Original Article

Report on Childhood Obesity in China (9): Sugar-sweetened Beverages Consumption and Obesity*

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Abstract

Objective To explore the associations between sugar-sweetened beverage (SSB) consumption and obesity as well as obesity-related cardiometabolic disorders among children in China.

Methods A total of 6974 (boys 3558, girls 3412) children aged 6-13 years participated in the study. Each participant's height, weight, waist circumference, fasting glucose, triglycerides, total cholesterol, high-density lipoprotein cholesterol, and low-density lipoprotein cholesterol were measured. The type of beverage consumption was determined using a self-administered questionnaire.

Results SSBs were consumed regularly by 46.1% of the children. The prevalence [adjusted odds ratio (95% confidence internal (CI)] of obesity was 7.6% [as the reference group (ref.)], 10.1% [1.36(1.07, 1.74)], and 11.6% [1.46(1.21, 1.75)], among children who regularly drank milk, other beverages and SSBs, respectively. Regularly drinking SSBs elevated the likelihood of abdominal obesity [adjusted odds ratio (95% CI): 1.36 (1.17, 1.59)]. The prevalence [adjusted odds ratio (95% CI)] of obesity among children who regularly drank sports/caloric beverages, carbonated beverages, sweet tea, and plant protein beverages was 16.8% [2.00(1.31, 3.07)], 12.7% [1.52(1.23, 1.88)], 11.5% [1.52(1.18, 1.95)], and 10.4% [1.41(1.03, 1.94)], respectively, which was higher than that of regular milk drinkers [7.6 % (ref.)]. The prevalence [adjusted odds ratio (95% CI)] of abdominal obesity among children who regularly drank sweet tea, fruit/vegetable juices, and carbonated beverages was 17.7% [1.55(1.26, 1.90)], 16.2% [1.36(1.09, 1.70)], and 15.3% [1.24(1.03, 1.50)], respectively, which was much higher than that of regular milk drinkers [12.8% (ref.)].

Conclusions Regular SSB consumption was positively related to obesity and abdominal obesity. This relationship should be investigated further using a longitudinal study design.

Key words: Sugar-sweetened Beverages; Obesity; Children

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INTRODUCTION

Worldwide there are 155 million overweight or obese children and 12 million of them live in China[1]. The prevalence of obesity among children has increased remarkably over the past two decades in China[2]. The obesity rate has more than quadrupled from 0.2% in 1982 to 0.9% in 2002[3].

The etiology of obesity reflects a complex interaction between genetic, metabolic, environmental, cultural, socioeconomic, and behavioral factors[4]. Beverage consumption and the subsequent impact on energy consumption has become a focus of research[5-6]. The consumption of sugar-sweetened beverages (SSBs) has increased in the United States and Mexico over the past few decades[5,7]. In the United States, the percentage of caloric intake from SSBs increased significantly from 11.8% in 1965 to 21.0% in 2002[5]. Energy intake from SSBs doubled from 1999 to 2006 across all age groups in Mexico[6]. There is increasing evidence that SSB consumption is associated with overweight and obesity[6,8] as well as an increased risk of high blood pressure, metabolic syndrome (MetS), type 2 diabetes, and coronary heart disease in adults[9-13]. It is estimated that SSB consumption accounted for at least one-fifth of the weight gain between 1977 and 2007 in the US population[14]. Reviews on the topic have concluded that the replacement of SSB with water or milk is associated with a reduction in total caloric intake and the prevalence of obesity in children[15-16].

The proportion of SSB consumption among children and adolescents increased significantly in China between 1998 and 2008[17]. However, information on the relationship between SSB consumption and obesity and obesity-related cardiovascular diseases is not available in China. Such information is important for decision makers to develop strategies and actions for obesity control and prevention. Therefore, the current study aimed to determine the relationship between SSB consumption and the prevalence of obesity and obesity-related cardiometabolic disorders among Chinese children.

MATERIALS AND METHODS

Sampling

A multistage, random sampling procedure was used to recruit the participants. Two urban communities were randomly selected from each of six provincial capital cities in China (Haerbin, Beijing, Jinan, Shanghai, Chongqing, and Guangzhou). Three primary schools, constituting children from a similar socio-economic group, were then randomly selected from each urban community. From each of these schools, two classes from each grade were randomly selected. All the students in the selected classes were recruited as the study participants.

Ethical Approval

The study protocol was approved by the Ethical Review Committee of the National Institute for Nutrition and Food Safety, Chinese Center for Disease Control and Prevention. Signed consent forms were obtained from both the children's parents or guardians and the children[18].

Anthropometric Measurements

All anthropometric measurements were performed by trained investigators following standardized procedures[18].

Height was measured to the nearest 0.1 cm with a freestanding stadiometer mounted on a rigid tripod (GMCS-I, XindongHuateng Sports Equipment Co. Ltd., Beijing, China). Fasting body weight was measured to the nearest 0.1 kg using a balance-beam scale (RGT-140, Weighing Apparatus Co. Ltd. Changzhou Wujin, China) with participants wearing lightweight clothing.

Body mass index (BMI) was calculated as mass in kilograms divided by the square of stature in meters [BMI=mass (kg)/ (stature (m))^2]. Waist circumference (WC) was measured to the nearest 0.1 cm, midway between the lowest rib and the superior border of the iliac crest with an inelastic measuring tape at the end of normal expiration. This measurement was performed twice. If the variation between these two measurements was greater than 2.0 cm, a third measurement was taken and the mean was calculated using the two closest measurements.

