre-primary schools in metropolitan Perth, Western Australia, were recruited and classified for enamel defects using the modified Developmental Defects of Enamel index. Caries experience of deciduous molars and canines was also recorded. Parents completed a child oral health-related quality of life questionnaire. Data were analysed using Kruskal-Wallis, Spearman's rank correlation, chi-square, multiple linear regression and ordered logistic regression to test the factors for their influence on the COHQoL. **Results:** From the 550 children assessed (mean age 7.2 years) 522 COHQoL questionnaires were returned. Mean COHQoL score was 8.9 (sd 8.8). Bivariate tests showed no association of COHQoL with enamel defect status of the first permanent molars. COHQoL was associated with dmft (mean dmft 1.96, sd 2.62). Higher caries experience children had poorer reported oral health-related quality of life. **Conclusion:** The presence of enamel defects in the first permanent molars did not affect the children's oral health-related quality of life.

**Key words:** enamel hypoplasia; quality of life; dental caries, child, enamel defect

## Introduction

The prevalence of demarcated enamel defects in the first permanent molars among school children in Western Australia has been reported and is at the higher end of reported levels in some European countries (Arrow, 2008; Weerheijm and Mejäre, 2003). The oral health consequences of the occurrence of the more severe type of defect associated with demarcated defects, where enamel is absent or breaks down quickly after eruption, can range from increased risk of caries with the resultant restorative care, ultimately to extraction of affected teeth (Kotsanos *et al.*, 2005; Mejäre *et al.*, 2005). It has also been reported that children with more severely affected molars required extensive treatments more often and the children themselves displayed difficult management behaviours and were generally more fearful of dental treatment (Jälevik and Klingberg, 2002; Kotsanos *et al.*, 2005; Leppäniemi *et al.*, 2001).

There is increasing interest in supplementing the traditional measures of oral diseases and conditions among children with measures which reflect the multidimensional nature of these diseases and conditions (McGrath *et al.*, 2004). A number of measurement tools have been developed to capture the more salient aspects of oral health among children, either using the child or their parents as reporters (Gherunpong *et al.*, 2004a; Jokovic *et al.*, 2002; 2003).

Some of these tools have assessed the effects of oral diseases and conditions on the child oral health-related quality of life (Gherunpong *et al.*, 2004b). The validity of a child oral health-related quality of life (COHQoL) instrument within a general child population in Australia has been evaluated (Do and Spencer, 2008) and the oral health-related quality of life of children in relation to dental caries, dental fluorosis, and dental treatment using the COHQoL have been reported (Do and Spencer, 2007; Malden *et al.*, 2008). Most reports on the quality of life effects of enamel defects has been in relation to aesthetic aspects of enamel defects, primarily in anterior teeth and mainly for the condition of dental fluorosis (Levy *et al.*, 2005; Riordan, 1993; Sigurjons *et al.*, 2004). To date there has been no report on the COHQoL which considers the overall aspects of oral health among children in relation to the presence of enamel defects on the first permanent molars.

Given the reported prevalence of demarcated opacities with hypoplastic type defects in the first permanent molars among children in Western Australia and elsewhere, the oral health impacts of these conditions require evaluation. The aim of this study was to describe the oral health-related quality of life among children in relation to the presence of enamel defects on the first permanent molars and dmft and test for differences in oral health-related quality of life.

## Methods

The setting and selection of the study participants have been described previously (Arrow, 2008). Briefly, parents of children in pre-school in 2005, and enrolled with the School Dental Service of the Health Department of Western Australia (1999-2000 year of birth) in metropolitan Perth were invited to participate. At this age, the child's first permanent molars are yet to erupt. Parents of participating children signed a consent form and completed a baseline questionnaire about the mother's health during pregnancy, smoking history, birth process and health-related information about the child's first three years. Socio-demographic information relating to mothers' education level and employment status was also sought.

