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Sociodemographic and Clinical Factors That Influence Oral Health-Related Quality of Life in Adolescents: a Cohort Study

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Objective: To determine the sociodemographic and clinical factors that may influence oral health-related quality of life (OHRQoL) at ages 12 to 15. ***Basic research design***: Cohort study. ***Participants***: Cluster-randomized sample of Hong Kong 12-year-olds. ***Main outcome measures***: The Child Perceptions Questionnaire (CPQ_{11-14}) was used to measure OHRQoL as the response variable. Periodontal status and caries were examined according to WHO criteria. Malocclusion was assessed using Dental Aesthetic Index. Potential predictors of OHRQoL (age, gender, father's education, mother's education, household income, periodontal status, caries, and malocclusion) were analyzed by structural equation modelling. ***Results***: At age 12, 589 participants (305 females, 284 males) were included. At age 15, 331 (172 females and 159 males) were followed up. For direct effects, age 15 was associated with higher oral symptoms (OS) scores (β=0.124, 95%CI=0.049 to 0.2) but lower emotional well-being (EWB) scores (β=-0.105, 95%CI=-0.184 to -0.03). Males had higher OS scores than females (β=0.126, 95%CI=0.059 to 0.208). Mother's education had positive effects on children's EWB (β=-0.096, 95%CI=-0.159 to -0.018). Malocclusion had negative effects on functional limitations (FL) (β=0.083, 95%CI=0.013 to 0.186). For indirect effect, mother's education showed a link via EWB to OHRQoL (β=-0.077, 95%CI=-0.123 to -0.018). Malocclusion showed a link via FL to OHRQoL (β=0.037, 95%CI=0.006 to 0.087). ***Conclusions***: Age, gender, mother's education and malocclusion predicted OHRQoL at ages 12 and 15.

Keywords*: adolescents, oral health-related quality of life*

Introduction

Oral health-related quality of life (OHRQoL), "*the impact of oral disease and disorders on aspects of everyday life that a patient or person values, that are of sufficient magnitude, in terms of frequency, severity or duration to affect their experience and perception of their life overall*" (Locker and Allen, 2007), is increasingly recognised as an important outcome to complement clinical measures of oral health.

Earlier studies have used the Wilson and Cleary model to investigate determinants of OHRQoL (Baker *et al.*, 2010; Gururatana *et al.*, 2014; Nammontri *et al.*, 2012; Wilson and Cleary, 1995). The model has five levels: biological and physiological variables, symptom status, functional status, general health perceptions, and overall quality of life. Oral diseases belong to the first level, which may cause symptoms that might limit functions of eating, communication, appearance, and lead to embarrassment, social problems and low self-esteem (Slade *et al.*, 1996). These relationships may be influenced by environmental characteristics. For example, individuals of higher socio-economic status (i.e. income, education or occupation) status tended to have more positive views of their oral health (Locker, 1992). Baker et al. (2010) reported higher family income was associated with better quality of life. However, Foster Page et al. (2013) found sociodemographic characteristics explained only a small proportion of the variance in OHRQoL. The model also suggested individual characteristics could influence subjects' quality of life. For example, Ashari and Mohamed (2015) reported younger people (12-19 years) tended to have worse OHRQoL than those aged 20-35 years, Locker (1992) found that females were more likely to report problems of dental pain, communication and chewing, whereas Siluvai et al. (2015) found that males had greater impacts of oral conditions than females.

In summary, oral diseases, as well as environmental and individual characteristics may impact on OHRQoL (Slade, 1997; Wilson and Cleary, 1995), but the nature of these relationships is unclear and much research has been cross-sectional. Therefore, the aim of this longitudinal study was to determine the sociodemographic and clinical factors that may influence OHRQoL. Participants were 12-year-olds randomly selected from secondary schools in Hong Kong.

Methods

Ethical approval for this study was granted by the Institutional Review Board of the University of Hong Kong/ Hospital Authority Hong Kong West Cluster (UW 09-453).

