

Original Article

Factors associated with dental caries among selected urban school children in Kuala Lumpur, Malaysia

Satvinder Kaur*, Dhivyalosini Maykanathan, Ng Kai Lyn

Department of Food Science and Nutrition, Faculty of Applied Sciences, UCSI University, No. 1, Jalan Menara Gading, UCSI Heights, 56000 Kuala Lumpur, Malaysia.

* Corresponding author: satvinderkaur@ucsiuniversity.edu.my

Submitted: 12/01/2015. Revised edition: 28/04/2015. Accepted: 08/06/2015. Published online: 08/06/2015.

Abstract This study aimed to assess the nutritional status (BMI), oral health behaviour, sugar consumption and the associated factors with dental caries among a group of 7 to 11 years old children in Kuala Lumpur, Malaysia. Three hundred and twelve students were recruited from February to July 2013. Information gathered were their socio-demographic characteristics, body mass index, sugar consumption, oral-health behaviour, oral hygiene index and decay-missing-filled teeth (dmft) index. Anthropometry measurements and sugar intake was measured using verified tools. Meanwhile, dmft was examined using the World Health Organization (WHO) criteria. 53.7% of the children were of the normal body weight with mean sugar consumption of 31.81 ± 4.24 g/day. Prevalence of dental caries was reported at 44.6% (95% CI: 42.2, 53.3) with a mean (SD) dmft of 1.27(1.84). No association was found between dental caries and weight status distribution. Most children tend to brush their teeth 2 times or more in a day (75%), however, they spent lesser time in tooth brushing (5.4%) and do not practice flossing (78%). Regression analysis showed that age ($p < 0.001$), duration of teeth brushing ($p = 0.023$) and the oral hygiene index ($p = 0.002$) were significant predictors of dental caries among this group of children. Present findings suggest that younger children, longer time taken to brush teeth and poorer oral hygiene index were predisposing factors in dental caries, especially for young children. Hence, education on dental health is important to improve oral health behaviour and oral hygiene practices to further reduce dental caries incidences among young children.

Keywords: body weight, children, dental caries, dietary sugar, oral health.

Introduction

Dental caries is a highly prevalent diet-and behaviour-related dental disease among children. Although not life-threatening, dental caries has a detrimental effect on the quality of life, having impact on self-esteem, eating ability, nutrition and health of a child (WHO, 2003). Risk of dental disease leads to the need for proper caries risk assessment and prediction in children to develop and implement preventive measures. Indicators in caries risk assessment will promote the disease to be treated during the process rather than the outcome. Apart from that, indicators can also help in determining the frequency needed for the preventive and restorative

treatment. (American Academy of Pediatric Dentistry, 2014).

In Malaysia, the prevalence of dental caries done among children was between 70-90% (Wan Salina *et al.*, 2007; Zahara *et al.*, 2010; Oo *et al.*, 2011; Ruhaya *et al.*, 2012). This has been observed to be increasing in the last couple of years. There are various factors that may contribute to the occurrence of dental caries such as dietary intake, oral health behaviour, oral hygiene practices and lifestyle habits (Granville-Garcia *et al.*, 2008; Touger-Decker and van Loveren, 2003; Kassawara *et al.*, 2010). In children, sugar consumption and oral health behaviour has been proven to amplify the severity of dental caries (Touger-Decker

and van Loveren, 2003; Yabao *et al.*, 2005).

Parental education background and socioeconomic status has been shown to contribute to more active decay and missing teeth as compared to children from higher socioeconomic status (Hallett and O'Rourke, 2006). This could be due to better privileges of taking preventive measures, early diagnosis and specific treatment which are affordable to them (Sogi and Bhaskar, 2002). Lower socioeconomic status documents higher dental caries probably due to their poor oral hygiene practices, lack of awareness, improper food intake and parents education level.

