

Letter to the Editor

**Association between BMI and Dental Caries among School Children and Adolescents in Jiangsu Province, China***

LI Wei^{1,^}, Taha Hussein Musa^{2,^}, GAO Rong^{3,^}, LI Xiao Shan², WANG Wei Xiang¹,
HONG Lei^{1,#}, and WEI Ping Min^{2,#}

Obesity and dental caries are increasing epidemics, especially among children and adolescents. This epidemiological observational cross-sectional study was conducted to assess the possible association between body mass index (BMI) and dental caries among 111,792 school children and adolescents in Jiangsu Province. We found that 13.14% participants of the study sample were overweight, and 7.37% were obese. The prevalence of dental caries was 12.95% in overweight and 7.89% in obese students. There were significant differences in caries prevalence by sex, region, age group, and BMI. Overweight and obesity statuses were associated with dental caries among the study population. BMI and dental caries present a continuous health problem. Thus, we recommend that oral health promotion be used for caries prevention and control.

Obesity has reached epidemic levels in recent years and remains a global public health problem worldwide despite improvements in oral disease prevention programs. Additionally, the prevalence of oral disease has rapidly increased in a number of low- and middle-income countries, accelerated by the greatest burden and higher risk factors, such as presenting in changes of eating habits, use of tobacco, excessive consumption of alcohol, and weak oral hygiene habits. In addition to limited availability and accessibility of oral health services, a lack of health promotion is associated with poor oral health^[1].

In addition to demonstrating the effect of obesity on oral health status, recent studies have identified that fluoride intake is significantly associated with a higher prevalence of dental

fluorosis. As a result, some concerns were raised about the sources of drinking water^[2]. One study showed a relationship between daily total fluoride intake and dental fluorosis and dental caries and revealed a significantly negative dose-response relationship between the total daily fluoride intake and the overall prevalence of dental caries^[3].

While some studies found no association between BMI-for-age and dental caries for children especially in permanent level, others found no significant differences for decayed, missing, and filled teeth (DMFT) at gender level among children in Portugal^[4] despite the fact that another study conducted in German elementary school children reported that the body height, weight, and age were significantly associated with caries frequency^[5]. However, an inverse association between dental caries and subsequent changes in BMI was reported among children with well-educated mothers, suggesting that a high incidence of dental caries may be an indicator of a low future risk of overweight status^[6]. Other studies in Iran reported no association between BMI and dental caries^[7].

In addition, other studies found that BMI is associated with increased dental caries prevalence. Moreover, the overweight was found to be associated with lower average means of DMFT, and no significant association between BMI-for-age and dental caries was reported among US children^[8]. In China, there is a noticeable unstable decline in the proportion of dental carries by sex, region, and age levels. Despite the greater improvements in oral health services, the prevalence of dental caries remains high among Chinese populations^[9].

doi: 10.3967/bes2017.101

*This work was fully supported by a Jiangsu Provincial Social Science Foundation Grant (13TYA001); and major Projects in the Nanjing Municipal Health and Family Planning Commission Program during the Thirteenth Five-Year Plan Period (ZDX16020).

1. Department of Infectious Disease Prevention and School Health, Nanjing Municipal Center for Disease Control and Prevention, Nanjing 210009, Jiangsu, China; 2. Key Laboratory of Environmental Medicine Engineering, Ministry of Education, Department of Epidemiology and Biostatistics, School of Public Health, Southeast University, Nanjing 210009, Jiangsu, China; 3. Department of Microbiology and Immunology, Medical School of Southeast University, Nanjing 210009, Jiangsu, China

Until now, little is known about the reasons of the increase in the prevalence of dental caries among Chinese populations although there are similar increasing trends have been seen in various populations over the world.

This study aimed to investigate the possible association between BMI and dental caries among children and adolescents aged 7-17 years in Jiangsu Province, China. The study population consisted of 111,792 school children and adolescents (55,828 girls and 55,964 boys) for whom we had complete information on anthropometric and dental caries examinations conducted in a follow-up of student's oral health status in Jiangsu Province over the 2010-2013.

School children and adolescents aged between 7 and 17 years were selected from 10 universities and 82 schools in Jiangsu Province, which has a total population of more than 79,800,000 (2015 estimate), is located on the eastern-central coastal of People's Republic of China (PRC) and covers an area of 102,600 km². The study population was divided by sex, age groups, region, and BMI categories.

Anthropometric measurements were taken before to the dental examination by an investigator who was trained to conduct body fitness measurements. A standard protocol for performing the measurements was followed. Each student's body weight and height were measured during the physical and health survey. Weight was measured in kilograms using a beam balance scale (RGT-140; Weighting Apparatus Co. Ltd., Changzhou, Wujin, China) with an error of < 0.1 kg. Students were measured in bare feet in a light school uniform and empty pockets. Height was measured in meters without shoes using a stadiometer. The BMI was calculated using the standard formula of weight in kilograms (kg) divided by height in meters squared (m²). Overall, the measured BMI, height, and weight of each subject were recorded at the same time of the clinical examination.