Cluster randomized sampling framed all local secondary schools in Hong Kong. Random numbers were generated by the Excel procedure of "RANDBETWEEN". A random sample of 45 of 465 schools (approximately 10% of all local secondary schools) in 18 districts in Hong Kong, SAR, was selected. Children were then selected from the birth cohort of "children of 1997" (Schooling *et al.*, 2011). Students born between April 1st and May 31st, 1997 were

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invited to participate in an oral health survey conducted by Faculty of Dentistry, the University of Hong Kong in 2010 and 2013. An invitation letter and patient information sheet were first sent to the parents/primary caregivers. Written consent from parents/primary caregivers, as well as a verbal consent from students, were obtained before oral examination. Participants were excluded if they were systemically unhealthy, had orthodontic treatment history, or had oral diseases other than caries, periodontitis and malocclusion. The sample size was calculated based on a previous study in Hong Kong (Lau, 2008). Assuming a difference of the Mean (SD) of Oral Symptoms score of the Child Perceptions Questionnaire (CPQ_{11-14}-ISF: 8) between ages 12 and 15 as 0.165 (0.903), $\alpha = 0.05$, a sample size of 315 would yield a power of $1-\beta = 0.9$. With a loss rate of 30% anticipated, an incept sample of at least 450 12-year-olds was required.

The Child Perceptions Questionnaire (CPQ_{11-14}) has demonstrated validity and reliability to measure OHRQoL in children aged 11 to 14 years old (Jokovic *et al.*, 2002). The questionnaire consists of four domains, namely oral symptoms (OS, 6 items), functional limitations (FL, 9 items), emotional well-being (EWB, 9 items) and social well-being (SWB, 13 items). Each item has a 5-point response format ranging from 0 to 4. The item scores of each domain are added together to obtain a domain score, and the scores of four domains are summed for a total CPQ_{11-14} score. Higher scores represent poorer OHRQoL. To facilitate its use in clinical settings and population-based surveys, CPQ_{11-14} has been shortened to 16 and 8 items by item impact and stepwise regression methods. We used the 8 item CPQ_{11-14} (CPQ_{11-14}-ISF: 8) for the participants at age 12 and age 15 (Lau, 2008; McGrath *et al.*, 2008).

The Community Periodontal Index (CPI) and the Decayed, Missing and Filled Teeth (DMFT) indices were used to measure periodontal status and dental caries and treatment experience according to WHO (1997) criteria. The Dental Aesthetic Index (DAI) was used to assess orthodontic treatment need, with scores categorized into 4 scales of orthodontic severity and treatment need (≤ 25, normal or minor malocclusion-no treatment need or slight need; 26-30, definite malocclusion-treatment selective; 31-35: severe malocclusion-treatment highly desirable; ≥ 36: very severe (handicapping) malocclusion-treatment mandatory) (Jenny and Cons, 1996).

Systemic health information, dental treatment history, parents' education (Primary school graduate or below, Secondary school graduate or below, College graduate or above), and household income (Below HK$10,000, HK$10,001-HK$20,000, HK$20,001-HK$30,000, HK$30,001-HK$40,000, Over HK$40,001) were collected using a self-complete questionnaire. Participants' oral health status was examined using an intra-oral disposable mouth mirror with a built-in LED light source (MirrorLite, Germany). The same trained and calibrated examiner performed the oral examinations. Dental impressions were made, and the plaster models were sent to OrthoLab (Poland) to make digital models. The same examiner used Software O3DM (version3.8.5 (c)) to analyze the models. Reassessments were performed among 10% randomly selected samples 2 weeks after the first assessment to test intra-examiner's reliability.

