DIET, BODY MASS INDEX AND DENTAL CARIES AMONG THAI CHILDREN AGED 3 TO 5 YEARS

Kemthong Mitrakul[1], Malee Arunakul[1], Yuwadee Asvanund[1], Tanai Laisirireoungrai[2], Tharawut Praneechotiros[2] and Peerapol Tevavichulada[2]

[1]Department of Pediatric Dentistry, Faculty of Dentistry, Mahidol University, [2]Dental Student, Faculty of Dentistry, Mahidol University, Bangkok, Thailand

Abstract. Early childhood caries (ECC) can cause pain and interfere with healthy nutrition affecting a child growth. The aim of this study was to determine if there is an association between dental caries and body mass index (BMI) among Thai children aged 3 to 5 years. We randomly selected 100 students attending Suan Missakawan School, Bangkok, Thailand. We examined each child to determine the number of decayed, missing and filled teeth (DMFT) giving a DMFT score. We also measured the height and weight for each subject and calculated their body mass index (BMI) as weight in kilograms divided by height in meter squared. Parents or guardians were asked to complete a questionnaire asking general information and the diet of the child. Data from the questionnaire were analyzed using the Kruskal-Wallis test. Associations between caries and variables were examined using the Spearman's correlation with significance set at $p<0.05$. The mean (±SD) age of the subject, the mean (±SD) DMFT score of the subject and the mean (±SD) BMI for the subjects were 4.21(±0.71) years old, 5.27(±4.78) and 16.46(±2.56) kg/m^2, respectively. Seventy-one percent of subjects had a normal BMI, 25% were overweight and 4% were underweight. Eighteen percent had no caries (DMFT score=0), 32% had a few caries (DMFT score=0.1-3.0), 14% had many caries (DMFT scores=3.1-6.9), and 36% had very many caries (DMFT≥7). The DMFT score was not significantly associated with a history of sugar consumption or BMI. The DMFT score was significantly negatively associated with estimated fat consumption and estimated iron consumption based on the diet reported by the parents or guardians. Further studies are needed to determine if these reported diets reflect actual consumption and if the associations are still significant.

Keywords: dental caries, body mass index, diet, sugar, fat, carbohydrate, young Thai children

INTRODUCTION

Early childhood caries (ECC) can negatively influence quality of life, interrupt routine activities and delay a child's development (Sheiham, 2006). Children with ECC are more likely to develop caries in permanent dentition than children who do not have ECC (Abanto *et al*, 2011). A national survey of dental health among children aged 3-5 years in Thailand found a caries prevalence of ≥50% (Dental Health Division, 2012); even though this rate is lower than a previous rate of 61-81%

Correspondence: Kemthong Mitrakul, Department of Pediatric Dentistry, Faculty of Dentistry, Mahidol University, 6 Yothee Street, Ratchathewi, Bangkok 10400, Thailand.
Tel: +66 (0) 2200 7821-23; Fax: +66 (0) 2200 7820
E-mail: mkemthong@yahoo.com

found in a national survey in 2006-2007 (Dental Health Division, 2006-2007) it is still high.

Dental caries are more common among children with a high sugar diet and among children who consume carbonated soft drinks and sugary snacks (James and Kerr, 2005; Johansson *et al*, 2010; Doichinova *et al*, 2015; Winter *et al*, 2015). The relationship between dental caries and body mass index (BMI) in children has been studied worldwide (Oliveira *et al*, 2008; Norberg *et al*, 2012; Winter *et al*, 2015). Consumption of sugary snacks between meals, high-fructose containing beverages and high carbohydrate foods is associated with higher prevalences of dental caries and obesity (Oliveira *et al*, 2008). However, some studies have found dental caries to be related to a low BMI in children with negative eating habits, such as being a picky eater, leading to malnutrition and inability to consume food adequately (Norberg *et al*, 2012; Winter *et al*, 2015). Some studies found no association between dental caries and body mass index in children (Macek and Mitola, 2006; Mitrakul, 2016). In the US, diet counseling is part of preventive advice given by pediatric dentists (Nunn *et al*, 2009). Pediatric dentists have been recommended to screen their patients for an inappropriate diet (AAPD, 2004). The US Department of Agriculture has developed the Healthy Eating Index (HEI), which measures the quality of diet compare to the recommendations set forth in "Dietary Guidelines for Americans" (Nunn *et al*, 2009). Consumption of a diet high in fruit, dairy products and grains reduced the incidence of ECC was reported by Nunn *et al* (2009).

