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Sociodemographic differences in oral health-related quality of life related to dental caries in Thai school children

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Objective: This study aimed to assess associations between sociodemographic and oral health behavioural factors with dental caries and oral health-related quality of life (OHRQoL) attributed to dental caries in a national representative sample of 12- and 15-year-old Thai children. ***Method***: A representative subsample from the sixth Thailand National Oral Health Survey, 1,063 12-year-olds and 811 15-year-olds, completed a questionnaire on sociodemographic and behavioural information and were orally examined and interviewed about OHRQoL using the Child-OIDP or OIDP indexes. Associations of sociodemographic and behavioural factors with DMFT and Condition-Specific impacts (CS-impacts) attributed to dental caries were investigated using Chi-square tests and regressions. ***Results***: For both groups, DMFT scores were associated with gender, geographic area and recently receiving dental treatment. Geographic area was the only sociobehavioural factor independently associated with CS-impacts. Dental caries accounted for the significant associations of sugary snacks and drinks consumption with CS-impacts. Significant associations of CS-impacts with consuming crispy snacks in 12-year-olds and fizzy drinks in 15-year-olds became non-significant when DT was entered into models. ***Conclusions***: There were considerable geographic differences in DMFT and CS-impacts attributed to dental caries among Thai children.

Key words: *adolescents, children, dental caries, oral health behaviour, quality of life, sociodemographic*

Introduction

Although levels of dental caries have decreased globally during the past decades, caries is still highly prevalent and a major cause of oral pain, and impacts on the quality of life of children in numerous countries (Casamassimo *et al*., 2009; Krisdapong *et al*., 2009). Many children have untreated dental decay that causes toothache and impacts on daily life activities such as eating, sleeping, studying and emotional stability (Krisdapong *et al*., 2009; Lewis and Stout, 2010). The levels of untreated caries and toothache vary by sociodemographic and oral health behavioural factors (Goes *et al*., 2007; Lewis and Stout, 2010). Yet, variations in oral health-related quality of life (OHRQoL) as the consequence of dental caries status by sociodemographic and oral health behavioural factors have not been extensively explored in school-aged populations. Nurelhuda *et al*. (2010) reported no differences in levels of OHRQoL between sociodemographically different areas within a state in Sudanese schoolchildren. Findings for other sociodemographic and oral health behavioural factors were inconclusive. The prevalence of impacts on school-aged children's quality of life differed by gender but not by school type and urban dwelling, while findings in relation to oral health behaviours such as dental visits, sugary drink consumption and tooth brushing habit varied (Castro *et al*., 2011; Mbawalla *et al*., 2010; Nurelhuda *et al*, 2010; Piovesan *et al*., 2010).

The small number of studies on associations between OHRQoL and sociodemographic and oral health behavioural factors all used generic OHRQoL measures which reflect impacts on quality of life due to overall oral diseases and not to specific conditions, such as caries. No study assessed OHRQoL related specifically to dental caries and investigated the association of specific OHRQoL with sociodemographic and oral health behavioural factors. Moreover, although sociodemographic variations in dental caries levels at a national level are known and many countries have included OHRQoL assessment in their national oral health surveys (John *et al*., 2004; Kelly *et al*., 2000), sociodemographic variation in OHRQoL related specifically to dental caries has never been assessed on a national sample. Therefore, the main objective of this study was to assess the associations of sociodemographic factors with dental caries and OHRQoL related to dental caries in a national representative sample of 12- and 15-year-old Thai children. In addition, the potential mediating role of oral health behaviours for these associations were investigated.

Method

The study was on subsamples of the 6th Thailand National Oral Health Survey (Dental Health Division, 2008). The total sample size of the national survey was 2,200 12- and 1,742 15-year-olds, based on a previous prevalence of dental caries, margin of error of 0.07 at the 95% confidence interval and a design effect of 1.5. A stratified multi-stage method was used for sample selection. Thailand was divided into five areas: Bangkok and four regions (North, South, Central and Northeast). Four provinces and 4 sub-districts were randomly selected from

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each area. For each province, 3 survey sites (1 municipal and 2 rural) were randomly selected. For Bangkok, 1 survey site was randomly selected from each of the 4 sub-districts. Samples were randomly drawn from the register of citizens of these 52 survey sites. The sample size within each selected site was based on the proportion of urban and rural populations in that province, and thus constituted an equal probability sample. Full details of the national sample procedures were described elsewhere (Krisdapong *et al*., 2009). The sample for the present study was half the sample of the national survey and consisted of all children in a randomly selected two of the four provinces/sub-districts in the national survey. Therefore this subsample included 1,100 12-year-olds and 871 15-year-olds.