Dental caries were diagnosed in primary dentition according to World Health Organization criteria and in permanent dentition according to the DMFT index^[1]. All subjects were clinically examined for dental caries. A clinical caries test for students was carried out using a dental explorer and mouth mirror under clinical lighting, so four guardant orders to test prediction sites of teeth using of caries and no filling caries were diagnosed no caries. Or else were diagnosed caries. Dental X-rays supported the diagnosis of dental caries at the clinical level;

however, no X-rays were taken. Both practices employed two dental practitioners during September of each year and continued up to 2 weeks. Dental professionals performed the dental caries investigation during the study period. The DMFT index scores were extracted from the personal dental health records of the referral center for pediatric dental care and the general dental practice in each city. Finally, caries recorded from each student were checked for logical errors and then transformed to the Health Literacy Promotion and Research Office in Jiangsu Province.

A statistical analysis of the epidemiological observational cross-sectional study data was performed using SPSS 19.0 for Windows (SPSS, Chicago, IL, USA). The significance level was set at $P < 0.05$.

Descriptive summary statistics were generated for all groups. Statistical comparisons were performed using Pearson's χ^2 tests or Fisher's exact test as appropriate. The association between caries experience and BMI was evaluated using logistic regression analysis.

A total of 111,792 school children and adolescents were investigated during the baseline follow-up period of 2010 to 2013 in Jiangsu Province with a 92.22% response rate. Among the study participants, 50.00% were living in the urban region and 50.00% were living in a rural area. The prevalence of students with dental caries was 21.35% with reported dental caries and 78.65% without dental caries. According to the BMI calculations, 79.50% subjects were of normal weight, 13.14% were overweight, and 7.37% were obese (Table 1).

Table 1. Demographic Characteristics of Study

Characteristics	N (%)
Gender	
Male	55,964 (50.06)
Female	55,828 (49.94)
Age groups (y)	
7-11	48,691 (43.55)
12-14	36,403 (32.56)
15-17	26,698 (23.88)
BMI Level	
Normal weight	88,872 (79.50)
Overweight	14,680 (13.14)
Obesity	8,240 (7.37)
Dental caries	
No	87,923 (78.65)
Yes	23,869 (21.35)
Region	
Urban	55,901 (50.00)
Rural	55,891 (50.00)

The comparison of dental caries prevalence showed that more female than male students had a caries diagnosis ($P < 0.001$). Statistically significant differences in dental caries were reported by age group ($\chi^2 = 5251.84$; $P < 0.001$) and BMI categories ($\chi^2 = 12.41$; $P < 0.05$), and differences in socioeconomic backgrounds were seen between urban and rural areas ($\chi^2 = 19.12$; $P < 0.001$) (Table 2). Table 3 shows the logistic regression analysis, which revealed a higher prevalence of dental caries in the 12–14-year-old group [odds ratio (OR), 3.79; 95% confidence interval (CI), 3.63-3.96] and the 15–17-year-old group (OR, 1.56; 95% CI, 1.49-1.64). In addition, the prevalence of dental caries was associated

with overweight (OR, 1.14; 95% CI, 1.08-1.20) and obesity (OR, 1.07; 95% CI, 1.0-1.14) school children and adolescents during the follow-up period.

To the best of our knowledge, in the past two decades, obesity rates have increased steadily in many countries, particularly in children and adolescents^[4-5]. The increasing obesity rate has accompanied an increased dental caries prevalence and severity and created numerous health problems among school children^[8]. Therefore, this is the first large epidemiological observational cross-sectional study to demonstrate the association between BMI and dental caries in school children and adolescents within Jiangsu Province, China.

Table 2. Prevalence of Dental Caries among School Children and Adolescents, 2010-2013

Characteristics	Normal, n (%)	Dental Caries, n (%)	χ^2	P-value
Gender				
Male	44,669 (79.82)	11,295 (20.18)	91.14	< 0.001
Female	43,254 (77.48)	12,574 (22.52)		
Region				
Urban	44,265 (79.18)	11,636 (20.82)	19.12	< 0.001
Rural	43,658 (78.11)	12,233 (21.89)		
Age groups (y)				
7-11	33,482 (68.76)	15,209 (31.24)	5251.84	< 0.001
12-14	30,631 (84.14)	5,772 (15.86)		
15-17	23,810 (89.18)	2,888 (10.82)		
BMI level				
Normal weight	69,979 (78.74)	18,893 (21.26)	12.41	< 0.05
Overweight	11,588 (78.94)	3,092 (21.06)		
Obesity	6,356 (77.14)	1,884 (22.86)		

Table 3. Risk Factor for Dental Caries, 2010-2013

Characteristics	β	SE	Wald	OR (95% CI)	P-value
Region	-0.05	0.02	12.23	0.95 (0.92-0.98)	< 0.001
Gender	-0.14	0.02	82.43	0.87 (0.85-0.90)	< 0.001
Age groups (7-11 y)			4971.18		< 0.001
Age groups (12-14 y)	1.33	0.02	3631.02	3.79 (3.63-3.96)	< 0.001
Age groups (15-17 y)	0.44	0.02	332.93	1.56 (1.49-1.64)	< 0.001
BMI level (normal weight)			26.04		< 0.001
BMI level (overweight)	0.13	0.03	20.83	1.14 (1.08-1.20)	< 0.001
BMI level (obesity)	0.07	0.03	3.69	1.07 (1.0-1.14)	0.055
Constant	-2.14	0.04	3499.27	0.12	< 0.001

Increased health risks of dental caries were previously reported to be associated with obesity^[5].