Studies of an association between dental caries and body mass index (BMI) among Thai children are limited. One study done by Narksawat *et al* (2009) found Thai children with a normal BMI had fewer decayed, missing and filled teeth (DMFT) than underweight children; they also found children with the lowest number of DMFT had a higher BMI. Mitrakul *et al* (2016) evaluated Thai children aged 6 to 12 years using a Thai diet analysis computer program developed by the Institute of Nutrition, Mahidol University called INMUCAL-nutrients (Institute of Nutrition, Mahidol University Calculation). They found no significant association between BMI and dental caries and the amount of sugar and carbohydrate consumption and dental caries. They also found negative association between sugar and carbohydrate consumption and dental caries. In addition, overweight and underweight children did not have a higher caries incidence than normal weight children.

The purpose of this study was to evaluate the association between dental caries and BMI and diet among children aged 3 to 5 years.

MATERIALS AND METHODS

Subject selection

We conducted a cross-sectional study of randomly selected kindergarten student aged 3 to 5 years old attending Suan Missakawan School, a government school in Bangkok, Thailand. This school we chose because it is near the Faculty of Dentistry, Mahidol University. Students with systemic disease, communication disorders or whom were taking antibiotics were excluded from the study.

The minimal sample size was calculated based on the McNemar test using nQuery Advisor program (Statistical Solution, Saugus, MA). The minimum number of subjects was calculated to be 100 in order to achieve a type I error of

Table 1
BMI and DMFT score distribution among 100 study subjects.

	Mean±SD or percentage
Age (years)	4.21 ± 0.71
BMI (kg/m^2)	16.46 ± 2.56
Underweight	4%
Normal	71%
Overweight	25%
Caries (DMFT scores)	5.27 ±4.78
No caries (0)	18%
Few caries (<3)	32%
Many caries (3.1-6.9)	14%
Very many caries (≥7)	36%

DMFT, decayed, missing and filled teeth; BMI, body mass index; SD, standard deviation.

5%, a Type II error of 15% and a power of 85% (Mitrakul *et al*, 2016).

The questionnaire and nutritional recording

Parents or guardians of participants were asked to complete a questionnaire. This questionnaire has been used in previous studies (Mitrakul *et al*, 2013, 2016). The questions were divided into 3 categories: 1) caregiver general information (age, career, education level, monthly income, caregiver relationship with subject and subject's oral hygiene care); 2) subject's general information (age, gender, dental insurance coverage, time watching television per day; 3) caregiver attitude about subject's diet (the number of times a day the subject brushes their teeth, whether the subject uses fluoride toothpaste or not, the type and frequency of snacks, when was the subject was last seen by a dentist, the types of snacks consumed, including meat, fresh fruit, fruit juice, sugary beverages, candies, gum, crispy crackers, bread, Thai desserts, sugar coated crackers, and whether the subject eats snacks while watching television).

Caregivers were asked to retrospectively record the child's diet for 3 days. Nutritional data were analyzed using the INMUCAL-nutrients® program. This program gives nutritional information about Thai food, desserts and an analysis of daily nutrients, which includes protein, sugars, fat, cholesterol, calcium, iron, vitamins A, B1, B2, C and niacin.

Oral examination and BMI measurement

All dental examinations were done by one undergraduate dental student. The dental examination was done using a natural light following World Health Organization criteria (Mohammadi *et al*, 2012). Weight and height were measured using a calibrated digital scale (SECA 888 Digital Scale, Hambury, Germany) and a standing wall measure. The BMI of each study subject was categorized using WHO criteria: 1) BMI < 13.25: underweight; 2) BMI 13.26-17.5: normal; 3) BMI 17.5-18.5: overweight; 4) BMI > 18.5: obese (Mohammadi *et al*, 2012). Primary DMFT was identified and recorded. DMFT scores were calculated for each child. The scores were categorized into 4 groups based on

WHO criteria: 1) DMFT < 3: few caries; 2) DMFT=3.1-4.5: moderate caries; 3) DMFT=4.6-6.9: many caries; 4) DMFT > 7: very many caries (Mohammadi *et al*, 2012).

Statistical analysis

Data from the questionnaires, oral examination and BMI were analyzed using the Kruskal-Wallis test (p=0.05). The associations between variables and BMI were analyzed using the Spearman's correlation (p=0.05).

Ethical approval

This study was approved by the Ethics Committee on Human Research, Faculty of Pharmacy and Faculty of Dentistry, Mahidol University (MU-DT/PY-IRB 2015/053.2710). The parents of each subjects gave written informed consent prior to the subject participating in this study. All subjects were free to withdraw from the study at any time.

RESULTS

One hundred subjects participated in this study (dropout rate=0%). Mean age, DMFT score and BMI were 4.21±0.71 years old, 5.27±4.78 and 16.46±2.56 kg/m^2, respectively. Seventy-one percent of subjects had a normal BMI, 4% were underweight and 25% were overweight. Eighteen percent of subjects had no caries (DMFT score=0), 32% had few caries (DMFT score=<3), 14% had many caries (DMFT score=3.1-6.9), and 36% had very many caries (DMFT score ≥7) (Table 1). No association was found between the DMFT score and BMI among study subjects.