Intra-examiner reliability was tested by kappa values for CPI, and Intra-class correlation coefficient (ICC) for DMFT and DAI. Missing data were filled with the mode of the item data. Longitudinal changes in participants' conditions were first assessed by Wilcoxon signed ranks test (two-related-samples tests). Structural equation modelling (SEM) determined whether the Wilson and Cleary model was an acceptable fit to the data (IBM SPSS Amos 26.0, maximum likelihood estimation). Mediation was tested by the significance of indirect effects using bias-corrected bootstrap confidence intervals (MacKinnon *et al.*, 2002). Model fit was evaluated by four indices recommended in the literature: chi-square/degrees of freedom (CMIN/DF), root-mean-squared error of approximation (RMSEA), comparative fit index (CFI), and standardized root-mean-squared residual (SRMR). A non-significant chi-square, a CMIN/DF ratio<3.0, RMSEA≤ 0.05, CFI of 0.9 or above and an SRMR<0.08 were taken as acceptable model fit (Hu and Bentler, 1999).

Results

At age 12, 668 students agreed to participate, of whom 589 (305 females, 284 males) were eligible to take part. Of the 79 excluded, 46 were systemically unwell, 21 had a history of orthodontic treatment or tooth trauma and 12 declined an oral impression. At age 15, 331 (172 females and 159 males) participants were followed up. The response rate at age 12 and 15 was 100% and 56.2%, respectively.

Data were missing for some questions about family information and CPQ_{11-14}. At age 12, 25 participants had missing data for one or two questions, which were imputed with the modal response for each item. At age 15, 30 participants had missing data. If the missing data were available at age 12, they were imputed with the item data at age 12. Only 3 participants had missing data in one or two questions, which were imputed with the item mode at age 15.

Kappa values for CPI in 2010 and 2013 were 0.740 and 0.789 respectively. ICCs for DMFT in 2010 and 2013 were 0.990 and 0.991, respectively. ICC for the DAI scores was 0.821.

Table 1 describes characteristics of the participants at age 12 and 15. Parents' educational attainment and household income increased in the interim. However, only father's education and household income increased significantly. The CPQ total score was similar at 12 and 15 years. At age 12, DMFT scores ranged between 0 and 7, and CPI scores ranged between 0 and 2. At age 15, DMFT scores ranged between 0 and 13, and CPI scores ranged between 0 and 2. The prevalence of oral diseases increased over time ($p<0.001$ for periodontal status, caries and malocclusion). Unhealthy periodontal conditions, i.e. bleeding and calculus, were more prevalent than dental cariesS (84.89% vs. 30.82% at 12 years, and 93.05% vs. 55.59% at 15).

SEM was performed on the data for 331 participants that were followed from age 12 to 15. To create a parsimonious model, at first all influence factors were modelled as predictor variables. The four domain scores, OS, FL, EWB and SWB, were modelled as response variables in separate models. Predictor variables were selected for

Table 1. Characteristics of 331 participants at 12 and 15 years.

	12 years	*15 years*	*P*
	%	*%*	
Father's education			
Primary school graduate or below	16.31	16.31	
Secondary school graduate or below	66.47	64.95	0.025*
College graduate or above	17.22	18.73	
Mother's education			
Primary school graduate or below	15.71	15.71	
Secondary school graduate or below	73.11	72.21	0.083
College graduate or above	11.18	12.08	
Household income			
Below HK$10,000	24.17	12.99	
HK$10,001-HK$20,000	35.95	41.69	
HK$20,001-HK$30,000	18.43	16.92	0.000**
HK$30,001-HK$40,000	9.06	11.18	
Over HK$40,001	12.39	17.22	
Periodontal status			
CPI score=0	15.11	6.95	0.000**
CPI score>0	84.89	93.05	
Caries experience			
DMFT=0	69.18	44.41	0.000**
DMFT>0	30.82	55.59	
DAI code			
Normal or minor malocclusion-no treatment need or slight need	54.98	42.30	
Definite malocclusion-treatment selective	26.89	30.21	
Severe malocclusion-treatment highly desirable	12.39	18.13	0.000**
Very severe (handicapping) malocclusion-treatment mandatory	5.74	9.37	
	Mean (SD)	**Mean (SD)**	
DMFT	0.52 (0.929)	1.79 (2.401)	0.000**
CPQ total score	7.27(3.625)	7.25(3.716)	0.818

DAI: Dental aesthetic index; CPI: Community Periodontal Index; DMFT: Decayed, Missing and Filled Teeth; CPQ: Child perception questionnaire ($CPQ_{11\text{-}14}$-ISF: 8).
Nonparametric Test-Wilcoxon (Two-Related-Samples Tests); *: P<0.05; **: P≤ 0.01.

the final model if the p value for the regression weight was below 0.1. The path diagram of the final model is presented in Figures 1 and 2. The fit indices were CMIN/DF=1.433 (p=0.100), RMSEA=0.026 (90% CIs 0.000-0.046), CFI=0.996, and SRMR=0.0278.