The protocol was approved by the Ethics Committee of Chulalongkorn University. Children were orally examined by 8 trained and calibrated community dentists using WHO guidelines (World Health Organization, 1997). Self-administered questionnaires collected data on sociodemographic characteristics (gender, school type (public/private), site (urban/rural), region, and daily pocket money for snacks) and oral health behaviours (frequency of tooth brushing, brushing after lunch at school and before going to bed, type of toothpaste used, frequency of crispy packeted snacks and fizzy drinks consumption and dental treatment in the current semester). Children were interviewed by 10 trained and calibrated interviewers about their OHRQoL using the validated Thai versions of the Child-Oral Impacts on Daily Performances (Child-OIDP) (Gherunpong *et al*., 2004) for 12-year-olds and the Oral Impacts on Daily Performances (OIDP) (Adulyanon and Sheiham, 1997) for 15-year-olds. If an impact on quality of life was reported, the child was asked to report oral conditions they perceived as its main causes. Inter-examiner reliability was not tested as examiners and interviewers were allocated to specific geographical areas and comparisons could not be done for logistic reasons as areas were far apart. However, all examiners and interviewers were trained and calibrated before fieldwork and intra-examiner reliability was tested by re-examining and re-interviewing 10% of children during the survey. The Intraclass Correlation Coefficients for oral examinations were 0.857 for 12- and 0.926 for 15-year-olds, and for interviews were 0.863 for 12 and 0.862 for 15-year-olds.

DT, FT and DMFT scores and condition-specific (CS)-impacts (CS-Child-OIDP for 12-year-olds and CS-OIDP for 15-year-olds) attributed to dental caries were calculated. CS-impacts were impacts caused by specific oral conditions, calculated by taking into account oral conditions that children perceived as the main causes of impacts. CS-impacts attributed to dental caries are impacts for which the main perceived causes were toothache, tooth sensitivity, cavities, broken fillings and toothache after fillings. Stata/SE 10.0 was used for data analysis. Data were double entered to verify data transfer.

Associations of categorical sociodemographic and oral behavioural variables with DT, FT and DMFT score were investigated using Mann-Whitney U and Kruskal-Wallis tests, and with presence/absence of CS-impacts attributed to dental caries using Chi-square tests. Multivariate analyses were performed for DMFT scores and the presence/absence of CS-impacts as the main outcomes of interest. Negative binomial regressions were used for DMFT scores as data were count variables and overdispersed. Logistic regressions were used for the presence/absence of CS-impacts. Multicollinearity of variables 'region' and 'site' existed because Bangkok was considered as urban, while the other four regions consisted of urban and rural areas. Therefore, we created a combined region-and-site variable, 'geographic area' (consisting of 9 categories, e.g. Bangkok, Central-urban, Central-rural) and performed different regression models adjusting for all separate variables simultaneously, and the combined variable. Goodness-of-fit of the models using the log-likelihood and pseudo R^2 showed that the best fit models contained this combined variable instead of separate ones. Therefore, the combined variable was used in the multivariate analyses. A conceptual framework was built to illustrate relationships between various variables (Figure 1). Based on the framework, variables were entered into models using a hierarchical approach (Victora *et al*., 1997). Sociodemographic factors are distal determinants that can affect dental caries through proximate oral health behaviours (a), and other proximate determinants (b). Oral health behaviours are proximal factors affecting dental caries (c). Sociodemographic factors were postulated to exert their effect on CS-impacts through dental caries (d), and other mediators (e). Robust standard errors were obtained. Statistical significance was indicated when $p<0.05$.

Results

The response rates were 96.6% (n=1,063) for 12- and 93.1% (n=811) for 15-year-olds. Ninety percent of both age groups attended public schools, 14% lived in Bangkok while about 30% were from the Northeast, and about 20% were from each of the other regions of Thailand. Caries prevalence (DMFT>0) was 58.8%, with a mean DMFT score of 1.6 (sd 2.1, DT=0.9, FT=0.7) for 12-year-olds and for 15-year-olds, 68.6% and 2.4 (sd 2.7, DT=1.2, FT=1.1) respectively. Of 12-year-olds, 47% reported CS-impacts attributed to dental caries and 40% of 15-year-olds (Table 1). For both age groups, mean DMFT scores differed by gender ($p<0.01$), geographic area ($p<0.01$), daily pocket money for snacks ($p<0.01$ for

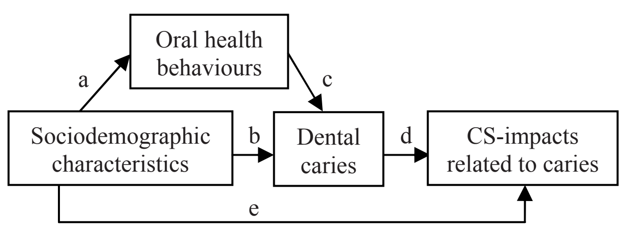

Figure 1. *Conceptual framework for dental caries and Condition Specific impacts (CS-impacts) attributed to dental caries*

Note: a, sociodemographic factors can affect oral health behaviours and, b, dental caries through other proximate determinants; c, oral health behaviours also affect dental caries; d, dental caries and e, other mediators both influence CS-impacts related to dental caries.