Both under and over nutrition plays a role in the development and consequences of dental caries among children. Dental pain that leads to eating difficulties often results into under nutrition (Ruhaya *et al.*, 2012). Over time, under nutrition will impact the tooth structure and thus increase the susceptibility of dental caries (Narang *et al.*, 2012). Malnutrition alters the homeostasis of oral which reduces the resistance to microbial biofilm which increases the progression of oral cavity (Sheetal *et al.*, 2013). On the other hand, obesity are generally due to negative dietary behaviour such as increased frequency of snacking and increased consumption of fermentable carbohydrates (Granville-Garcia *et al.*, 2008; Sadeghi and Alizadeh, 2007) which may be contributors to dental caries incidences as well. Oral bacteria ferment the carbohydrate and produces acid which dissolves tooth enamel; therefore sweetened beverages or food are most likely to increase risk of dental caries (Touger-Decker and van Loveren, 2003).

Oral health behaviour has received attention in being a factor that significantly impacts one's quality of life and well-being (WHO, 2003). Dental caries is likely to occur with poor practices of oral hygiene such as tooth brushing (Petersen *et al.*, 2001). Exposure of good oral health behaviours such as tooth brushing skills, flossing, amount of toothpaste used, good dietary habits to children at a young age is likely to ensure them to continue the practices throughout their life (Curnow *et al.*,

2002). Therefore, early education in dental care should be viewed as a crucial component among children. Children who are from communities that have adequate fluoridation are shown to have higher protective effect against dental caries.

Development of caries during the primary dentition often results into caries development in the permanent and mixed dentition as well. Those aged 6 to 11 years old are at the mixed dentition stage; therefore, it is imperative to study this age group in order to develop necessary intervention and education in the area of dental health (Kassawara *et al.*, 2010). Dental education should be promoted among the children as the inference of dental caries on primary dentition causes a major problem on public health. Furthermore, improvement in oral health practices among this particular population becomes important due to factors such as irregular dental visits, fright gained by dental treatment, high costs of dental care, sugary intake, plaque control, fluoride exposure and lack of parental support among the children (Yabao *et al.*, 2005; Touger-Decker and van Loveren, 2003; Curnow *et al.*, 2002). Promotion of oral health care should be emphasized as a lifelong practice, of which schools would be the best place to deliver such knowledge (Cheah *et al.*, 2010).

In Malaysia, studies on nutritional aspects in relation to dental caries are still limited and very much needed to improve dental education among children. Hence, this study was undertaken to assess the nutritional status (BMI), oral health behaviour, sugar consumption and the associated factors with dental caries among a group of 7 to 11 years old children in Kuala Lumpur, Malaysia.

Materials and methods

A total of 312 school going children aged between 7 to 11 years old agreed to participate in this cross-sectional study involving random and convenience sampling method. They were recruited from February to July 2013. Children who met the inclusion criteria of having informed consent form given, able to

communicate well and perform the dental check were included in the study. Two schools were randomly selected from the list of public schools in Cheras: Sekolah Kebangsaan Tun Hussein Onn and Sekolah Jenis Kebangsaan (Cina) Tsun Jin which are located in Cheras, Kuala Lumpur. Sample size was calculated using the prevalence from previous study conducted in the Philippines (Yabao *et al.*, 2005). Written consent form was obtained from the parents or guardians of children that were invited to participate in the study. The study was approved by the Ministry of Health (KKM-60(13/9) Jld 2 and ethical approval (Proj-FAS-EC-12-009) was obtained from the faculty research ethics committee.

A structured questionnaire was used to assess children's information on socio-demographic characteristics, frequency of sugar consumption and oral health behaviour. The section on socio-demographic characteristics explored on the household income, parent's age, education level and marital status. Household income categorization is based on average Malaysian household income (Economic Planning Unit, Malaysia, 2013).

Sugar consumption section (Yabao *et al.*, 2005) was adapted upon obtaining approval which assessed on the frequency and amount of sugary foods and drinks consumed by the children in the past one week. Oral health behaviour questions such as the frequency and time of tooth brushing, dental floss, mouthwash usage and dental visits were adapted from a previous study (Yabao *et al.*, 2005). The questionnaire was first translated into the Malay and Chinese language by language experts to ensure better understanding of the questions. The questionnaires were then retranslated into English to ensure proper translation. Pre-test was conducted in all 3 languages (Malay, Chinese and English) at Sekolah Kebangsaan Seri Budiman II among students of all ethnic groups to help verify the understanding of the questionnaires.

