Original Article

Sugary beverage intakes and obesity prevalence among junior high school students in Beijing – a cross-sectional research on SSBs intake

Meng Jia MS†, Chao Wang MD†, Yumei Zhang PhD, Yingdong Zheng PhD, Long Zhang MD, Yanjie Huang MD, Peiyu Wang PhD

School of Public Health, Peking University, Beijing, China

Background: Excessive consumption of sugar-sweetened beverages (SSBs) may increase the risk of obesity. Data in regards to the consumption of SSBs is insufficient in the Chinese population, especially in middle school students experiencing rapid nutritional transition. We aimed to describe the consumption of SSBs among junior high school students and explore the relationship between SSB intake and adolescents' overweight/obesity in Beijing. Methods: This was a cross-sectional study under which 322 (46%) male and 380 (54%) female (age 11-15 y, median 13 y) were recruited from two middle schools of Xicheng District in Beijing. All subjects completed a questionnaire and 24-hour dietary recall for 3 consecutive days. Results: Prevalence of overweight was 21.1% in males and 11.6% in females. Prevalence of obesity was 22.7% in males and 10.3% in females. Of the students, 7.7% consumed SSBs at least once per day. Students whose storage of SSBs at home is more than 1 type are more likely to consume higher quantities of SSBs everyday (p<0.001). After adjusting for confounding factors, OR of high SSBs intake group versus low SSBs intake group was 2.6. Students whose parents had a higher BMI had a higher risk of overweight/obesity (OR=1.13, p=0.007). Conclusions: Among middle school students in Beijing, prevalence of obesity is more severe than that of overweight. Sugar-sweetened beverages have been the most popular drinks, and consumption of SSBs has a positive association with levels of overweight/obesity among male students.

Key Words: beverages, energy, overweight, obesity, dietary

INTRODUCTION

Prevalence of overweight and obesity has increased rapidly in recent decades and has been a serious health issue in many countries. In China, along with rapid development of the economy and swift transition of lifestyles, the problem of overweight/obesity is becoming increasingly evident. According to the report by Working Group on Obesity in China (WGOC), the prevalence of overweight/obesity among adolescents in China is approaching the level in moderately developed countries. Obesity during adolescence can not only cause contemporary physiological and psychological problems, but also increase the risk of diabetes, hyperlipidemia and cardiac cerebral and vascular diseases in adulthood. Therefore, it is imperative to carry out public health intervention promptly and actively reduce risk factors of obesity.

Many researches have revealed that overweight/obesity is influenced by genetic factor, excessive energy intake and lack of physical activity. At the same time, excessive sugar-sweetened beverages (SSBs) intake might also be another important risk factor related to overweight/obesity. Several studies have identified a positive relationship,[1-6] while others have not.[7-11] A study in America found that the prevalence of obesity increased 1.6 times when children drank an extra cup of SSBs every day.[12] Coke consumption per capita in Mexico is the highest in the world, and its obesity rate is ranked number two throughout the world, with the USA in first place. The energy proportions that adolescents and adults take from SSBs versus total energy intake everyday are 20.1% and 22.3%, respectively.[13] Most SSBs are energy dense, and will lead to satiety frequently compared to solid food. So it is easy for individuals to consume excessive sugar and energy by drinking SSBs. Consequently, more than 30 countries and districts have established regulations to restrict or prohibit the flow of SSBs into campus, as one way of reducing overweight/obesity.[14] So far, there is no relevant policy or regulation carried out in China. Considering the controversial results in this field and the significance the results might have on the health prevention system among adolescents, in this survey, we aimed to explore the relationship between SSBs intake and overweight/obesity among adolescents in Beijing, China. Presumably the findings

Corresponding Author: Dr Yumei Zhang, School of Public Health, Peking University, No.38 XueYuan Road, Haidian District, Beijing, China.
Tel: +86-15001010693; Fax: +86-01082802502
Email: zhangyumei@hsc.pku.edu.cn
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†First two authors contributed equally to this work.

from the current study will help policy makers to make decision on the control on the consumption of SSBs and the prevention of obesity, especially for adolescents in China in the long term.

MATERIALS AND METHODS

Subjects

This survey was a cross-sectional study. After approval by Center for Disease Control (CDC) of Xicheng District, Beijing, two junior high schools in Xicheng District were selected after stratification by the school scale. A total of 1085 students were included with informed consent signed and a questionnaire was distributed. The students were between 11 and 15 years old from Grade 7 or 8. The ratio of male to female was 1.2:1. Physical examination data including body weight (to the nearest 0.1 kg) and height (to the nearest 0.1 cm) of the subjects were obtained, which were measured 2 months before the survey. Finally, 702 completed surveys were retrieved. The data was collected on December 28, 2010.