The presence of enamel defects on the first permanent molars of participating children was assessed progressively, as they erupted, during 2006–2008 by one examiner using the modified Developmental Defects of Enamel Index (DDE Index) (FDI Commission on Oral Health Research & Epidemiology, 1992). Children without erupted first permanent molars at an examination were recalled the following year. Examinations were undertaken before any treatment on the first permanent molars to overcome bias from treatment effects for teeth with enamel defects. Children were grouped into those with: no enamel defects, diffuse/diffuse plus hypoplastic enamel defects, demarcated/demarcated plus hypoplastic enamel defects, and pit defects (in this study the term "hypoplasia" is used where enamel was found to be missing). To determine the impact of hypoplastic defects on COHQoL, children were also grouped into those with no enamel defects; diffuse/demarcated defects; diffuse/demarcated defects with hypoplasia. The examiner was blind to the information from the baseline questionnaire. Also recorded were information on the caries status of the deciduous molars and canines using the WHO criteria and expressed as dmft (WHO, 1997), and the presence of any enamel defects on deciduous molars and canines, and permanent incisors (when present) using the DDE Index.

Parents of participating children were mailed a validated parental perception questionnaire, (PPQ), to be completed before attending for their child's examination, which elicited information on their perceptions of their child's oral health-related quality of life (Jokovic *et al.*, 2002; 2003). The PPQ elicits responses for overall oral health, overall wellbeing and four domains within oral health-related quality of life measures (symptoms, function, emotional and social domains). Items within domains used a scale with response options: never, 0; once or twice, 1; sometimes, 2; often, 3; very often, 4; and don't know, also 0. Scoring 0 for the *don't know* option has little or no effect on the validity of the scale and helps retain valuable information (Jokovic *et al.*, 2004; Marshman *et al.*, 2007). The overall rating on oral health was scored: excellent/very good, 0; good, 1; fair/poor, 2. The rating for overall wellbeing ranged was scored: not at all/very little, 0; some, 1; a lot/very much, 2. Each domain score was calculated by summing the responses to all the items within each domain and overall COHQoL was calculated by summing over all the domains. A family impact measure from the same instrument was also used and scored in the same

manner to assess the overall impact of the presence of enamel defects on first permanent molars and dmft on family life (Locker *et al.*, 2002). Low scores indicate higher oral health-related quality of life and low family impact. Parents who did not complete the mailed questionnaire were asked to complete the PPQ when the child presented for the clinical examination, and for children recalled because their first permanent molars had not erupted the questionnaire was repeated at each visit, and the responses from their last visit were used in the data analysis.

Sample size estimates were based on published data (Do and Spencer, 2007); parental report of COHQoL of children without enamel defects was estimated to be 11 (sd 12) and that it would be meaningful to detect a difference of 30% in COHQoL between those with and without enamel defects with at least 80% power at the 0.05 significance level. The estimated sample size was 416 children.

Ethical approval for the study was obtained from the University of Western Australia, Human Research Ethics Committee and the Director, Dental Health Services gave permission for the conduct of the study.

Summary measures of overall oral health, wellbeing ratings (%), domain scores within the PPQ, and the overall oral health-related quality of life score were calculated together with the family impact measure (mean, sd). Spearman's rank correlation analysis was undertaken to test the association between total COHQoL scores and individual domain scores with the overall oral health and wellbeing ratings. Bivariate analyses tested the association of various independent factors (dmft grouped into 0, 1-2, 3-4 and 5 or more; gender; mother's education; mother's employment; enamel defects on the first permanent molars; and enamel defects on the permanent incisors) with the overall oral health and wellbeing ratings and individual domain and total COHQoL scores. The Kruskal Wallis and Spearman rank correlations for continuous variables and chi square test for grouped variables were used. Multivariate analysis used multiple linear regression with total COHQoL as the dependent variable to determine the combined effects of independent variables. Ordered logistic regression using the proportional odds model determined the influential variables on overall ratings of oral health (3 groups) and overall well-being (3 groups). The child's gender, mother's education and mother's employment status were used as sociodemographic control variables. Statistical significance was set at 0.05. In the multiple linear regression backward elimination variable selection was used and model fit assessed using established model diagnostics. Purposeful variable selection was used in ordered logistic regression and adopted the outline of Hosmer and Lemeshow (2000) in model building, variable selection, assessment of model fit and interpretation

## Results

Of the eligible 1135 children, 634 (54%) agreed to participate. At follow up, 550 children (87% of participants) were clinically examined and 522 questionnaires were returned (95% questionnaire return rate). Not all the returned questionnaires were usable due to missing

**Table 1.** Frequency distribution of enamel defects by type of tooth and most severe defect at the individual level, n‡ (%\*)