Table 1. Relationship between DMFT, DT, FT and condition-specific (CS)-impacts attributed to caries, by sociodemographic and behavioural characteristics in 12- and 15-year-old Thai children.

Sociodemographic and behavioural variables	*12-year-olds (n=1063)*					*15-year-olds (n=811)*				
	%	*mean (sd) DT*	*mean (sd) FT*	*mean (sd) DMFT*	*CS-impacts*	*%*	*mean (sd) DT*	*mean (sd) FT*	*mean (sd) DMFT*	*CS-impacts*
Study sample	100	0.9 (1.6)	0.7 (1.3)	1.6 (2.1)	47.7	100	1.2 (1.9)	1.1 (1.9)	2.4 (2.7)	40.7
Sociodemographic										
Gender										
Boy	49.6	0.8 (1.5)	0.6 (1.3)	1.5 (2.0)	49.3	48.2	1.1 (1.9)	0.9 (1.8)	2.1 (2.6)	38.1
Girl	50.4	1.0 (1.6)	0.7 (1.3)	1.8 (2.1)[b]	46.1	51.8	1.3 (1.9)[c]	1.2 (2.0)[b]	2.7 (2.8)[b]	43.1
School type										
Public	90.3	0.9 (1.6)	0.7 (1.3)	1.7 (2.1)	48.3	89.3	1.3 (1.9)	1.0 (1.8)	2.4 (2.7)	40.5
Private	9.7	0.8 (1.4)	0.5 (1.2)[c]	1.3 (1.9)[c]	41.7	10.7	1.0 (1.5)	1.4 (2.7)	2.6 (3.2)	42.5
Site										
Urban	43.0	0.9 (1.5)	0.5 (1.2)	1.4 (1.9)	46.4	43.3	1.1 (1.6)	1.1 (2.1)	2.3 (2.7)	44.2
Rural	57.0	0.9 (1.7)	0.8 (1.4)[a]	1.7 (2.2)[b]	48.7	56.7	1.4 (2.1)	1.0 (1.8)	2.5 (2.8)	38.0
Geographic area										
Bangkok	14.0	0.7 (1.3)	0.5 (1.1)	1.3 (1.8)	38.3	14.2	1.0 (1.7)	0.9 (1.9)	1.9 (2.7)	43.5
Central - urban	6.7	0.9 (1.3)	0.6 (1.5)	1.5 (2.0)	43.7	6.2	1.1 (1.7)	1.1 (1.7)	2.2 (2.5)	40.0
Central - rural	14.0	1.0 (1.9)	0.7 (1.5)	1.8 (2.5)	45.6	11.6	1.0 (1.6)	1.3 (2.1)	2.4 (2.4)	33.0
North - urban	6.9	0.8 (1.3)	0.7 (1.4)	1.5 (1.8)	50.7	6.2	1.4 (1.6)	1.4 (2.0)	2.8 (2.3)	62.0
North - rural	13.3	0.6 (0.9)	1.5 (1.8)	2.1 (2.0)	50.0	13.4	0.9 (1.4)	1.8 (2.5)	2.7 (3.0)	39.4
South - urban	5.4	1.2 (1.7)	0.2 (0.7)	1.5 (1.9)	57.9	6.0	1.1 (1.3)	1.7 (3.1)	2.9 (3.2)	57.1
South - rural	10.6	1.3 (2.1)	0.3 (0.7)	1.8 (2.2)	57.5	12.3	1.8 (2.1)	0.5 (1.0)	2.6 (2.5)	58.0
Northeast - urban	10.1	1.1 (1.7)	0.4 (1.0)	1.5 (2.0)	50.5	10.7	1.0 (1.5)	1.0 (1.7)	2.2 (2.5)	29.9
Northeast - rural	19.0	0.9 (1.6)[c]	0.5 (1.0)[a]	1.4 (2.0)[b]	45.0[c]	19.4	1.6 (2.6)[c]	0.6 (1.0)[a]	2.3 (3.0)[b]	27.4[a]
Daily pocket money for snacks										
0-10 baht	34.8	0.8 (1.3)	0.6 (1.2)	1.4 (1.7)	45.0	19.0	1.1 (1.6)	0.8 (2.0)	2.0 (2.6)	42.2
>10 baht	65.2	1.0 (1.7)[c]	0.7 (1.3)	1.7 (2.2)[b]	49.2	81.0	1.3 (2.0)	1.1 (1.9)[c]	2.5 (2.8)[c]	40.3
Behavioural										
Frequency of brushing										
0-1 times per day	20.2	1.1 (1.8)	0.7 (1.2)	1.8 (2.1)	49.3	7.9	1.0 (1.8)	0.9 (1.8)	2.0 (2.6)	34.4
2 or more times per day	79.8	0.9 (1.5)	0.6 (1.3)	1.6 (2.0)[d]	47.3	92.1	1.3 (1.9)	1.1 (1.9)	2.4 (2.7)[d]	41.2
Brushing after lunch at school										
Never	40.7	0.9 (1.5)	0.8 (1.4)	1.7 (2.1)	52.0	87.1	1.2 (1.9)	1.1 (2.0)	2.4 (2.8)	40.2
Every day/sometimes	59.3	1.0 (1.6)	0.4 (1.1)[a]	1.5 (2.0)[c]	44.8[c]	12.9	1.5 (2.0)	0.9 (1.6)	2.4 (2.6)	43.8
Brushing before going to bed										
Not every day	56.3	1.0 (1.7)	0.6 (1.2)	1.7 (2.1)	49.9	40.0	1.3 (2.0)	1.0 (1.7)	2.4 (2.7)	42.3
Every day	43.7	0.7 (1.3)[b]	0.7 (1.4)	1.5 (1.9)[d]	44.8[d]	60.0	1.2 (1.9)	1.1 (2.0)	2.4 (2.8)	39.6
Type of toothpaste used										
Non-fluoride	9.9	0.9 (1.3)	0.5 (1.0)	1.4 (1.7)	43.8	10.7	1.0 (1.6)	1.1 (2.0)	2.2 (2.6)	40.2
Fluoride	90.1	0.9 (1.6)	0.7 (1.3)	1.6 (2.1)	48.1	89.3	1.3 (1.9)	1.0 (1.9)	2.4 (2.8)	40.7
Consuming crispy packeted snacks										
Rarely/never	24.3	0.7 (1.3)	0.6 (1.2)	1.3 (1.7)	41.9	23.8	1.1 (1.7)	1.2 (2.2)	2.4 (2.8)	47.7
Sometimes/Every day	75.7	1.0 (1.7)[c]	0.7 (1.3)	1.7 (2.1)[c]	49.6[c]	76.2	1.3 (2.0)	1.0 (1.8)	2.4 (2.7)	38.5[c]
Consuming fizzy drinks										
Rarely/never	36.0	0.8 (1.4)	0.6 (1.2)	1.5 (1.9)	43.6	26.5	1.0 (1.5)	1.0 (2.0)	2.1 (2.5)	39.6
Sometimes/Every day	64.0	1.0 (1.7)	0.7 (1.3)	1.7 (2.1)[d]	50.0[c]	73.5	1.3 (2.0)	1.1 (1.9)	2.5 (2.8)[c]	43.7[d]
Received dental treatment in current semester										
No	56.1	0.9 (1.6)	0.4 (1.1)	1.4 (1.9)	47.5	63.9	1.3 (1.9)	0.8 (1.8)	2.1 (2.6)	40.2
Yes	43.9	0.9 (1.6)	0.9 (1.5)[a]	1.8 (2.2)[b]	48.0	36.1	1.2 (2.0)	1.6 (2.0)[a]	2.9 (2.8)[a]	41.6