Questionnaire components

We used a self-administered questionnaire including two parts and each was completed by student and parent separately. The questionnaire for the students mainly include the following variables: 1) social demographic characteristics (gender, age, nationality, hometown, etc.); 2) physical activities; 3) intake of SSBs (frequency, quantity, intake habit, etc.) and other types of drinks (pure water, pure milk and soybean milk, etc.)' and 4) 24-hour dietary recalls for 3 consecutive days (Thursday, Friday and Saturday). Similarly, for the parents' part, the variables primarily contain: 1) social demographic characteristics (age, height, weight, etc.) and 2) SSBs intake status of their children. Definition of SSBs was explained in the introduction of the questionnaire.

Field research

The 24-hour dietary recalls and the parents' part of the questionnaire were completed at home. All other parts were conducted by investigators after school lunch time. All investigators were trained by professional researchers before the survey, and one investigator was assigned to each class. After informed consent from the subjects were obtained, the investigator distributed questionnaire and make sure that students fully understand the purpose of the study and the precise definition of SSBs. Investigators were with the students during the completion of the questionnaire in case there were further questions.

Dietary research

24-hour dietary recalls for 3 consecutive days (2 weekdays and 1 weekend day) were used in this study to collect nutritional information. On the survey day, students completed the breakfast and lunch recall of that day with the assistance from investigators. The remaining part (supper that day and dietary intake in the subsequent 2 days) were completed by the students after school with the help of their parents.

The school lunch was a nutritious meal distributed by a specific food corporation. To increase the validity of the research, with the permission, we finally got the lunch recipes of the 2 survey weekdays from the corporation. When students recalled the lunch at school, they only needed to fill out the proportions they finished: the whole meal, 1/2, 1/3 or 1/4, and noted that if there were any selection of specific ingredient.

We have to emphasize that the dietary recall did not include the consumption of drink, so SSBs intake was excluded from the calculation of total energy intake. Data entry was performed by well-trained investigators using Epidata, and specific software was used to calculate the nutrients generated by the foods.

Definition of overweight/obesity

From the data of the 2010 Beijing primary and middle school students health physical examination, height (to the nearest 0.1 cm) and body weight (to the nearest 0.1 kg) were obtained; BMI was calculated in the form of weight (kg) divided by square of height (m^2). We defined overweight/obesity in male and female students according to WGOC overweight/obesity screening standard of BMI for school age children (Table1).

Statistical analysis

Statistical analysis included binary and multifactor analysis. Frequency and percentage were used to describe the consumption condition. T-test and chi-square test were used to identify if there were difference between different levels of SSBs intake and degrees of anthropometric measurements, health-related behavior and consumption behavior. Logistic regression analysis was used to identify risk factors that influence the consumption of SSBs. Finally, logistic regression model was used to evaluate OR and 95% CI of factors related to overweight/obesity, such as gender, age, SSBs intake level, physical activity (active, negative), experience of dietary education (never, occasionally, always), experience of physical education (never, occasionally, always), and frequency of dining out (<2, 2-4, >4 times/wk). Total energy intake was adjusted. SPSS16.0 (Chicago, IL, USA) was used for the analysis, and the test level was defined as α=0.05 (bilateral).

RESULTS

Proportion of overweight/obesity

As shown in Table 2, the overall prevalence of overweight and obesity in males were 21.1% and 22.7%, respectively; and 11.6% and 10.3%, respectively in females. Thus, the prevalence of overweight and obesity within the same gender were very similar.

Table 1. WGOC overweight/obesity screening standard of BMI for school age children

Age (y)	Male		Female	
	over-weight	obesity	over-weight	obesity
11~	20.3	23.6	21.1	23.3
12~	21.0	24.7	21.9	24.5
13~	21.9	25.7	22.6	25.6
14~	22.6	26.4	23.0	26.3
15~	23.1	26.9	23.4	26.9

Table 2. Rate of overweight and obesity in male and female middle school students

Age group	Male		Female	
	Overweight (%)	Obesity (%)	Overweight (%)	Obesity (%)
12~	22/103 (20.6)	18/103 (17.6)	20/150 (13.3)	13/150 (9.1)
13~	34/165 (20.6)	45/165 (27.3)	21/182 (11.5)	23/182 (12.6)
14~	11/51 (21.6)	9/51 (17.6)	3/48 (6.3)	3/48 (6.3)
total	68/322 (21.1)	73/322 (22.7)	44/380 (11.6)	39/380 (10.3)