<i>Tooth status</i>	<i>Tooth 16</i>		<i>Tooth 26</i>		<i>Tooth 36</i>		<i>Tooth 46</i>		<i>Person</i>	
Sound	220	(41)	194	(36)	250	(46)	242	(45)	151	(27)
Diffuse	250	(47)	260	(49)	223	(41)	226	(42)	249	(45)
Diffuse and hypoplastic	6	(1)	4	(1)	8	(1)	10	(2)	18	(3)
Demarcated	41	(8)	62	(12)	38	(7)	41	(8)	86	(16)
Demarc and hypoplastic	14	(3)	11	(2)	14	(3)	11	(2)	32	(6)
Pits	3	(1)	4	(1)	14	(3)	13	(2)	14	(3)
Total	534		535		547		543		550	

\* Percentages may not sum to 100 due to rounding.

‡Numbers differ from total persons for tooth type due to some teeth not yet erupted at examination.

**Table 2.** Spearman's rank correlations between overall oral health and overall wellbeing ratings and specific domains and total COHQoL

<i>Variables</i>	<i>Overall Oral Health</i>	<i>Overall wellbeing</i>
Oral symptoms	0.29*	0.31*
Functional limitations	0.18*	0.22*
Emotional wellbeing	0.20*	0.33*
Social wellbeing	0.23*	0.27*
Family impact	0.32*	0.32*
Total COHQoL	0.32*	0.34*
dmft	0.33*	0.04

\* p<0.001

information; five did not rate the overall oral health, 15 did not rate the wellbeing and 20 had some items missing in the other sections. There was no significant difference in any of the baseline values nor child's caries experience between those who returned a complete COHQoL and those that did not. Mean age of the child at the time of clinical examination was 7.2 years (sd 0.6). Most of the COHQoL questionnaires were completed by the child's mother and most parents rated their child's overall oral health as excellent/very good (51%), 36 % rating it good, and 13 % as fair/poor. A larger majority of parents rated their child's overall wellbeing as not at all/very little affected by their oral health condition while, 10% rated as "some", and 6% "a lot/very much" affected.

Table 1 shows the distribution of children with enamel defects on the first permanent molars; 6% of children had at least one first permanent molar with demarcated enamel defects and where enamel had broken down or missing. Mean dmft was 1.96, sd 2.62.

The Spearman rank correlations were all in the expected direction and all the domain scores and total COHQoL were related to the overall ratings, suggesting the measuring instrument has good construct validity (Table 2).

The mean scores for each domain, family impact score and total COHQoL score for each of the independent variables are shown in Table 3. Impacts were reported more frequently in the symptom and functional domain. Overall scores and scores within the domains were skewed and a high proportion scored zero (7% symptoms; 38% functional limitations, 59% emotional impacts, 67% social

impacts and 69% family impacts scored zero. There was no association between the presence of enamel defects either in the first permanent molars or in the permanent incisors and any of the quality of life domains, family impact score or the total COHQoL score. The family impact score and total COHQoL were associated with caries experience (Table 3).

Multiple linear regression modelling using total COHQoL score as a dependent variable and independent variables as reported in Table 3 is shown in Table 4. Increasing dmft increases the total COHQoL score (poorer oral health quality of life, p=0.04). Children whose mothers had a university qualification had better reported COHQoL (R<sup>2</sup>=0.02, p=0.04).

To test the effects of the independent factors on the overall oral health and overall wellbeing, two separate ordered logistic regressions were conducted. The model shows that dmft, and enamel defects on the incisors were all associated with the overall oral health rating (Table 5). Parents of children with increased dmft were more likely to report poorer oral health; and there was a gradient evident in the poorer overall oral health with higher levels of caries. Parents of children with 1–2 dmft were nearly twice as likely to report poorer overall oral health (good/fair/poor vs excellent/very good and good/excellent/very good vs fair/poor). Children with 3–4 and 5 or more dmft were five and six times as (OR 4.6 and 6.3, respectively) likely to have report poorer overall oral health. Also, the presence of demarcated defects on the incisors were associated with a lower likelihood of reported poorer overall oral health. The likelihood-ratio test of proportionality of odds across the overall oral health categories indicated proportionality of odds ratios.