Dental caries were recorded using the dmft (d = decayed, m= missing due to caries, f = filled, t = teeth) indices for primary teeth using the WHO 1997 criteria

(WHO, 1997). Meanwhile, the oral hygiene index (OHI) was classified into good, fair and poor; as categorized by Greene and Vermillion (1960). This was conducted and evaluated by the trained dentist and staff nurse in the classroom on a portable dental chair under a good lighting. The dmft index was calculated from total number of decayed, missing and filled primary teeth by the dentist. Presence of caries was determined by having any decayed, missing or filled primary tooth (WHO, 1997).

Anthropometric measurements of weight, height and body mass index (BMI) were conducted upon completion of questionnaires. All children were weighed to the nearest 0.1 kg on a portable OMRON Body Fat Analyser Scale (HBF-356, Japan). The height of the children was measured using a stadiometer to the nearest 0.1 cm. The BMI-for-age classification for both boys and girls aged 5 to 19 year old are based on the WHO Reference 2007 (WHO, 2007). For individual aged 5-19 years old, severe thinness and thinness refer to unfavourable low weight-for height that is below -3 SD and -2 SD of the median Z score of the WHO reference respectively. Normal is defined as optimal weight-for-height that is within -2 SD and +1 SD of the median Z score. Weight- for -height for more than +1 SD and over +2 SD of the median Z score is considered overweight and obese respectively.

Statistical analysis

Statistical Package for Social Sciences (SPSS) version 20 was used to analyse the data. Chi square analysis was conducted to determine association of age, weight status and oral health behaviours with dental caries prevalence. Independent student t-test was used to determine mean daily sugar intake among those with and without caries. Multiple linear regressions analysis was performed to determine predictors of dental caries among the children by controlling the gender. The level of significance was set at $p < 0.05$.

Results

Socio-demographic characteristics of the children and parents

A total of 312 primary school children aged 7 to 11 years participated in this study, with 131 males (42%) and 181 females (58%). This study consisted of Chinese (51.6%) and Malays (48.4%) ethnic groups with the mean (SD) age at 9.3 (SD 1.31) years. The majority of the children came from the dual-parentage background. One hundred and sixty two (51.9%) of the parents were primary school educated and children were mostly from the medium household income category (Table 1).

Prevalence of dental caries and its distribution with body mass index (BMI) and oral health behaviour among the school children

Prevalence of dental caries was found to be at 44.6% (95% CI: 42.2, 53.3) among this group of school going children. Based on Table 2, the proportion of dental caries among the females was found to be higher (48.1%) than their male counterparts. Age ($p < 0.001$), duration of tooth brushing ($p < 0.01$) and flossing behaviour ($p < 0.05$) seemed to have significant association among those with and without dental caries. Younger age children had more caries ($p < 0.05$) as compared to the older age group. Meanwhile, children that brushed their teeth more than 4 minutes (35%) had lower caries prevalence ($p < 0.05$). Children who practices teeth flossing (67%) were mostly free of caries ($p < 0.05$). Seventy five percent of the children brush their teeth at least twice a day. Only 59 (18.9%) of the participants visited the dentist twice a year and the majority of them (58.3%) visits dentist only when necessary. Those who visited dentist only when necessary were mostly (58%) caries free. There were no significant differences of sugar consumption among those with and without dental caries. Sugar consumption was calculated by the following formula (Yabao *et al.*, 2005):

Sugar (g/day) = [(frequency x weight of food/number of days)] x sugar content in 100 g of food

Based on Fig. 1, the distribution of dental caries appears to be more among the underweight (29.5%) children as compared to the overweight and obese (14.4%) children. However, this resulted in an insignificant association (χ^2 (df=2) = 0.385, $p=0.825$).

Table 3 depicts the multiple linear regression analysis of the dental caries index (dmft) in relation to several independent variables which were age, sugar consumption, oral hygiene index, and duration of teeth brushing, flossing habits and their body mass index. The variables in the model explained 16% of the variance in caries index for the school children. Younger children, poorer oral hygiene index and shorter time of teeth brushing were significantly associated with higher proportion of dental caries in this group of children.

Discussion

The dental caries prevalence in this study was 44.6% (95% CI: 42.2, 53.3). The reported caries prevalence was significantly lower compared to a study among rural schoolchildren in north east Malaysia which was at 93% (Oo *et al.*, 2011). Meanwhile, in the urban Philippines, a study has documented a higher prevalence of 71.7% of primary dentition caries (Yabao *et al.*, 2005). The mean dmft value in this study was found to be low and is comparable to studies done in the West which is below 2 (Marthaler *et al.*, 1996).