No associations were seen between age, total monthly parental income, parental levels education, and DMFT scores (Table 2). We found a negative association between fat and iron consumption (Table 3).

DISCUSSION

In this study, we found no association between DMFT scores, carbohydrate, sugar consumption and BMI. These results are similar to previous studies that showed no association between dental caries and BMI among pre-school and school-aged children among Iranian and Thai children (Bagherian and Sadeghi, 2013; Mitrakul *et al*, 2016). Chen *et al* (1998) found no association between DMFT scores and nutritional status among 3 year old children with obesity. Macek and Mitola (2006) found no association between BMI and age and dental caries among children with primary dentition. A previous study found being overweight was not associated with an increased prevalence of dental caries in primary or permanent teeth, nor was it associated with a high DMFT score in primary dentition (Oliveira *et al*, 2008). These findings imply the relationship between being overweight and dental caries in children is complex and may not be explained by carbohydrate consumption alone (Mohammadi *et al*, 2012).

A systematic review of the associations between obesity and dental caries among children, adolescents and adults reported in 33 papers published during 1984-2004 in English (Heyden *et al*, 2013) found: children who had a BMI indicating they were overweight had more caries and higher mean DMFT scores than children with a normal BMI (Oliveira *et al*, 2008, Mohammadi *et al*, 2012). When further categorized into permanent and primary teeth, childhood obesity was significantly associated with dental caries in permanent teeth in children (Hong *et al*, 2008). Our study findings are different from Narksawat *et al* (2009) study, in that Thai children with a normal BMI had a

Table 2
Selected characteristics of study subjects and their families.

Studied characteristic	Number	Mean±SD	*p*-value[a]
Age (years)			
3	28	3.79±4.58	0.062
4	38	5.89±4.67	
5	34	5.79±4.91	
Total monthly family income (baht)			
<10,000	10	5.60±6.59	0.531
10,001-20,000	31	5.84±4.81	
20,001-30,000	32	5.31±4.12	
30,001-40,000	14	4.64±4.47	
40,001-50,000	8	2.50±3.33	
>50,000	5	7.00±7.10	
Parental education level			
Primary school	13	5.38±4.29	0.145
High school	34	6.56±4.92	
Diploma degree	11	2.91±4.30	
Bachelor degree	36	4.67±4.76	
Master degree	6	2.50±3.33	
Subject gender			
Male	51	5.65±5.12	0.613
Female	49	4.88±4.40	
BMI			
Underweight	4	3.00±4.24	0.157
Normal	71	5.77±4.87	
Overweight	25	4.20±4.43	

[a]Kruskal-Wallis test at $p<0.05$.

Table 3
Nutrients per day reported by parents of the study subjects.

Nutrient (mg/day)	Mean±SD	*R*	*p*-value
Carbohydrate	182.60±79.87	-0.133	0.188
Fat	61.06±32.15	-0.197	0.049
Protein	62.67±27.91	-0.151	0.133
Calcium	721.08±379.19	-0.196	0.051
Iron	9.89±10.40	-0.205	0.040
Vitamin A	445.42±429.19	-0.140	0.164
Vitamin B1	1.07±1.74	0.028	0.780
Vitamin B2	1.69±0.82	-0.172	0.087
Vitamin C	36.59±63.13	-0.107	0.287
Niacin	8.93±2.56	-0.096	0.341

Spearman's correlation.

lower DMFT scores than those with an underweight BMI, and those with the lowest DMFT scores were children with a high BMI. Previous studies in populations with high levels of nutritional deficiency found underweight children had more caries in their primary teeth (Matheson *et al*, 2004; Sisson *et al*, 2009).

In our study, we found an association between dental caries and iron and fat consumption. Sadeghi *et al* (2012) found a higher serum iron levels was associated with lower DMFT scores among children aged 24-71 months. Nunn *et al* (2009) found overweight subjects had higher percents of body fat but fewer DMFT scores.

There were some limitations in this study. First, no cause-effect relationship can be deduced from the cross sectional study. Part of the data were obtained from self-reports and subject to recall bias. This study used convenience sampling, which did not represent the population. A larger sample size, random sampling and a diet journal for longer than 3 days are needed to provide more nutritional data.

In summary, our study found no significant association between caries and BMI or diet, suggesting these relationships are more complex. A longitudinal study with a larger sample size is needed to better evaluate these relationships in the study population.