None of the independent factors were of significance in ordered logistic model for overall wellbeing. Because there were few children in the category of a lot/very much overall wellbeing rating for the various dmft groups, the rating was collapsed into a binary variable (not at all/very little, 0, and some/a lot/very much, 1) and a logistic regression undertaken. There were no statistically significant variables in the standard logistic model. The findings of the modelling did not alter when the enamel defects were recoded into those without any enamel defects, with diffuse/demarcated defects, and diffuse / demarcated defects with hypoplasia for both overall oral health, and wellbeing.

**Table 3.** Mean domain scores and overall family impact and COHQoL scores for various factors

Variable (% in category)	Oral symptoms, mean (sd)	Functional limitations, mean (sd)	Emotional wellbeing, mean (sd)	Social wellbeing, mean (sd)	Family impact, mean (sd)	Total COHQoL <sup>#</sup> mean (sd)
Overall	4.2 (2.9)	2.4 (3.2)	1.3 (2.5)	1.0 (2.7)	1.3 (3.0)	10.2 (10.9)
<i>Gender</i>						
Boys (45)	4.0 (2.9)	2.4 (3.1)	1.1 (2.0)	0.9 (2.2)	1.1 (2.6)	10.7 (11.9)
Girls (55)	4.3 (2.9)	2.5 (3.4)	1.4 (2.7)	1.2 (3.0)	1.4 (3.3)	9.5 (9.6)
<i>Mother's employment</i>						
Fulltime (11)	3.6 (2.3)	2.4 (3.4)	0.9 (1.9)	0.6 (1.4)	1.1 (2.7)	8.7 (9.0)
Part-time (34)	4.3 (2.6)	2.3 (3.2)	1.4 (3.0)	1.3 (3.4)	1.4 (3.5)	10.7 (11.9)
Home duties (51)	4.3 (3.1)	2.5 (3.2)	1.3 (2.2)	1.1 (2.4)	1.2 (2.7)	10.3 (10.8)
Others (4)	3.8 (3.3)	3.0 (3.8)	0.9 (1.8)	0.2 (0.9)	1.0 (2.3)	8.9 (9.2)
<i>Mother's education</i>						
Highschool (50)	4.3 (3.0)	2.4 (3.2)	1.4 (2.3)	1.2 (2.8)	1.4 (3.1)	10.7 (11.1)
Technical College (31)	4.2 (2.7)	2.7 (3.4)	1.4 (3.3)	1.2 (3.3)	1.4 (3.6)	11.0 (12.9)
University (19)	3.8 (2.8)	2.1 (2.8)	0.9 (1.3)	0.4 (0.7)	0.8 (1.7)	8.1 (6.9)
<i>Enamel defects, molars</i>						
No defect (28)	4.4 (3.0)	2.6 (3.5)	1.6 (3.3)	1.3 (3.2)	1.4 (3.8)	11.2 (13.5)
Diffuse defect (47)	4.1 (2.9)	2.4 (3.3)	1.3 (2.2)	1.1 (2.9)	1.3 (2.9)	10.3 (10.9)
Diffuse+hypoplasia (3)	4.8 (3.3)	1.6 (2.5)	1.1 (2.1)	0.8 (1.3)	0.4 (0.7)	8.5 (7.3)
Demarcated defect (15)	4.0 (2.9)	2.3 (2.8)	1.1 (1.8)	0.8 (1.6)	1.5 (2.9)	9.5 (8.8)
Demarcated+hypoplasia (6)	4.3 (2.7)	2.5 (3.4)	0.8 (1.4)	0.8 (1.4)	0.8 (1.5)	8.9 (7.3)
<i>Enamel defects, incisors</i>						
No Defects (39)	4.6 (2.0)	2.3 (3.1)	1.2 (2.0)	1.0 (2.0)	1.2 (2.4)	10.4 (9.4)
Diffuse defects (45)	4.3 (2.9)	2.3 (2.9)	1.4 (3.2)	1.1 (3.0)	1.3 (3.7)	10.4 (12.0)
Demarcated defects (16)	3.6 (2.7)	2.0 (2.8)	0.8 (2.0)	0.8 (2.2)	0.8 (2.7)	7.8 (10.1)
<i>dmft grouped</i>						
0 dmft (54)	4.0 (2.7)	2.3 (3.2)	1.3 (2.7)	1.0 (3.0)	<b>0.8 (2.8)†</b>	<b>9.2 (11.1)*</b>
1-2 dmft (11)	3.5 (2.5)	3.1 (3.8)	0.9 (1.6)	1.0 (2.0)	1.6 (3.2)	10.2 (9.4)
3-4 dmft (14)	4.6 (3.0)	2.8 (2.9)	1.7 (2.4)	1.4 (2.3)	1.5 (2.6)	11.9 (9.7)
5+ dmft (21)	4.7 (3.2)	2.5 (3.3)	1.1 (2.3)	1.2 (2.9)	1.9 (3.2)	11.4 (12.1)