Current study found that younger age was a factor in caries development among the children. This finding was similar to a study in North Jordan (Al-Omiri *et al.*, 2006), of which younger children who receives minimal parental supervision, have inadequate basic oral health knowledge and are unaware of methods available to clean their teeth, and thus may predispose risks in developing caries in those young children. Poor parental supervision also leads to parents being unaware that their child might only brush their teeth once daily or none at all. This perhaps can be explained as Asians parents were documented to have less

positive dental attitude and lack of further education among parents also contributed to these growing prevalence of caries among young children (Williams *et al.*, 2002).

Oral health behaviour and oral hygiene are important aspects to be addressed among young children in order to ensure proper care are given in their dental hygiene practices. Tooth brushing should be the first line of oral cleansing method unless scaling or professional fluoridation are needed (Ministry of Health Singapore, 2004). The percentage of tooth brushing of twice or more in a day (75.3%) was nearly similar to a study reported in Thailand, of which 77% of the children aged 6 and 12 years old brush their teeth twice a day (Petersen *et al.*, 2001). In contrast, a study found that most of school children aged 10 to 16 in North Jordan reported irregular times of tooth brushing, even though there was a high percentage of children brush their teeth at least once daily (Al-Omiri *et al.*, 2006). Interestingly, we found that duration taken to brush their teeth was shown as a significant predictor to dental caries through the regression analysis. Children who brushed their teeth longer had lower dmft values.

Flossing is recommended at least once per day to ensure good oral hygiene (Hagan *et al.*, 2008). Tooth flossing was not a common oral health practice among schoolchildren as reported (Wan Salina *et al.*, 2007; Narksawat *et al.*, 2009). Lack of oral health education and higher cost may account for the rare use of tooth floss and mouthwash (Al-Omiri *et al.*, 2006; Hagan *et al.*, 2008). Similarly, we also found that most children (77.9%) do not practice tooth flossing. However, among those that practiced flossing their teeth, 67% of them were found to be caries free. Children were further classified into three different categories of their oral hygiene index which are poor, medium and good. Poor oral hygiene index also appeared to have been a predictor of dental caries in this group. Good oral hygiene practices of at least twice a day have been recommended by dental professionals to ensure good oral cavity among individuals (Ministry of Health Singapore, 2004).

Visiting dentist benefits a child's dental health, and it is recommended to visit the dentist twice a year to protect oral health (Hagan *et al.*, 2008). The result from this study was in accordance with other findings (Yabao *et al.*, 2005; Petersen *et al.*, 2001; Ministry of Health Singapore, 2004), of which an irregular dental visit was common among children, and majority of the children visited dentist only when necessary, especially when experiencing pain in the mouth. This could be due to parental and economic factors (Narksawat *et al.*, 2009) as dental cost has been on the rise of late. Caries has been found to be more prevalent among young and older children who avoided dental appointments due to dental anxiety and behavioural management during the scheduled appointments (Bedi *et al.*, 2006). This resulted in parents avoiding and cancelling their children's dental appointments (Wigen *et al.*, 2009) which lead to the child of not having adequate dental attention.

This study found no association between weight status and caries incidence. However, looking at the distribution, more underweight children had higher caries prevalence. A study done in Lucknow (Narang *et al.*, 2012) among children also depicted similar results, of which no relationship was observed between BMI and dental caries index. However, they revealed that the predisposition of caries were more among those who were underweight as well. This can best be explained by the fact that malnutrition may impact the tooth structure and increase dental caries susceptibility (Sadeghi and Alizadeh, 2007). Similarly, a previous study in Thailand (Willershausen *et al.*, 2007) reported that thin and normal weight schoolchildren had higher risk of having a permanent caries score as compared to overweight and obese schoolchildren. The high prevalence of dental caries among the thin weight schoolchildren could probably be related to the defects in the tooth structure which may occur during teeth formation and adverse salivary flow (Sadeghi and Alizadeh, 2007), and therefore increases caries susceptibility.