Mann-Whitney U and Kruskal-Wallis tests for DMFT, DT, FT scores, Chi-square test for proportions of CS-impacts.
[a] $p<0.001$, [b] $p<0.01$, [c] $p<0.05$, [d] $p\leq0.2$ (further included in multivariate analysis).

age 12, p<0.05 for age 15) and receiving dental treatment in current semester (p<0.01 for age 12, p<0.001 for age 15). There were also regional differences in DMFT components. For both age groups, DT and FT scores differed significantly by geographic area (p<0.001), as they did for recently receiving dental treatment (p<0.001). There was statistically significant variability in prevalence of CS-impacts attributed to dental caries by geographic area. It ranged from 38% (Bangkok) to 58% (South) in 12-year-olds and 27% (Northeast-Rural) to 62% (North-urban) in 15-year-olds (Table 1).

In the multivariate analyses for DMFT, variables that obtained p<0.2 for the bivariate analyses were included. The fully adjusted model (Model 3) for DMFT score in 12-year-olds included gender, geographic area and daily pocket money for snacks as sociodemographic variables and all behavioural variables, except type of toothpaste used. For 15-year-olds, the fully adjusted model (Model 3) for DMFT score included gender and geographic area as sociodemographic variables as well as frequency of toothbrushing per day, fizzy drinks consumption and receiving dental treatment in the current semester as behavioural variables (Table 2). Gender, geographic area and receiving dental treatment in the current semester were associated with DMFT score for both groups. Girls had higher DMFT scores than boys and the DMFT score was higher for children who received dental treatment in the current semester for both age groups. Compared to Bangkok children, 12-year-olds in Central-rural, North-rural and South-rural, and 15-year-olds in South-urban and South-rural had statistically significantly higher DMFT scores. Those aged 12 who consumed crispy packeted snacks, and 15-year-olds who consumed fizzy drinks sometimes or every day had significantly higher mean DMFT scores than those who rarely or never consumed fizzy drinks.