Direct and indirect effects on OHRQoL are presented in Table 2. For direct effects, age predicted OS and EWB scores (β=0.124, 95%CI=0.049 to 0.2 and β=-0.105, 95%CI=-0.184 to -0.03 respectively). Children at age 15 were likely to have more oral symptoms but better emotional well-being than they were at age 12. Males were likely to have more oral symptoms than females. (β=0.126, 95%CI=0.059 to 0.208). Higher maternal education was associated with better emotional well-being in their children (β=-0.096, 95%CI=-0.159 to -0.018). More severe malocclusion predicted more functional limitations (β=0.083, 95%CI=0.013 to 0.186). Indirect effects included mothers with higher education predicting better emotional well-being in their children, which in turn led to better OHRQoL (β=-0.077, 95%CI=-0.123 to -0.018). Higher level of malocclusion predicted more functional limitations, hence worse OHRQoL (β=0.037, 95%CI=0.006 to 0.087).

Discussion

This longitudinal study identified demographic and clinical predictors of OHRQoL in Hong Kong. Participants were randomly selected at age 12 and followed for three years. At age 15, participants had worse oral symptoms but better emotional well-being. Males were more likely to have oral symptoms. Mothers' education had a positive effect on participants' OHRQoL, while malocclusion had a negative effect.

Among sociodemographic factors, age, gender and mother's education predicted children's OHRQoL. Other cohort studies have also associated demographic factors with quality of life. For example, Baker et al., (2010) found higher family income directly predicted better quality of life. Likewise, Gururatana et al., (2014) found that socioeconomic status (i.e. family income and parental education) both directly and indirectly predicted better OHRQoL.

The structure of children's health cognitions is age-dependent because of their continuous cognitive, emotional, social, and language development (Jokovic *et al.*, 2002). Siluvai et al. (2015) reported that the OHRQoL of 13-14 year olds was more likely to be impacted than their counterparts of 15-17 years. In our study, participants at age 15 tended to have more oral symptom but better emotional well-being than they were at age 12.

Findings of gender differences in OHRQoL are inconsistent in the literature. Females have been reported to have worse, similar or better OHRQoL than males (de Paula *et al.*, 2013; Piovesan *et al.*, 2010; Siluvai *et al.*, 2015; (Clijmans *et al.*, 2015). An international study found gender differences in oral health satisfaction to vary across countries (Arnljot *et al.*, 1985).

Mothers are usually the main caregivers of their children. Many studies associate the mother's situation with their children's physical and mental health (Murray and Cooper, 1997; Sun, 2020). In our study, mother's education level was associated with children's OHRQoL. Father's education had the same tendency, with higher