Table 3. Consumption of sugary beverages

Characteristics	Male (n=322)		Female (n=380)		Total (n=702)	
	n	(%)	n	(%)	n	(%)
The most popular drinks						
Sugar-sweetened beverages	286	88.8	344	90.5	630	89.7
Sugar-free beverages	137	42.5	146	38.4	283	40.3
Milk/ soya-bean milk	165	51.2	200	52.6	365	52.0
The frequency of consuming SSBs						
Less than twice a week	184	57.1	208	54.7	392	55.8
Three or four times a week	82	25.5	117	30.8	199	28.3
Five or six times a week	27	8.4	30	7.9	57	8.1
More than once a day	29	9.0	25	6.6	54	7.7
The dominating route of gaining SSBs						
Supermarket out of school	320	99.4	376	98.9	696	99.1
Supermarket inside school	2	0.6	4	1.1	6	0.9
Vending machine inside school	2	0.6	1	0.3	3	0.4
School canteen	3	0.9	1	0.3	4	0.6
The timing of consuming SSBs						
With meal	54	16.8	46	12.1	100	14.2
Without meal	75	23.3	85	22.4	160	22.8
Irregularly	193	59.9	249	65.5	442	63.0
kinds of SSBs stored at home						
None	119	37.0	102	26.8	221	31.5
One	83	25.8	107	28.2	190	27.1
Two	76	23.6	110	28.9	186	26.5
More than three	44	13.7	61	16.1	105	15.0

Consumption of SSBs

As illustrated in Table 3, SSBs were the most popular drinks among middle school students. About 7.7% of the students drank SSBs at least once per day. The most popular route of gaining SSBs was supermarkets beside the school. Of the students, 14.2% chose to drink SSBs with meal, while 22.8% preferred them outside a meal. Fifteen percent of the students had at least 3 kinds of SSBs available to them at home.

Table 4. Values of variables for logistic regression analysis

Variables	Values
SSBs intake	1=low; 2=high
Gender	1=male;2=female
Energy intake	1=low; 2=high
Educational experience	1= hardly;2= frequently
Family diet education	1= hardly;2= frequently
Family exercise education	1= hardly;2= frequently
Out-eating frequency	1= hardly;2= frequently
Physical activity	1= negative;2=active
Parent's BMI	1=obesity and overweight;2=normal

Relationship between SSBs consumption and overweight/obesity

The variables taken into multifactor logistic regression analysis are shown in table 4. Using the method of backward (α=0.05), variables excluded from the model are shown in table 5.

Table 6 presents the final logistic regression model for BMI (obesity/overweight versus normal). It is indicated that when controlling for age and total energy intake, the subjects with the high level of SSBs intake were 2.59 times more likely to be obese/overweight than the ones with the low level of SSBs intake, and that students who have negative physical activities were more likely to be obesity/overweight than those with active physical activities. Parent's BMI was also positively associated with children's obesity/overweight status. Students whose parents have high BMIs were more likely to be obese or overweight, compared with students whose parents have low BMI values.

Table 5. Variables not in the model (backward method)

Variables
Gender
Educational experience
Family diet education
Family exercise education
Out-eating frequency

Table 6. Binary logistic regression analysis for overweight/obesity in male and female

	p -value	OR(95% C.I.)
SSBs intake (high vs low)	0.012	2.59 (1.18,3.71)
Physical activity (negative vs active)	0.048	1.93 (1.04, 3.99)
Energy intake	0.004	4.00 (3.88, 5.11)
Parent's BMI	0.007	1.13 (1.03, 1.24)

DISCUSSION

This research was conducted in China, a developing country, but the overweight prevalence (male 22.7%, female 10.3%) and obesity prevalence (male 21.1%, female 11.6%) were already comparable to that in the U.S. Compared to the contemporary adolescents' overweight/obesity rate in Beijing, the results were higher. This was possibly related to the selection of the subjects. Most of the subjects lived in the central district of the city (Xicheng District) where family income was higher than those living in rural areas.

One thing that we have to emphasize is that the 24-hour dietary recall did not include the consumption of SSBs; the information was obtained by a section of specially designed questions in the questionnaire, which was similar with a cross-sectional study in Jamaica.[15] So the energy intake from SSBs was calculated specifically from that part instead of at the 24-hour dietary recall, and was then added to the total energy. This was different from other studies,[16] and was one of the limitations of the research.