Obesity and dental caries are both multifactorial in its occurrence. Hence, many studies showed contradicting findings in this area (Ruhaya *et al.*, 2012; Sadeghi and Alizadeh, 2007; Sheiham, 2001). Nutritionally, obesity has been linked to higher energy intake as well as higher sugar intake. This could possibly then explain the relationship with dental caries. However, our study did not prove this, which was similar to other previous study (Zahara *et al.*, 2010). Sugar consumption was not a predictor of dental caries development after conducting the regression analysis. In the current study, mean sugar consumption per day was found to be much lower than children aged 6-12 year old from the Philippines (31.8 vs. 59 g/day) (Yabao *et al.*, 2005). Nevertheless, the sugar intake per day of children in this study was close to the recommendation for children which is at 30 g per day (Sheiham, 2001). Urban children may be more aware of the negative effect of sugar as young children in urban Thailand acknowledged that eating and drinking sweet things will cause tooth decay (Petersen *et al.*, 2001).

A systematic review (Burt and Pai, 2001) concluded that sugar consumption is a more powerful indicator for caries risk in persons who do not have regular exposure to fluoride. The safe level of sugar consumption increases if the fluoride in drinking water is 0.7 - 1.0 ppm (WHO, 2004), and Malaysia is within the recommended fluoride level of 0.5-0.9 mg/L (Shaharuddin *et al.*, 2009). Therefore, the safe level of sugar consumption increases with wide coverage of fluoridated water in urban areas

in Malaysia. Nevertheless, it is advisable for parents to stay attentive on children's sugar consumption patterns, limit the sugar intakes and fermentable carbohydrates, and use fluoridated toothpaste (Kopycka-Kedzierawski *et al.*, 2008) to prevent caries.

The R^2 value of the model appears to be low showing only about 16% of variation of the data into the model. This indicates only 16% of improvement of dental caries may be expected in terms of the variables assessed. However, despite being low, these are important issues to be addressed especially in their oral hygiene and time spent on tooth brushing to ensure proper care are given to their dental health. The sample size also may have a role in the small R value. Hence, for future studies, a larger sample with equal distribution of ethnicity and longitudinal study design may be required to further explore these predictors in dental caries.

In conclusion, dental caries is complex as it involves multiple caries-induced factors. The implications of our study is that certain oral health practices such as time spent on teeth brushing and oral hygiene index was shown to play a role in dental caries in our study participants. Younger children had higher caries experience as compared to older children and therefore, government and health professionals need to continue to develop dental education approaches on oral health practices and also changes of oral health behaviour in combating dental caries problems in younger children.

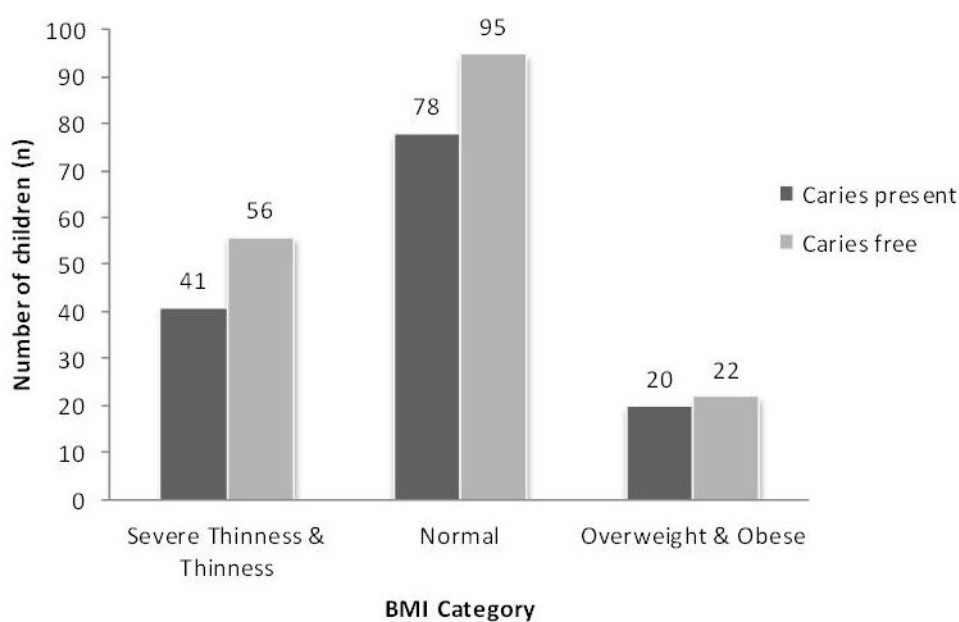


Fig. 1 Percentage of dental caries experience according to their BMI.