Multiple logistic regressions for associations of sociodemographic factor with CS-impacts attributed to dental caries were performed in 3 steps; unadjusted (Model 1), adjusted for behavioural factors (Model 2) and fully adjusted for behavioural factors and dental caries (Model 3) (Table 3). Unadjusted analyses showed that associations of CS-impacts with DT scores were stronger than with DMFT and FT scores. Odds ratios (ORs) of CS-impacts on DT score were 1.4 (95% CI: 1.2, 1.5) for 12-year-olds and 1.4 (95% CI: 1.3, 1.6) for 15-year-olds, while ORs for DMFT score were 1.2 (95% CI: 1.1, 1.3) for 12-year-olds and 1.2 (95% CI: 1.2, 1.3) for 15-year-olds and for FT scores were 1.0 (95% CI: 0.9, 1.1) for 12-year-olds and 1.1 (95% CI: 1.0, 1.2) for 15-year-olds. Therefore DT score was entered into the final models (Model 3). In the fully adjusted models for both age groups, geographic area was the only sociodemographic or behavioural factor statistically significantly and independently associated with CS-impacts (Table 3). The associations of geographic area with CS-impacts remained significant after further controlling for DT score. Those aged 12 in both urban and rural areas of the South were about twice as likely to report CS-impacts, while 15-year-olds in both urban and rural Northeast areas were about half as likely to report CS-impacts as those in Bangkok. Significant associations of CS-impacts with consuming crispy snacks in 12-year-olds and with consuming fizzy drinks in 15-year-olds became non-significant after adjusting for DT score, showing that the effect of oral health behaviour on CS-impacts was mediated through the DT score.

Discussion

This is the first study reporting sociodemographic differences in prevalence of OHRQoL related specifically to dental caries in a national sample of children. The only sociodemographic factor that was statistically significantly and independently associated with CS-impacts attributed to dental caries for both age groups was geographic area. Among the 9 geographic areas, the highest prevalence of CS-impacts was nearly twice that in the lowest prevalence area in 12-year-olds, and more than twice the prevalence in 15-year-olds (Table 1). Odds ratios of CS-impacts throughout the analyses using a hierarchical technique suggest that geographic differences in OHRQoL related to dental caries were only partly mediated by oral health behaviours and DT score. Geographic area appeared to independently affect children reporting oral health impacts. Children in the South region, irrespective of urban dwelling, reported many more CS-impacts than Bangkok children, while children in the Northeast region, irrespective of urban dwelling, reported fewer impacts. The differences in children's OHRQoL between regions might be explained by the influence of sociocultural characteristics on health-related perceptions (Wilson and Cleary, 1995). Different Thai areas' social characteristics impinging on children's perceptions about health in different regions was expected as certain socioeconomic and cultural characteristics varied between regions. An example of regional cultural differences was that whereas over 90% of people in Bangkok, Central, North and Northeast were Buddhists, the percentage of Buddhists in the South was only 70%. Educational attainment higher than primary school level was lowest in the Northeast (27%) while the percentage was as high as 57% in some other regions. Most people in the Northeast (53%) were agricultural-related workers, while the percentages of such workers ranged from 1% to 35% in other regions. Moreover, in the Northeast, 80% of people were self-employed compared with 25% to 64% in other regions (National Statistical Office Thailand, 2010). Such regional differences in social characteristics might explain the variation in children's OHRQoL as found in this study. There is no previous study assessing children's OHRQoL in different geographic areas of a country. However, the significant difference in CS-impacts by geographic area found in this study was comparable to a study reporting considerable variability of prevalence of toothache in children between US states; the prevalence ranged from 7.4% to 17.6% (Lewis and Stout, 2010). Therefore, in addition to disease outcomes usually used as indicators reflecting oral health disparities, this study provides evidence on oral health disparities at a national level as measured by a broader oral health outcome, namely an oral health-related quality of life measure.

This study applied a condition-specific-OHRQoL measure related specifically to dental caries. Others have used generic OHRQoL measures reflecting oral impacts due to overall oral diseases. Although findings were not comparable, the non-significant association of CS-impacts with gender found in this study was consistent with previous studies on toothache (Bastos *et al*., 2008; Goes *et al*., 2007). However, all other previous studies in children and adolescents that used a generic OHRQoL index or self-rated oral health found that girls were statistically significantly more likely than boys to report problems with, or poor oral health (Castro *et al*., 2011; Mbawalla *et al*., 2010; Pattussi *et al*., 2007; Piovesan *et al*., 2010). For other sociodemographic factors, the non-significant associations of CS-impacts with urbanization and school type found in this study were consistent with previous studies in Sudan and Tanzania (Mbawalla *et al*., 2010; Nurelhuda *et al*., 2010).