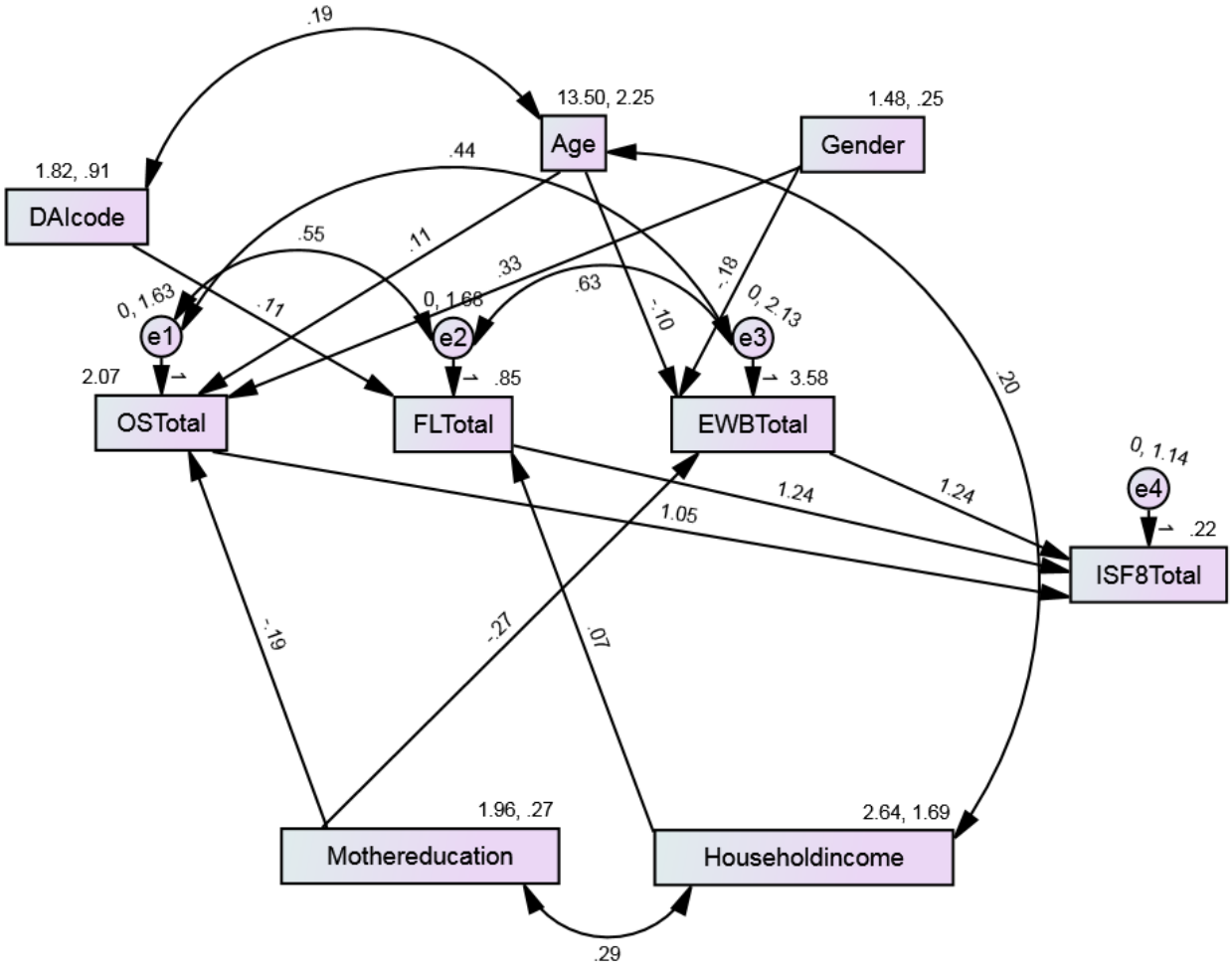

Figure 1. Path diagram of unstandardized estimates. DAI: Dental aesthetic index; OS: oral symptoms domain; FL: functional limitations domain, EWB: emotional well-being domain; CPQ: Child perception questionnaire.

education level associated with lower CPQ scores (i.e. better OHRQoL) of their children but this relationship did not reach significance. A study from Brazil also found that mother's education and family income had strong positive impacts on all domains of CPQ_{11-14} at age 12 (de Paula *et al.*, 2013); while Canadian data showed that household income, but not mother's education, had a positive effect on CPQ scores in 11-14 year olds (Locker, 2007). A possible explanation for the different findings is that the nature and magnitude of impacts of various factors could vary with different cultural backgrounds (Allison *et al.*, 1999).

A negative effect of unhealthy periodontal conditions on OHRQoL has been reported (de Paula *et al.*, 2013; Slade *et al.*, 1996). Although our participants with unhealthy periodontal conditions tended to have higher CPQ scores, the result was not statistically significant. Only bleeding and calculus were detected in our participants, which may not be sufficiently severe to hazard OHRQoL.