Table 1 Socio-demographic characteristics of the children and parents (n=312)

Variables	Children n (%)	Parents n (%)
Gender		
Male	131 (42.0)	
Female	181 (58.0)	
Race		
Malay	151 (48.4)	
Chinese	161 (51.6)	
Age^a	9.3 (1.31)	40.5 (5.77)
Marital Status		
Single		18 (5.8)
Married		294 (94.2)
Educational Level		
Primary		162 (51.9)
Secondary		79 (25.3)
Tertiary		71 (22.8)
Monthly Household Income		
Low (\leq RM1500)		37 (11.9)
Medium (RM1501-RM4500)		150 (48.1)
High (\geq RM4501)		125 (40.1)
^a Mean (SD)		

Table 2 Dental caries according to socio-demographic characteristics and oral health behaviours (n=312)

Variables	Dental caries		Total (% of N)
	No n (%)	Yes n (%)	
dmft ^a		1.27±1.84	
DMFT ^a		1.0±0.4	
Age^b (years)			
7	13 (41.9)	18 (58.1)	31 (9.9)
8	30 (42.9)	40 (57.1)	70 (22.4)
9	27 (39.7)	41 (60.3)	68 (21.8)
10	39 (56.5)	30 (43.4)	69 (22.1)
11	54 (72.9)	20 (27.1)	74 (23.7)
Gender			
Male	69 (52.7)	62 (47.3)	131 (42.0)
Female	94 (51.9)	87 (48.1)	181 (58.0)
Parent's educational level			
Primary	75 (46.3)	87 (53.7)	162 (51.9)
Secondary	48 (60.8)	31 (39.2)	79 (25.3)
Tertiary	40 (56.3)	31 (43.7)	71 (22.8)
Household income			
Low	17 (45.9)	20 (54.1)	37 (11.9)
Medium	77 (51.3)	73 (48.7)	150 (48.1)
High	69 (55.2)	56 (44.8)	125 (40.1)
Frequency of tooth brushing			
Once a day	39 (50.6)	38 (49.3)	77 (24.7)
≥ 2 times per day	124 (52.8)	111 (47.2)	235 (75.3)
Duration of teeth brushing^c			
≤ 1 minute	67 (45.9)	79 (54.1)	146 (46.8)
2- 3 minutes	95 (63.8)	54 (36.2)	149 (47.8)
≥ 4 minutes	11 (64.7)	6 (35.3)	17 (5.4)
Flossing^d			
Yes	46 (66.7)	23 (33.3)	69 (22.1)
No	127 (52.3)	116 (47.7)	243 (77.9)
Dental visits			
Once a year	35 (52.2)	32 (47.7)	67 (21.5)
2 times a year	28 (47.5)	31 (52.5)	59 (18.9)
Only when necessary	107 (58.5)	76 (41.5)	183 (58.7)
Sugar consumption^a	31.64 (4.83)	31.99 (3.50)	31.80 (4.24)

^a Mean(SD); ^b χ^2 (df=4) = 21.328, $p < 0.001$; ^c χ^2 (df=2) = 10.154, $p < 0.01$; ^d χ^2 (df=1) = 4.513, $p < 0.05$

Table 3 Association between age, sugar consumption, oral hygiene and oral health behaviour with dmft using multiple linear regressions

Variables	Unstandardized Coefficients		Standardized Coefficients Beta	t (df)	p-value
	β	SE			
Constant	4.40	1.06		4.20 (311)	<0.001
Child's age	-4.47	0.08	-0.31 (-0.60, -0.30)	-6.04 (311)	<0.001*
Oral hygiene index	0.78	0.25	0.17 (0.28, 1.20)	3.14 (311)	0.002*
Duration of teeth brushing	-0.38	0.17	-0.12 (-0.60,-0.09)	-2.67 (311)	0.023*
Sugar intake/day	0.03	0.02	0.06 (-0.02, 0.07)	1.27 (311)	0.253
Flossing	-0.19	0.24	-0.04 (-0.08, 0.14)	0.50 (311)	0.421

$R^2 = 0.16$; $F(5,306) = 11.6$, * $p < 0.05$

Acknowledgements

The authors would like to extend gratitude to teachers, school children and their parents who willingly participated in this study. Apart from that, gratification is also extended to the Ministry of Health (Dental Division) personnel in approving the study and all dentists that contributed to the study.