Table 2. Regression models for the associations of sociodemographic and behavioural characteristics with DMFT scores in Thai children.

Sociodemographic and behavioural variables	*12-year-olds (n=1,063)*			*15-year-olds (n=811)*		
	*Model 1** *RR (95% CI)*	*Model 2** *RR (95% CI)*	*Model 3** *RR (95% CI)*	*Model 1** *RR (95% CI)*	*Model 2** *RR (95% CI)*	*Model 3** *RR (95% CI)*
Sociodemographic						
Gender						
Boy	1	1	1	1	1	1
Girl	1.2 (1.0, 1.4)[c]	1.2 (1.0, 14)[c]	1.2 (1.0, 1.4)[c]	1.3 (1.1, 1.5)[b]	1.3 (1.1, 1.5)[b]	1.2 (1.0, 1.4)[b]
School type						
Public	1	1	-	-	-	-
Private	0.8 (0.6, 1.1)	0.9 (0.6, 1.3)	-	-	-	-
Geographic area						
Bangkok	1	1	1	1	1	1
Central - urban	1.2 (0.8, 1.8)	1.2 (0.8, 1.4)	1.3 (0.9, 1.9)	1.2 (0.8, 1.7)	1.1 (0.8, 1.7)	1.1 (0.7, 1.7)
Central - rural	1.4 (1.0, 1.9)[c]	1.4 (1.0, 2.0)[c]	1.4 (1.1, 2.0)[c]	1.4 (0.9, 1.7)	1.2 (0.9, 1.7)	1.2 (0.9, 1.7)
North - urban	1.2 (0.9, 1.7)	1.1 (0.8, 1.7)	1.3 (0.9, 1.9)	1.4 (1.0, 2.0)[c]	1.4 (0.9, 2.0)	1.3 (0.9, 1.9)
North - rural	1.7 (1.3, 2.2)[a]	1.7 (1.3, 2.4)[b]	1.8 (1.4, 2.4)[a]	1.4 (1.0, 1.9)[c]	1.4 (1.0, 1.9)[c]	1.4 (1.0, 2.0)[c]
South - urban	1.2 (0.8, 1.8)	1.2 (0.8, 1.7)	1.5 (0.9, 2.2)	1.5 (1.0, 2.2)[c]	1.5 (1.0, 2.3)[c]	1.5 (1.0, 2.3)[c]
South - rural	1.4 (1.0, 1.9)[c]	1.4 (1.0, 2.1)[c]	1.7 (1.2, 2.4)[b]	1.3 (0.9, 1.8)	1.3 (0.9, 1.9)	1.4 (0.9, 1.9)
Northeast - urban	1.2 (0.9, 1.7)	1.2 (0.8, 1.7)	1.2 (0.9, 1.7)	1.1 (0.8, 1.6)	1.1 (0.8, 1.6)	1.1 (0.8, 1.5)
Northeast - rural	1.1 (0.8, 1.5)	1.2 (0.9, 1.7)	1.2 (0.9, 1.7)	1.2 (0.8, 1.6)	1.2 (0.8, 1.6)	1.1 (0.8, 1.6)
Daily pocket money for snacks						
0-10 baht	1	1	1	1	1	-
>10 baht	1.3 (1.1, 1.5)[b]	1.3 (1.1, 1.6)[a]	1.3 (1.1, 1.5)[b]	1.3 (1.0, 1.6)[c]	1.2 (0.9, 1.5)	-
Behavioural						
Frequency of brushing						
0-1 times per day	1		1	1		1
2 or more times per day	0.9 (0.7, 1.1)[d]		0.9 (0.7, 1.1)	1.2 (0.9, 1.7)[d]		1.2 (0.8, 1.6)
Brushing after lunch at school						
Never	1		1	-		-
Every day, sometimes	0.9 (0.7, 1.0)[c]		0.8 (0.7, 0.9)[b]	-		-
Brushing before going to bed						
Not every day	1		1	-		-
Every day	0.9 (0.8, 1.1)[d]		0.9 (0.8, 1.1)	-		-
Consuming crispy packeted snacks				-		-
Rarely/never	1		1			
Sometimes/every day	1.3 (1.0, 1.5)[c]		1.3 (1.0, 1.5)[c]	-		-
Consuming fizzy drinks						
Rarely/never	1		1	1		1
Sometimes/every day	1.1 (0.9, 1.3)[d]		1.1 (0.9, 1.2)	1.2 (1.0, 1.4)[c]		1.2 (1.0, 1.4)[c]
Received dental treatment in current semester						
No	1		1	1		1
Yes	1.3 (1.1, 1.5)[b]		1.3 (1.1, 1.5)[b]	1.4 (1.2, 1.6)[a]		1.3 (1.1, 1.6)[a]

RR: rate ratio, CI: confidence interval

* Model 1 was unadjusted, representing overall crude effect of sociodemographic factors on DMFT score;

Model 2 was adjusted for other sociodemographic variables;

Model 3 was further adjusted for behavioural variables, representing effect of behaviours on DMFT score adjusted for sociodemographic factor, and effect of sociodemographic factors on DMFT score that is not mediated through oral health behaviours.