# Total includes family impact score; \* p<0.05; † p<0.001; (Kruskal-Wallis test) 0 dmft against other levels

**Table 4.** Multiple linear regression of total COHQoL score with caries experience, mother's education level and molar enamel defects

Variable	Unstandardised Coefficient	Standard Error	p value
dmft	0.41	0.19	<b>0.04</b>
<i>Mother's education</i>			
Highschool	Reference		
Technical college	0.6	1.2	0.63
University	-2.9	1.4	<b>0.04</b>
<i>Enamel Defects</i>			
Sound	Reference		
Diffuse defects	-0.96	1.2	0.43
Demarcated defects	-2.2	1.5	0.14

**Table 5.** Ordered logistic regression on overall oral health rating grouped into: 0, excellent/very good; 1, good; and 2, fair/poor

Variables	Odds ratio	95% confidence interval	p value
<i>dmft grouped</i>			
0	1		
1 – 2	1.7	0.7 – 3.9	0.22
3 – 4	4.6	1.7 – 10.5	<b>&lt;0.01</b>
5 or more	6.3	2.9 – 15.0	<b>&lt;0.01</b>
<i>Enamel defects molars</i>			
Sound	1		
Diffuse defect	1.1	0.6 – 2.3	0.73
Demarcated defect	1.1	0.5 – 2.5	0.73
<i>Mother's education</i>			
High school	1		
Technical college	0.6	0.3 – 1.1	0.09
University	0.6	0.3 – 1.2	0.16
<i>Enamel defects incisors</i>			
No defect	1		
Diffuse defect	1.0	0.5 – 1.8	0.93
Demarcated defect	0.3	0.1 – 0.7	<b>&lt;0.01</b>

## Discussion

For young children, parents have been used as proxy informants for their child's oral health-related quality of life in a number of studies but some concerns have been expressed as to whether parents adequately reflect the child's perception (Barbosa and Gavião, 2008; Jokovic *et al.*, 2004). However, these authors none-the-less deemed that this parental reporting provides valuable information and should not be discounted. This study used parents as proxy reporters because no validated survey instrument was available at the time to elicit the child's responses for the age group in this study.

The response rate was deemed acceptable as 56% of the eligible study population agreed to participate, of which 87% provided clinical information (48% of eligible population) and 95% of those examined provided information on the COHQoL (46% of the eligible population). Whilst this level of participation is less than desirable it was deemed unlikely to have biased the findings of the study because the findings relate to occurrence of enamel defects in the first permanent molars, and these teeth were unerupted at the time of recruitment, avoiding non-participation bias. The completion of the questionnaire by 95% of those successfully followed for their clinical examination (87%) was deemed an acceptable response rate. Furthermore, the primary tooth caries experience of participating children were similar to the primary tooth caries experience of 7-year-old children seen by SDS in Western Australia in 2007 (1.96 vs 1.91: M Glick, Acting Director, Dental Health Service, personal communication).

This study confirms the construct validity and supports the discriminant validity of the PPQ among this study population and supports its usefulness among a general child dental population. The Spearman correlations in this study were in the expected direction, were significant and were similar to those reported in evaluation of the COHQoL instrument in a South Australian general child population, and a UK evaluation of the PPQ (Do and Spencer, 2008; Marshman *et al.*, 2007). The overall oral health ratings varied with caries experience in the expected directions.