There is still controversy about the association between SSBs and BMI. Some studies show that increasing consumption of SSBs would increase total energy intake, but would not increase BMI.[11] A similar conclusion was also drawn from a meta-analysis.[17] Our current study showed that there was no significant association between SSBs intake and BMI, which was consistent with some but not all findings. Clearly, more epidemiological and clinical research are required to reach conclusion.

The increment of total energy after SSBs consumption might be one reason contributing to the positive connection between SSBs and overweight/obesity. In the U.S. approximately 90% of children and adolescents consume SSBs every day; SSBs provide 10%-15% of the total energy. Popkin *et al* reported that American residents consume an extra 150-300 KJ compared to the past, of which 50% was from consumption of SSBs.[18] It was recently found that by substituting SSBs with pure water in children and adolescents, the daily total energy intake would be lowered by an average of 982 KJ.[19]

The main ingredient of SSBs is simple sugar. So far, SSBs have been listed as one of the high glycemic index (GI) foods. The rapid change of the blood sugar level will stimulate the feeling of starvation.[20,21] Compared to solid food, beverages can be emptied fast in the stomach, and reduce the signal to the gastrointestinal tract.[22] Sugar-sweetened beverages can decrease one's feeling of satiety, or increase one's taste for sweetness, both of which will lead to more energy intake from other food.[20,23,] On the other hand, the increased intake of SSBs will to some degree decrease intake of healthy drinks such as milk and soybean milk, subsequently causing decreased intake of some important nutrients, such as calcium. Some reports have showed that consumption of SSBs have positive association with intake of carbohydrates.[24] Consumption of SSBs reduces the intake of protein, juice, fruit and vitamin B-2, but the data regarding the association between SSBs and the intake of fat, vitamin A and B-12 are still lacking.[20] In the present study, no association was found between intake of SSBs and protein, dietary fiber and vitamins by the 24-hour dietary recall methods.

This study also surveyed the parents' behavior and found that if parents stored more than 1 type of SSBs in the home, the frequency of the child's consumption of SSBs would increase accordingly. On the contrary, frequently healthy diet education program would lower the intake of SSBs. Besides, because of the influence of parents' dietary habit on the dietary preference of children and the hereditary factor, parents' BMI and children's overweight/obesity were positively related. According to a relevant report, if both parents were obese, children have a 70%-80% incidence of being obese,[25] which was supported by our findings. Therefore, parents play a critical role in helping their children maintain health eating habit and body weight. The government, dietitians and social media should work together to promote healthy eating behavior in adolescents with a special focus on the role parents play.

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AUTHOR DISCLOSURES

All authors for the paper published by APJCN named "Sugary beverage intakes and obesity prevalence among junior high school students in Beijing – a cross-sectional research on SSBs intake" stated that we have no confliction of interest.

REFERENCES

1. Schwartz RP. Soft drinks taste good, but the calories count. J Pediatr. 2003;142:599-601.
2. Malik VS, Schulze MB, Hu FB. Intake of sugar-sweetened beverages and weight gain: a systematic review. Am J Clin Nutr. 2006;84:274-88.
3. Dhingra R, Sullivan L, Jacques PF, Wang TJ, Fox CS, Meigs JB, et al. Soft drink consumption and risk of developing cardiometabolic risk factors and the metabolic syndrome in middle-aged adults in the community. Circulation. 2007;116:480-8.