[a] $p<0.001$, [b] $p<0.01$, [c] $p<0.05$, [d] $p\leq0.2$ (further included in multivariate analysis).

This study showed that dental caries accounted for the significant associations of sugary snacks and drinks consumption with CS-impacts in both age groups. After controlling for potential sociodemographic and other behavioural confounders, DMFT score was statistically significantly associated with crispy packeted snacks in 12- and with fizzy drinks consumption in 15-year-olds. When DT score was entered into models of CS-impacts, 12-year-olds who sometimes or usually consumed crispy packeted snacks and 15-year-olds who sometimes or usually consumed fizzy drinks did not have a statistically significantly higher chance of experiencing CS-impacts attributed to dental caries. The influence of sugary snacks consumption on OHRQoL mediated through dental caries was consistent with a previous study that used a generic OHRQoL measure. Nurelhuda *et al*. (2010) reported that 12-year-old children who consumed sugary snacks more than 3 times per week were more likely to experience

Table 3. Logistic regression models of the associations of sociodemographic, behavioural and clinical variables with condition-specific (CS)-impacts attributed to dental caries in Thai children.

Independent variable	*12-year-olds (n=1063)*			*15-year-olds (n=811)*		
	Model 1[*] *OR (95% CI)*	*Model 2*[*] *OR (95% CI)*	*Model 3*[*] *OR (95% CI)*	*Model 1*[*] *OR (95% CI)*	*Model 2*[*] *OR (95% CI)*	*Model 3*[*] *OR (95% CI)*
Sociodemographic variable						
Geographic area						
Bangkok	1	1	1	1	1	1
Central - urban	1.3 (0.7, 2.2)	1.2 (0.7, 2.2)	1.3 (0.7, 2.2)	0.9 (0.4, 1.7)	0.9 (0.4, 1.6)	0.8 (0.4, 1.7)
Central - rural	1.4 (0.9, 2.2)	1.3 (0.8, 2.1)	1.3 (0.8, 2.0)	0.6 (0.4, 1.1)	0.6 (0.4, 1.1)	0.6 (0.4, 1.1)
North - urban	1.7 (0.9, 2.9)	1.6 (0.9, 2.8)	1.7 (0.9, 2.9)	2.1 (1.1, 4.2)[c]	2.1 (1.1, 4.1)[c]	1.9 (0.9, 3.9)
North - rural	1.6 (1.0, 2.6)[c]	1.7 (1.1, 2.8)[c]	1.8 (0.9, 2.7)	0.8 (0.5, 1.4)	0.9 (0.5, 1.4)	0.9 (0.5, 1.5)
South - urban	2.2 (1.2, 4.1)[c]	2.1 (1.1, 4.1)[c]	2.1 (1.1, 4.1)[b]	1.7 (0.9, 3.4)	1.7 (0.9, 3.3)	1.7 (0.9, 3.3)
South - rural	2.2 (1.3, 3.6)[b]	2.0 (1.2, 3.5)[c]	2.0 (1.2, 3.3)[b]	1.8 (1.0, 3.1)[c]	1.8 (1.0, 3.1)[c]	1.4 (0.8, 2.4)
Northeast - urban	1.6 (0.9, 2.7)	1.7 (1.0, 2.9)[c]	1.6 (0.9, 2.6)	0.6 (0.3, 1.0)[c]	0.6 (0.3, 1.0)[c]	0.5 (0.3, 0.9)[c]
Northeast - rural	1.3 (0.9, 2.0)	1.3 (0.8, 2.0)	1.3 (0.8, 2.0)	0.5 (0.3, 0.8)[b]	0.5 (0.3, 0.8)[b]	0.4 (0.2, 0.6)[a]
Behavioural variables						
Brushing after lunch at school						
Never	1	1	-	-	-	-
Every day, sometimes	0.8 (0.6, 0.9)[c]	0.8 (0.6, 1.1)	-	-	-	-
Brushing before going to bed						
Not every day	1	1	-	-	-	-
Every day	0.8 (0.6, 1.0)[d]	0.9 (0.7, 1.1)	-	-	-	-
Consuming crispy packeted snacks						
Rarely/never	1	1	1	1	1	-
Sometimes/every day	1.4 (1.0, 1.8)[c]	1.4 (1.0, 1.8)[c]	1.3 (0.9, 1.8)	0.7 (0.5, 0.9)[c]	0.8 (0.6, 1.2)	-
Consuming fizzy drinks						
Rarely/never	1	1	-	1	1	1
Sometimes/every day	1.3 (1.0, 1.7)[c]	1.3 (0.9, 1.7)	-	1.2 (1.0, 1.5)[c]	1.2 (1.0, 1.6)[c]	0.9 (0.7, 1.3)
DT score		-	1.3 (1.2, 1.5)[a]			1.5 (1.3, 1.6)[a]