None of the statistical tests of association between the presence of enamel defects on the first permanent molars and parental ratings of overall oral health or wellbeing or individual domain and overall COHQoL scores were significant. This differs from other studies, which have reported adverse oral consequences for children with severe enamel defects of the first permanent molars (Jälevik and Klingberg, 2002; Mejäre *et al.*, 2005). It is possible that the number of children with severe defects in this study was not sufficient to detect a difference in their parentally reported COHQoL. Although it is more likely that because of the young age of the children in this study they have not experienced the long-term consequences of first permanent molars with enamel defects (none of the first permanent molars have been restored or extracted) and the differences in quality of life might be more evident among older children.

The presence of enamel defects on the permanent incisors was found to be statistically significant for the overall oral health rating in the ordered logistic regression analysis. Parents of children with demarcated defects were

more likely to report their child's oral health rating as excellent/very good. This finding is somewhat similar to that reported by Do and Spencer (2007) where children with mild levels of fluorosis were rated by their parents as having better oral health-related quality of life than for children without any fluorosis. Whereas the findings of the study by Do and Spencer may be explained by the association between fluorosis and dental caries; a reduction in dental caries being more highly valued by parents than the mild aesthetic impact of fluorosis. The reason for the association with demarcated enamel defects in this study is less clear. Therefore, the finding in this study of the association between better COHQoL score and presence of demarcated enamel defects on incisors need to be treated with caution because many children in this study did not have their incisors erupted at the time of the clinical examination when parents would be unaware of any defects.

This study's finding of the association of enamel defects on permanent incisors and COHQoL differs from the evaluation study of Marshman *et al.* (2007), where no such association was found between the presence of opacities and COHQoL scores and the domain scores. The differences in findings suggest that further research is needed to determine whether the PPQ, reporting COHQoL by parents, is sensitive enough to differentiate the oral health effects of different levels of enamel defects.

The children's dmft, used as a controlling variable to test the validity of using the instrument to measure child oral health-related quality of life in this population, was associated with COHQoL. Family impact score and the total COHQoL score were statistically significantly related to dmft (Table 3). This finding is of interest and contrasts with the lack of association reported from South Australia and the UK (Do and Spencer, 2007; Marshman *et al.*, 2007). Those Australian children were older, and would have been in receipt of continual care from their School Dental Service and the effects of caries may have been mitigated over time, and the UK study compared the permanent tooth caries experience only. These differences may explain the observed differences in findings. Further, the study by Do and Spencer (2007) reported findings similar to the present study in the parent's rating of the overall oral health with respect to the child's caries experience; higher caries experience was associated with poorer overall oral health rating.

Caries experience was associated with the family impact score. The children in this study are relatively young and their exposure to dental care is relatively recent and the associated impact on the family of the child's oral health status and the processes involved in receipt of care may be more readily recalled and reported by the parents of children in this age group. Also younger children, being more dependent, are more likely to report the effect of their oral health conditions (symptoms and function) to their parents.

Children with university-educated mothers were rated with better COHQoL than the children of high school educated mothers (Table 4) though no significant relationship was found with overall oral health rating (Table 5). The effect of sociodemographic factors on COHQoL has also been reported with a greater proportion of parents in low deprivation category reported improvements in the

family impact scale after their child had dental treatment under general anaesthesia (Malden *et al.*, 2008).

The findings in this study further confirm the usefulness of the PPQ in assessing the oral health-related quality of life among children. There was an association between parental report of family impact, total COHQoL and overall oral health rating with the child's dmft. There was no association between COHQoL and overall oral health and wellbeing ratings with the presence of enamel defects on the first permanent molars. Further research in a longitudinal setting could test this finding. The findings in this study also highlight the need to consider socio-demographic factors in any oral health-related quality of life assessments.