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REFERENCES

Abanto J, Carvalho TS, Mendes FM, Wanderley MT, Bonecker M, Raggio DP. Impact of oral diseases and disorders on oral health-related quality of life of preschool children. *Community Dent Oral Epidemiol* 2011; 39: 105-14.

American Academy of Pediatrics Committee on School Health (AAPD). Soft drinks in schools. *Pediatrics* 2004; 113: 152-4.

Bagherian A, Sadeghi M. Association between dental caries and age-specific body mass index in preschool children of an Iranian population. *Indian J Dent Res* 2013; 24: 66-70.

Chen W, Chen P, Chen SC, Shih WT, Hu HC. Lack of association between obesity and dental caries in three-year-old children. *Acta Paediatr Sin* 1998; 39: 109-11.

Dental Health Division, Ministry of Public Health, Thailand. The 6th National Dental Health Status Survey. Nonthaburi: Dental Health Division, 2006-2007.

Dental Health Division, Ministry of Public Health, Thailand. The 7th National Dental Health Status Survey. Nonthaburi: Dental Health Division, 2012.

Doichinova L, Bakardjiev P, Peneva M. Assessment of food habits in children aged 6-12 years and the risk of caries. *Biotechnol Biotechnol Equipm* 2015; 29: 200-4.

Heyden C, Bowler JO, Chambers S, *et al*. Obesity and dental caries in children: a systematic review and meta-analysis. *Community Dent Oral Epidermiol* 2013; 41: 298-308.

Hong L, Ahmed A, McCunniff M, Overman P, Mathew M. Obesity and dental caries in children aged 2-6 years in the United States: national health and nutrition examination survey 1999-2002. *J Public Health Dent* 2008; 68: 227-33.

James J, Kerr D. Prevention of childhood obesity by reducing soft drinks. *Int J Obes* (Lond) 2005; 29 (suppl 2): S54-7.

Johansson I, Holgerson PL, Kressin NR, Nunn ME, Tanner AC. Snacking habits and caries in young children. *Caries Res* 2010; 44: 421-30.

Macek MD, Mitola DJ. Exploring the association between overweight and dental caries among US children. *Pediatr Dent* 2006; 28: 375-80.

Matheson DM, Killen JD, Wang Y, Varady A, Robinson TN. Children's food consumption during television viewing. *Am J Clin Nutr* 2004; 79: 1088-94.

Mitrakul K. Assessing associations between caries prevalence and body mass index and nutrition data among children aged in 6-12 years. *Southeast Asian J Trop Med Public Health* 2016; 47: 152-9.

Mitrakul K, Vongsavan K, Suratanachaikul P. Prevalence of *Streptococcus mutans* and *Lactobacillus fermentum* in plaque and their association with early childhood caries and dietary habits. *Eur Arch Paediatr Dent* 2013; 14: 83-7.

Mohammadi TM, Hossienian Z, Bakhteyar M. The association of body mass index with dental caries in an Iranian sample of children. *JOHOE* 2012; 1: 29-35.

Narksawat K, Tonmukayakul U, Boonthum A. 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* 2009; 40: 338-44.

Norberg C, Hallstrom Stalin U, Matsson L, Thorngren-Jerneck K, Klingberg G. Body mass index (BMI) and dental caries in 5-year-old children from southern Sweden. *Community Dentistry Oral Epidemiol* 2012; 40: 315-22.

Nunn ME, Braunstein NS, Krall Kaye EA, Dietrich T, Garcia RI, Henshaw MM. Healthy eating index is a predictor of early childhood caries. *J Dent Res* 2009; 88: 361-6.

Oliveira LB, Sheiham A, Bonecker M. Exploring the association of dental caries with social factors and nutritional status in Brazilian preschool children. *Eur J Oral Sci* 2008; 116: 37-43.

Sadeghi M, Darakhshan R, Bagherian A. Is there an association between early childhood caries and serum iron and serum ferritin levels? *Dent Res J (Isfahan)* 2012; 9: 294-8.

Sheiham A. Dental caries affects body weight, growth and quality of life in pre-school children. *Br Dent J* 2006; 201: 625-6.

Sisson SB, Church TS, Martin CK, *et al*. Profiles of sedentary behavior in children and adolescents: the US National Health and Nutrition Examination Survey, 2001-2006. *Int J Pediatr Obes* 2009; 4: 353-9.

Supasyndh O, Satirapoj B, Seenamngoen S, Yongsiri S, Choovichian P, Vanichakarn S. Nutritional status of twice and thrice-weekly hemodialysis patients with weekly Kt/V > 3.6. *J Med Assoc Thai* 2009; 92: 624-31.

Winter J, Glaser M, Heinzel-Gutenbrunner M, Pieper K. Association of caries increment in preschool children with nutritional and preventive variables. *Clin Oral Invest* 2015; 19: 1913-9.