We found no effect of caries on OHRQoL. Some studies are consistent with this finding (de Paula *et al.*, 2013; Locker, 2007), whereas others are not (Baker *et al.*, 2010; Piovesan *et al.*, 2010). This may be because the epidemiology and treatment conditions of caries differ between regions. Hong Kong has had fluoridated water from 1961, with a current level of 0.5 ppm. The mean DMFT score dropped from 0.8 in 2001 to 0.3 in 2012 (Zhang *et al.*, 2014). In addition, basic and preventive dental care is provided to almost all primary school children. These strategies generally decrease the prevalence of untreated caries, and hence reduce its impact on OHRQoL. It is worth noting that caries was positively correlated with CPQ scores in the original CPQ_{11-14} validation (Jokovic *et al.*, 2002). This may be because participants of the study were recruited from a dental hospital and had severe caries.

More severe malocclusion predicted greater functional limitation. This meant that they were more likely to report problems when they had tough, hot or cold food. This finding is consistent with other studies. For example, English et al. (2009) reported that the ability to chew fresh carrots or celery and firm meat varied between malocclusion groups, with class III participants reporting the greatest difficulty, followed by Class II, Class I, and those with normal occlusions. Malocclusion could be a risk factor for occlusal trauma and temporomandibular disorders (TMD) (Clark, 1991; Geiger, 2001). After the treatment of severe malocclusion, significant improvements were found in facial pain, symptoms of TMD, and OHRQoL (Silvola *et al.*, 2016).

Although this longitudinal study contributed to the understanding of OHRQoL, it has limitations. Whilst other studies report psychological well-being as a significant mediator of young people's OHRQoL (Baker *et al.*, 2010;