4. Ansa VO, Anah MU, Ndifon WO. Soft drink consumption and overweight/obesity among Nigerian adolescents. CVD Prevention Control. 2008;3:191-6.
5. Lim S, Zoellner JM, Lee JM, Burt BA, Sandretto AM, Sohn W et al. Obesity and sugar-sweetened beverages in African-American preschool children: a longitudinal study. Obesity (Silver Spring). 2009;17:1262-8.
6. Allison DB, Mattes RD. Nutritively sweetened beverage consumption and obesity: the need for solid evidence on a fluid issue. JAMA. 2009;301:318-20.
7. Brewis A. Biocultural aspects of obesity in young Mexican schoolchildren. Am J Hum Biol. 2003;15:446-60.
8. Rodriguez-Artalejo F, Garcia EL, Gorgojo L, Garces C, Royo MA, Martin MJ et al. Consumption of bakery products, sweetened soft drinks and yogurt among children aged 6-7 years: association with nutrient intake and overall diet quality. Br J Nutr. 2003;89:419-29.
9. Lin BH, Huang CL, French SA. Factors associated with women's and children's body mass indices by income status. Int J Obes Relat Metab Disord. 2004;28:536-42.
10. Newby PK, Peterson KE, Berkey CS, Leppert J, Willett WC, Colditz GA. Beverage consumption is not associated with changes in weight and body mass index among low-income preschool children in North Dakota. J Am Diet Assoc. 2004; 104:1086-94.
11. O'Connor TM, Yang SJ, Nicklas TA. Beverage intake among preschool children and its effect on weight status. Pediatrics.2006;118:e1010-8.
12. Ludwig DS, Peterson KE, Gortmaker SL. Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. Lancet. 2001; 357:505-8.
13. Popkin BM. Global changes in diet and activity patterns as drivers of the nutrition transition. Nestle Nutr Workshop Ser Pediatr Program. 2009;63:1-10, 10-4, 259-68.
14. Hawkes C. The worldwide battle against soft drinks in schools. Am J Prev Med. 2010;38:457-61.
15. Francis DK, Van den Broeck J, Younger N, McFarlane S, Rudder K, Gordon-Strachan G et al. Fast-food and sweetened beverage consumption: association with overweight and high waist circumference in adolescents. Public Health Nutr. 2009;12:1106-14.
16. Bermudez OI, Gao X. Greater consumption of sweetened beverages and added sugars is associated with obesity among US young adults. Ann Nutr Metab. 2010;57:211-8.
17. Forshee RA, Anderson PA, Storey ML. Sugar-sweetened beverages and body mass index in children and adolescents: a meta-analysis. Am J Clin Nutr. 2008;87:1662-71.
18. Popkin BM, Armstrong LE, Bray GM, Caballero B, Frei B, Willett WC. A new proposed guidance system for beverage consumption in the United States. Am J Clin Nutr. 2006;83: 529-42.
19. Wang YC, Ludwig DS, Sonneville K, Gortmaker SL. Impact of change in sweetened caloric beverage consumption on energy intake among children and adolescents. Arch Pediatr Adolesc Med. 2009;163:336-43.
20. Vartanian LR, Schwartz MB, Brownell KD. Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. Am J Public Health. 2007;97: 667-75.
21. Wolff E, Dansinger ML. Soft drinks and weight gain: how strong is the link? Medscape J Med. 2008;10:189.
22. Almiron-Roig E, Chen Y, Drewnowski A. Liquid calories and the failure of satiety: how good is the evidence? Obes Rev. 2003;4:201-12.
23. Harrington S. The role of sugar-sweetened beverage consumption in adolescent obesity: a review of the literature. J Sch Nurs. 2008;24:3-12.
24. Schulze MB, Manson JE, Ludwig DS, Colditz GA, Stampfer MJ, Willett WC et al. Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women. JAMA. 2004;292:927-34.
25. Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. Obes Rev. 2004;5(S1):4-104.

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School of Public Health, Peking University, Beijing, China

北京初中学生含糖软饮料摄入与肥胖发生率研究—关于含糖软饮料摄入的横断面研究

目的：过量摄入含糖软饮料(SSBs)会增加肥胖的风险，中国目前针对中学生人群的相关研究很少。本次调查目的在于了解目前北京市中学生 SSBs 的消费现况，并研究 SSBs 摄入与中学生超重/肥胖流行之间的关系，为建立健全青少年超重肥胖预防体系提供理论支持。方法：本次调查为横断面研究，对北京市某区两所中学 11-15 岁初中生(男生 322 位，女生 380 位)进行自填式问卷调查和连续 3 天的 24 小时膳食回顾调查。结果：肥胖率男生为 22.7%，女生为 10.3%；超重率男生为 21.1%，女生为 11.6%。家中储备 SSBs 的种类在 2 种以上的人平均每日 SSBs 摄入量较高($p<0.001$)。在校正了混杂因素后，SSBs 摄入高水平的学生与摄入低水平的学生相比，发生超重/肥胖的相对危险度为 OR=2.6；父母的 BMI 与子女超重/肥胖的发生存在关联(OR=1.130，$p=0.007$)。结论：在北京 11-15 岁中学生人群当中，肥胖的流行趋势与超重相比更加严峻，而 SSBs 已成为最经常消费的饮料品种；在男生当中，高摄入量的含糖软饮料与超重/肥胖的发生显著相关。

关键词：含糖软饮料、能量、超重、肥胖、膳食