This study revealed that 21.35% of school children and adolescents had dental caries. Thus, our finding was lower than that among 13-year-old adolescents in Portugal^[4], while the dental caries prevalence in Jiangsu province was found lower than it was reported among primary and secondary school children in Shenyang the largest city of Liaoning Province, Liaoning Province, Jiangsu Province^[10]. Furthermore, previous studies have explored the association between BMI and caries in children and adolescents^[4-8], but it remains poorly understood. Our study findings indicate that overweight and obesity are significantly associated with caries prevalence, and obesity has been noted to have an indirect effect on oral health problems and other health concerns^[5,8-9].

Lempert et al. reported conflicting finding that, an inverse association between caries and BMI among children of well-educated mothers^[6]. Finally, to our knowledge, this is one of the very few studies, to report the prevalence of dental caries and BMI-for-age in school children and adolescents, as others did not report any correlation between BMI and dental caries^[7].

The epidemiology of dental caries in Chinese populations is currently poorly understood, and our study findings help explain the outcomes between caries and BMI level. Furthermore, the frequency of dental caries prevalence decreased as age group increased. In summary, overweight and obesity were associated with the risk of dental caries among the study population. Another question raised during the analysis is that BMI is significantly associated with risk factors for caries among the study population. Due to these findings, we recommend that comprehensive oral health promotion activities may be the key to dental caries prevention and control.

We highly appreciate the outstanding staff of Student's Health Literacy Promotion and Research in Jiangsu Province and wish to express our gratitude to the medical staff and health officers of Jiangsu Provisional Center for Disease Control and Prevention for their extraordinary contributions. We also thank the students, teachers, and health workers in the rural and urban areas of Jiangsu Province for their kind cooperation and assistance during the study period.

The authors declare no conflicts of interest.

The study protocol was discussed and approved by the institutional review board, while the study was approved by the School of Public Health and Student's Health Literacy Promotion and Research in Jiangsu Province.

[^]These authors contributed equally to this work.

[#]Correspondence should be addressed to WEI Ping Min, Tel: 86-25-83243899, Fax: 86-21-64338864, E-mail: mpw1963@126.com; HONG Lei, E-mail: 930582@qq.com

Biographical notes of the first authors: LI Wei, male, born in 1984, master's degree majoring in infectious disease prevention; Taha Hussein Musa, male, born in 1978, PhD student, majoring in epidemiology and biostatistics; GAO Rong, female, born in 1987, doctor degree, majoring in clinical laboratory diagnostics.

Received: June 19, 2017;

Accepted: October 1, 2017

REFERENCES

1. World Health Organization. Oral health surveys: basic methods, Fifth Edition: World Health Organization, 2013. <http://www.icd.org/content/publications/WHO-Oral-Health-Surveys-Basic-Methods-5th-Edition-2013.pdf>. [2017-3-1]
2. Mahvi AH, Zazoli MA, Younecian M, et al. Survey of fluoride concentration in drinking water sources and prevalence of DMFT in the 12 years old students in Behshar City. *J Med Sci*, 2006; 6, 658-1.
3. Xiang Q, Zhou M, Wu M, et al. Relationships between daily total fluoride intake and dental fluorosis and dental caries. *J Nanjing Med Univer*, 2009; 23, 33-9.
4. Frias-Bulhosa J, Barbosa P, Gomes E, et al. Association between body mass index and caries among 13-year-old population in Castelo de Paiva, Portugal. *Revista Portuguesa de Estomatologia, Medicina Dentária e Cirurgia Maxilofacial*, 2015; 56, 3-8.
5. Willerhausen B, Blettner M, Kasaj A, et al. Association between body mass index and dental health in 1,290 children of elementary schools in a German city. *Clin Oral Investing*, 2007; 11, 195e200.
6. Lempert SM, Froberg K, Christensen LB, et al. Association between body mass index and caries among children and adolescents. *J Dent Child*, 2016; 83, 146-51. (In Chinese)
7. Sadeghi M, Lynch CD, Arsalan A. Arsalans there a correlation between dental caries and body mass index-for-age among adolescents in Iran? *Community Dent Health*, 2011; 28, 174-7.
8. Macek MD, Mitola DJ. Exploring the association between overweight and dental caries among US children. *Pediatr Dent*, 2006; 28, 375-80.
9. Hu DY, Hong X, Li X. Oral health in China trends and challenges. *Int J Oral Sci*, 2011; 3, 7-12.
10. CHEN R, ZHANG D, TAN YING H. Prevalence of dental caries among primary and secondary school students in Shenyang city. *Chin J Public Health*, 2010; 1, 016. (In Chinese)