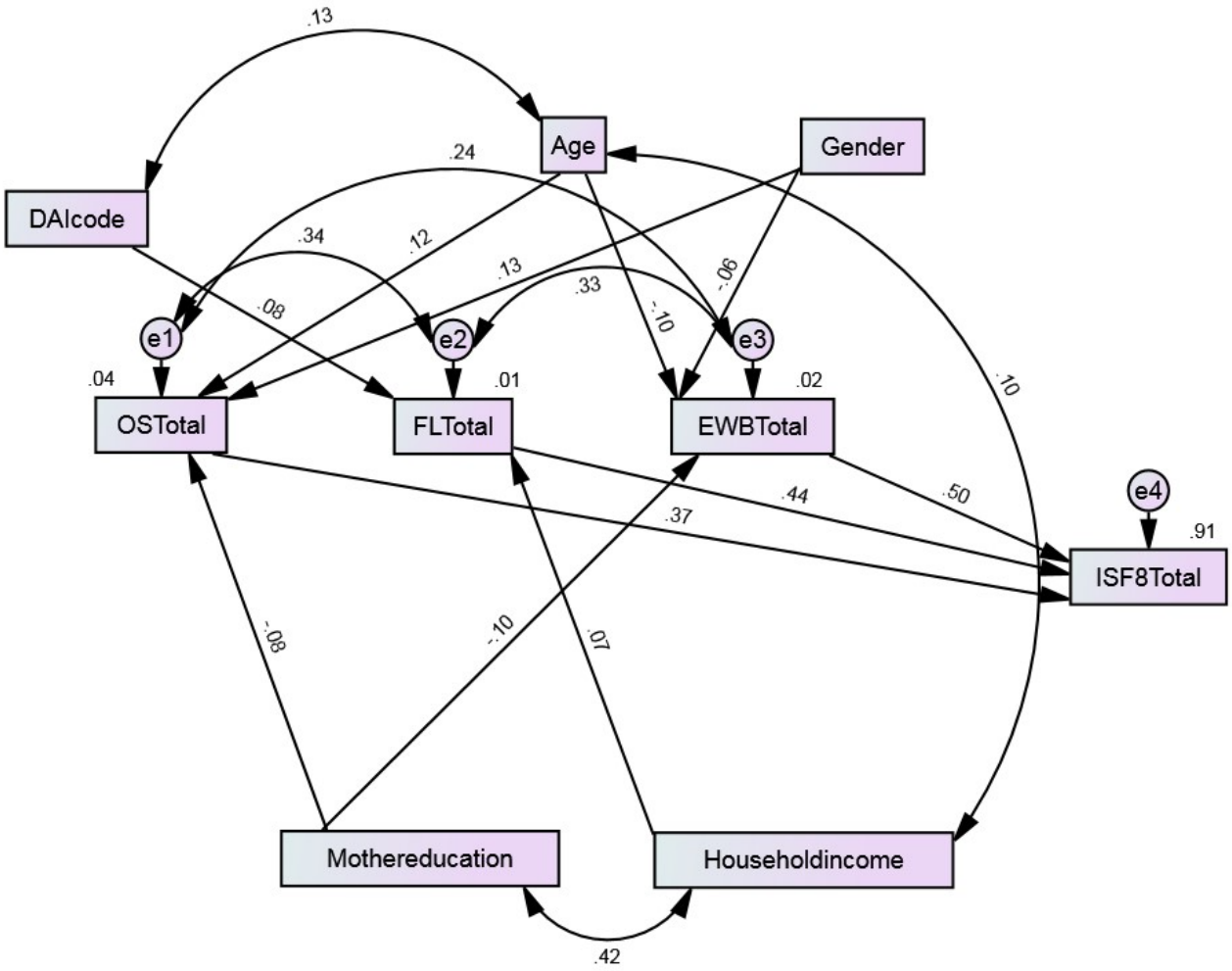

Figure 2. Path diagram of standardized estimates. DAI: Dental aesthetic index; OS: oral symptoms domain; FL: functional limitations domain, EWB: emotional well-being domain; CPQ: Child perception questionnaire.

Table 2. Significant direct and indirect effects for the final model.

	β	*Bootstrap SE*	*Bias-corrected 95%CI*	*% of total effect*
Direct effect				
Age - OS score	0.124	0.039	0.049/0.2**	100
Age - EWB score	-0.105	0.038	-0.184/-0.03*	100
Gender - OS score	0.126	0.036	0.059/0.208**	100
Gender - EWB score	-0.061	0.033	-0.124/0.01	100
Mother's education - OS score	-0.077	0.037	-0.141/0.014	100
Mother's education - EWB score	-0.096	0.037	-0.159/-0.018*	100
Household income - FL score	0.066	0.036	-0.005/0.13	100
DAI code - FL score	0.083	0.042	0.013/0.186*	100
Indirect effect				
Age - CPQ total score	-0.007	0.024	-0.061/0.037	100
Gender - CPQ total score	0.016	0.023	-0.03/0.067	100
Mother's education - CPQ total score	-0.077	0.025	-0.123/-0.018*	100
Household income - CPQ total score	0.029	0.016	-0.001/0.059	100
DAI code - CPQ total score	0.037	0.019	0.006/0.087*	100

*p<0.05, **≤0.01. β: bootstrapped standardized estimate; SE: standard error; CI: confidence interval; OS: oral symptoms domain; FL: functional limitations domain, EWB: emotional well-being domain; DAI: Dental aesthetic index; CPQ: Child perception questionnaire (CPQ_{11-14}-ISF:8).

Gururatana *et al.*, 2014; Nammontri *et al.*, 2012), it was not assessed in this study. In addition, participants were recruited only from Hong Kong. The findings may not be generalizable to other countries because of differences in geographical, cultural, and economical factors.

In conclusion, this longitudinal study investigated factors that may influence OHRQoL. The degree of malocclusion, periodontal status and caries experience worsened from age 12 to 15. Participants reported more oral symptoms at age 15, but their emotional well-being became better. Males reported more oral symptoms than females. Better maternal education led to better OHRQoL in children. More severe malocclusion resulted in worse OHRQoL. These results may help clinical practitioners to understand patients' OHRQoL at age 12 and age 15.

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