OR: odds ratio, CI: confidence interval

[*] Model 1 was unadjusted, representing overall crude effect of sociodemographic factors on CS-impacts

Model 2 was adjusted for sociodemographic and behavioural variables, representing effect of behaviours on CS-impacts adjusted for sociodemographic factors, and effect of sociodemographic factors on CS-impacts that is not mediated through oral health behaviours

Model 3 was further adjusted for DT score, representing effect of DT score on CS-impacts adjusted for sociodemographic and behavioural factors, and effect of sociodemographic factors on CS-impacts that is not mediated through oral health behaviours and DT score

[a] $p<0.001$, [b] $p<0.01$, [c] $p<0.05$, [d] $p\leq0.2$ (further included in multivariate analysis)

general oral health impacts compared to their counterparts. However, when dental caries was entered into a model, the association was not statistically significantly. The present study found that the association between sugars intake and CS-impacts and with DMFT differed between 12- and 15-year-old Thai children. While snacks consumption was associated with CS-impacts and DMFT in 12-year-olds, fizzy drinks consumption was for 15-year-olds. These findings agree with a study in 12-year-olds (Nurelhuda *et al*., 2010) and a study by Mbawalla *et al*. (2010) reporting significant associations of general oral health impacts with sugary drinks consumption on 12 to 21-year-olds (mean age 15).

This study also found significant associations of DMFT and FT scores with dental attendance but the association between dental attendance and CS-impacts was not statistically significant. Children who received dental treatment in the current semester tended to have higher DMFT and FT scores than those not receiving dental treatment. This finding was consistent with previous studies reporting that children with toothache or poor OHRQoL were statistically significantly more likely to attend dental services (Goes *et al*., 2007; Mbawalla *et al*., 2010). This might relate to reasons for the dental visits; whether they were symptomatic attendance, routine checkups or by appointment, which probably relate to the school dental service system of countries. Thai schoolchildren have annual oral screenings and, if necessary, are given dental appointments. Early treatment of carious lesions before oral impacts on quality of life occur might explain the significant associations of receiving dental treatment with DMFT/FT scores and the non-significant relation with CS-impacts attributed to dental caries.

Similar to findings on CS-impacts, geographic difference was also observed using DMFT as a outcome measure. In addition, gender was another sociodemographic factor statistically significantly associated with DMFT in both age groups, while urban dwelling and daily pocket money also was, but only for 12-year-olds. Consistent with this study's findings, a study in South Thailand 12-year-olds reported that girls and rural children had higher mean DMFT scores than males and those in urban areas (Petersen *et al*., 2001). In addition to sociodemographic factors, this study also found that oral health behaviours such as toothbrushing, sugary snacks and drinks consumption and dental visits for treatment were statistically significantly associated with DMFT. These findings agree with established evidence on sociobehavioural risk factors of dental caries (Petersen, 2005). However, using a hierarchical approach in the analyses, this study's findings suggest that behavioural factors accounted only partly for geographic differences in DMFT. The geographic area of Thailand where a child lived seemed to affect dental caries independently or through other proximate oral health behaviours not measured by this study. Behavioural risk factors do not occur in isolation but are determined by socioenvironmental factors (Petersen, 2005). Geographic differences in dental caries, as found in many developed and developing countries, suggest differences in socioenvironmental causes of dental caries between geographic areas (Do, 2012). Higher levels of disease might be expected in areas with less supportive socioenvironmental conditions. This study's findings confirmed the role of socioenvironmental factors on children's oral health. However, a lack of other important characteristics such as poverty level that might distinguish those geographic areas is a limitation of this study. This limitation is due to the fact that the national oral health survey collected data directly from children, not from their parents. Moreover, significant associations between sociodemographic factors and caries and OHRQoL, as found in this study, cannot be fully explained by this study. Therefore, further studies are needed to identify the underlying social causes leading to differences in dental caries and OHRQoL between geographic areas. Another limitation of this study was that the sample was selected through a multistage stratified sampling procedure and the estimates were not re-weighted to adjust for different probabilities of selection. Thus, inter-region comparisons might not be fully comparable.

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