References

- Al-Omiri MK, Al-Wahadni AM, Saeed KN (2006). Oral health attitudes, knowledge, and behavior among school children in North Jordan. *J Dent Educ*, **70**(2): 179-187.
- American Academy of Pediatric Dentistry (2014). *Guideline on Caries-risk Assessment and Management for Infants, Children and Adolescents*. Chicago, IL: American Academy of Pediatric Dentistry.
- Bedi R, Sutcliffe P, Donnan P, Barrett N, McConnachie J (2006). Dental caries experience and prevalence of children afraid of dental treatment. *Community Dent Oral Epidemiol*, **20**(6): 368-371.
- Burt BA, Pai S (2001). Sugar consumption and caries risk: a systematic review. *J Dent Educ*, **65**(10): 1017-1023.
- Cheah WL, Tay SP, Chai SC, Bong CS, Baharuddin LH, Che'Jalil ZB (2010). Oral-health knowledge, attitude and practice among secondary school students in Kuching, Sarawak. *Arch Orofac Sci*, **5**(1): 9-16.
- Curnow MM, Pine CM, Burnside G., Nicholson JA, Chesters RK, Huntington E (2002). A randomised controlled trial of the efficacy of supervised toothbrushing in high-caries-risk children. *Caries Res*, **36**(4): 294-300.
- Economic Planning Unit, Malaysia (2013) *Household Income & Poverty: Table 1 - Percentage Distribution of Households by Income Class, Malaysia, 1970-2012*. Available from: <http://www.epu.gov.my/en/household-income-poverty>. Accessed on 24 September, 2014.
- Granville-Garcia AF, de Menezes VA, de Lira PI, Ferreira JM, Leite-Cavalcanti A (2008). Obesity and dental caries among preschool children in Brazil. *Rev Salud Publica*, **10**(5): 788-795.
- Greene JC, Vermillion JR (1960). The oral hygiene index: A method for classifying oral hygiene status. *J Am Dent Assoc*, **61**: 172-179.
- Hagan JF, Shaw JS, Duncan PM (eds.) (2008). *Bright Futures: Guidelines for Health Supervision of Infants, Children, and Adolescents, Third Edition. Pocket Guide*. Elk Grove Village, IL: American Academy of Pediatrics.
- Hallett KB, O'Rourke PK (2006). Pattern and severity of early childhood caries. *Community Dent Oral Epidemiol*, **34**(1): 25-35.
- Kassawara AB, Tagliaferro EP, Cortelazzi KL, Ambrosano GM, Assaf AV, Meneghim Mde C *et al.* (2010). Epidemiological assessment of predictors of caries increment in 7-10-year-olds: a 2-year cohort study. *J Appl Oral Sci*, **18**(2): 116-120.
- Kopycka-Kedzierawski DT, Auinger P, Billings RJ, Weitzman M (2008). Caries status and overweight in 2- to 18-year-old US children: findings from national surveys. *Community Dent Oral Epidemiol*, **36**(2): 157-167.
- Marthaler TM, O'Mullane DM, Vrbic V (1996). The prevalence of dental caries in Europe 1990-1995. ORCA Saturday afternoon symposium 1995. *Caries Res*, **30**(4): 237-255.
- Ministry of Health Singapore (2004). *Nursing Management of Oral Hygiene. MOH Nursing Clinical Practice Guidelines 1/2004*. Singapore: Ministry of Health, Singapore.
- Narang S, Saha S, Jagannath GV, Sahana S, Kumari M, Mohd S (2012). Nutritional status and caries experience among 12 to 15 years old school going children of Lucknow. *J Int Dent Med Res*, **5**(1): 30-35.
- Narksawat K, Tonmukayakul U, Boonthum A (2009). Association between nutritional status and dental caries in permanent dentition among primary schoolchildren aged 12-14 years, Thailand. *Southeast Asian J Trop Med Public Health*, **40**(2): 338-344.
- Oo MMT, Naing L, Mani SA, Ismail AR (2011). Dental caries experience and treatment needs in the mixed dentition in North East Malaysia. *Arch Orofac Sci*, **6**(2): 41-48.
- Petersen PE, Hoerup N, Poomviset N, Prommajan J, Watanapa A (2001). Oral health status and oral health behaviour of urban and rural schoolchildren in Southern Thailand. *Int Dent J*, **51**(2): 95-102.
- Ruhaya H, Jaafar N, Jamaluddin M, Ismail AR, Ismail NM, Badariah TC, Azizah M, Mohamed SZ (2012). Nutritional status and early childhood caries among preschool children in Pasir Mas, Kelantan, Malaysia. *Arch Orofac Sci*, **7**(2): 56-62.