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### References

- Arrow, P. (2008): Prevalence of developmental enamel defects of the first permanent molars among school children in Western Australia. *Australian Dental Journal* **53**, 250-259.
- Barbosa, T.S. and Gaviao, M.B. (2008): Oral health-related quality of life in children: part III. Is there agreement between parents in rating their children's oral health-related quality of life? A systematic review. *International Journal of Dental Hygiene* **6**, 108-113.
- Do, L. and Spencer, A. (2007): Oral health-related quality of life of children by dental caries and fluorosis experience. *Journal of Public Health Dentistry* **67**, 132-139.
- Do, L.G. and Spencer, A.J. (2008): Evaluation of oral health-related quality of life questionnaires in a general child population. *Community Dental Health* **25**, 205-210.
- FDI Commission on Oral Health Research & Epidemiology (1992): A review of the developmental defects of enamel index (DDE Index). *International Dental Journal* **42**, 411-426.
- Gherunpong, S., Tsakos, G. and Sheiham, A. (2004a): Developing and evaluating an oral health-related quality of life index for children; the CHILDOIDP. *Community Dental Health* **21**, 161-169.
- Gherunpong, S., Tsakos, G. and Sheiham, A. (2004b): The prevalence and severity of oral impacts on daily performances in Thai primary school children. *Health and Quality of Life Outcomes* **2**, 57.
- Hosmer, D. and Lemeshow, S. (2000): *Applied logistic regression*. New York, John Wiley & Sons.
- Jälevik, B. and Klingberg, G. (2002): Dental treatment, dental fear and behaviour management problems in children with severe enamel hypomineralization of their permanent first molars. *International Journal of Paediatric Dentistry* **12**, 24-32.
- Jokovic, A., Locker, D. and Guyatt, G. (2004): How well do parents know their children? Implications for proxy reporting of child health-related quality of life. *Quality of Life Research* **13**, 1297-1307.
- Jokovic, A., Locker, D., Stephens, M., Kenny, D., Tompson, B. and Guyatt, G. (2002): Validity and reliability of a questionnaire for measuring child oral-health-related quality of life. *Journal of Dental Research* **81**, 459-463.
- Jokovic, A., Locker, D., Stephens, M., Kenny, D., Tompson, B. and Guyatt, G. (2003): Measuring parental perceptions of child oral health-related quality of life. *Journal of Public Health Dentistry* **63**, 67-72.
- Kotsanos, N., Kaklamanos, E.G. and Arapostathis, K. (2005): Treatment management of first permanent molars in children with Molar-Incisor Hypomineralisation. *European Journal of Paediatric Dentistry* **6**, 179-184.
- Leppäniemi, A., Lukinmaa, P.-L. and Alaluusua, S. (2001): Nonfluoride hypomineralizations in the permanent first molars and their impact on the treatment need. *Caries Research* **35**, 36-40.
- Levy, S., Warren, J., Broffitt, B. and Nielsen, B. (2005): Factors associated with parents' esthetic perceptions of children's mixed dentition fluorosis and demarcated opacities. *Pediatric Dentistry* **27**, 486-492.
- Locker, D., Jokovic, A., Stephens, M., Kenny, D., Tompson, B. and Guyatt, G. (2002): Family impact of child oral and oro-facial conditions. *Community Dentistry and Oral Epidemiology* **30**, 438-448.
- Malden, P., Thomson, W., Jokovic, A. and Locker, D. (2008): Changes in parent-assessed oral health-related quality of life among young children following dental treatment under general anaesthetic. *Community Dentistry and Oral Epidemiology* **36**, 108-117.
- Marshman, Z., Rodd, H., Stern, M., Mitchell, C. and Robinson, P.G. (2007): Evaluation of the Parental Perceptions Questionnaire, a component of the COHQoL, for use in the UK. *Community Dental Health* **24**, 198-204.
- McGrath, C., Broder, H. and Wilson-Genderson, M. (2004): assessing the impact of oral health on the life quality of children: implications for research and practice. *Community Dentistry and Oral Epidemiology* **32**, 81-85.
- Mejäre, I., Bergman, E. and Grindeffjord, M. (2005): Hypomineralized molars and incisors of unknown origin: treatment outcome at age 18 years. *International Journal of Paediatric Dentistry* **15**, 20-28.
- Riordan, P. (1993): Perceptions of dental fluorosis. *Journal of Dental Research* **72**, 1268-1274.
- Sigurjons, H., Cochran, J.A., Ketley, C.E., Holbrook, W.P., Lennon, M.A. and O'Mullane, D.M. (2004): Parental perception of fluorosis among 8-year-old children living in three communities in Iceland, Ireland and England. *Community Dentistry and Oral Epidemiology* **32**, 34-38.
- Weerheijm, K. and Mejäre, I. (2003): Molar incisor hypomineralization: a questionnaire inventory of its occurrence in member countries of the European Academy of Paediatric Dentistry (EAPD). *International Journal of Paediatric Dentistry* **13**, 411-416.
- World Health Organization (1997): *Oral health surveys - basic methods*. Geneva: WHO.