- Sadeghi M, Alizadeh F (2007). Association between dental caries and body mass index-for-age among 6-11-year-old children in Isfahan in 2007. *J Dent Res Dent Clin Dent Prospects*, **1**(3): 119-124.
- Shaharuddin MS, Kamil YM, Ismail YM, Firuz RM, Aizat IS, Yunus AM (2009). Fluoride Concentration in Malaysian Drinking Water. *American-Eurasian J Agric Environ Sci*, **6**(4): 417-420.
- Sheetal A, Hiremath VK, Patil AG, Sajjansetty S, Kumar SR. (2013). Malnutrition and its oral outcome – a review. *J Clin Diagn Res*, **7**(1): 178-180.
- Sheiham A (2001). Dietary effects on dental diseases. *Public Health Nutr*, **4**(2B): 569-591.
- Sogi GM, Bhaskar DJ (2002). Dental caries and oral hygiene status of schoolchildren in Davangere related to their socio-economic levels: an epidemiological study. *J Indian Soc Pedod Prev Dent*, **20**(4): 152-157.
- Touger-Decker R, van Loveren C (2003). Sugars and dental caries. *Am J Clin Nutr*, **78**(4): 881S-892S.
- Wan Salina WS, Nizam A, Naing L (2007). The association of birth order and sociodemographic factors with caries experience among adolescents in Tumpat. *Arch Orofac Sci*, **2**: 45-50.
- Wigen TI, Skaret E, Wang NJ (2009). Dental avoidance behaviour in parent and child as risk indicators for caries in 5-year-old children. *Int J Paediatr Dent*, **19**(6): 431-437.
- Willershausen B, Moschos D, Azrak B, Blettner M (2007). Correlation between oral health and body mass index (BMI) in 2071 Primary School Pupils. *Eur J Med Res*, **12**(7): 295-299.
- Williams NJ, Whittle JG, Gatrell AC (2002). The relationship between socio-demographic characteristics and dental health knowledge and attitudes of parents with young children. *Br Dent J*, **193**(11): 651-654.
- World Health Organization (1997). *Oral Health Surveys: Basic Methods*. 4th edn. Geneva: World Health Organization.
- World Health Organization (2003). *Diet, Nutrition and the Prevention of Chronic Diseases*. WHO Technical Report Series No. 916. Geneva: World Health Organization.
- World Health Organization (2004). *Rolling Revision of the WHO Guidelines for Drinking-Water Quality*. Available from: http://www.who.int/water_sanitation_health/dwq/nutfluoride.pdf. Accessed on 24 September, 2014.
- World Health Organization (2007). *Growth Reference 5-19 Years*. Available from: <http://www.who.int/growthref/en>. Accessed on 24 September, 2014.
- Yabao RN, Duante CA, Velandria FV, Lucas M, Kassu A, Nakamori M *et al.* (2005). Prevalence of dental caries and sugar consumption among 6–12-year-old schoolchildren in La Trinidad, Benguet, Philippines. *Eur J Clin Nutr*, **59**(12): 1429-1438.
- Zahara AM, Fashihah MH, Nurul AY (2010). Relationship between frequency of sugary food and drink consumption with occurrence of dental caries among preschool children in Titiwangsa, Kuala Lumpur. *Malays J Nutr*, **16**(1): 83-90.