Blood Pressure

After a 10 minute rest, trained nurses measured seated blood pressure using a mercury sphygmomanometer (XJ300/40-1, Shanghai). The first and the fifth Korotkoff sounds were used to determine systolic blood pressure (SBP) and diastolic blood pressure (DBP). Three measurements were taken at 2-min intervals and rounded off to the nearest 2 mmHg. The average of the last two measurements was then calculated. Using the mean of the two measurements, we calculated SBP (DBP).

Glucose and Lipid Profiles

Morning fasting (10-14 hours overnight) venous blood samples (5 mL) were obtained from each participant. Serum glucose was determined within four hours after the fasting blood sample using the glucose-oxidize method (Daiichi Pharmaceutical Co., Ltd, Tokyo, Japan). Conventional enzymatic assays, using an Automatic Analyzer (Model 7080, Daiichi Pharmaceutical Co.) was used to measure serum triglycerides (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C) levels, and low-density lipoprotein cholesterol (LDL-C) levels.

Quality Control

The same Automatic Analyzer was used at each of the six study sites and all analysis was performed by trained investigators using standardized procedures. Duplicate measurements performed in subgroups showed high reproducibility (correlation coefficients of duplicate measurements were 0.99 for height and 0.98 for weight). Every tenth serum sample was measured twice (correlation coefficient of duplicate measurements was 0.98).

Definition of Obesity and Cardiometabolic Disorders

Obesity was defined as a BMI of ⩾95 th percentile using age- and sex-specific BMI cutoff points[19]. Abdominal obesity was defined as WC of ⩾90 th percentile using age- and sex-specific WC cutoff points[20].

Cardiometabolic disorders included high blood pressure, elevated glucose level, hypertriglyceridemia, hypercholesterolemia, dyslipidemia, and MetS. High blood pressure was defined as a SBP and/or DBP>95 th age and gender specific percentile[21]. Hypercholesterolemia was defined as triglycerides (TG) ⩾1.7 mmol/L. Hypercholesterolemia was defined as total cholesterol (TC) ⩾5.18 mmol/L[22]. Dyslipidemia was defined as having one or more of the following three indexes: TG⩾1.7 mmol/L, TC⩾5.18 mmol/L, and HDL-C⩽1.04 mmol/L[22]. An elevated glucose level was defined as a fasting serum glucose of ⩾5.6 mmol/L. MetS was defined as obesity ⩾90 th percentile as assessed by waist circumference and having two or more of the following four indexes: TG⩾1.7 mmol/L, HDL-C⩽1.04 mmol/L, high blood pressure and fasting serum glucose⩾5.6 mmol/L[23].

Beverage Consumption

Information regarding the types of beverages consumed was collected using a self-administered questionnaire. Three mutually exclusive beverage categories were identified: SSBs (including carbonated drinks, fruit/vegetable juices, sweet tea, and sports/caloric beverages), milk (including milk, yogurts, and flavored milk), and other drinks (including plant protein beverages, powder drinks, unsweetened tea, and coffee)[24]. The daily total energy intake as well as the energy intake from SSBs and milk per day was derived from a 24-h dietary recall over three consecutive days (two weekdays and one weekend day).

Socioeconomic Status

General information, including average monthly household income per capita, occupations and parental education levels, was collected from the parents using a self-administered questionnaire.

Statistical Analysis

Continuous variables are presented as mean ±standard deviation (SD). Chi-square testing was used to determine the difference in the distribution between regular SSB drinkers and non-regular SSB drinkers. The General Linear Model (GLM) was used to compare the differences in BMI, WC, blood pressure, glucose, and lipid profiles between the different beverage categories, after adjustment for fixed effects such as sex, age, family income, and education levels. A logistic regression random-effects model was used to explore the role of SSB consumption in the development of obesity and obesity-related cardiometabolic disorders after adjustment for fixed effects such as sex, age, feeding types, birth weight, parents' weight, parents' educational level, and average family income per month per capita. The school in center was treated as a two level random effect. A *P* value<0.05 was considered significant. All statistical analysis was performed using SAS 9.2 for Windows (SAS Institute Inc, Cary, NC).

Sensitivity Test

Among the 6 974 children, 5 828 (83.7%) had complete dietary recall data. A sensitivity analysis was performed in this subgroup to determine whether adjustment for dietary energy intake could explain the association between SSB consumption and obesity and obesity-related chronic disease risk factors. In this subgroup, after adjustment for energy intake, the *P* value increased from 0.0001 to 0.0018, and the *P* value for energy intake was

0.1169 for the prevalence of obesity. The *P* value changed from 0.0005 to 0.0066 after adjustment for energy, and the *P* value of energy was 0.0477 for the prevalence of abdominal obesity. So, dietary energy intake did not change the association between SSB consumption and obesity and abdominal obesity.

RESULTS

Characteristics of the Participants

The sample size initially selected was 9 000. From this sample 283 children declined to participate in the study giving a response rate of 97%. A total of 8 707 children were then enrolled in the study. Participants who did not provide complete data relating to SSB consumption frequency (*n*=150) as well as those with missing anthropometric data or serum profiles (*n*=1 583) were excluded from the study. Thus, data from 6 974 participants (boys 3 558, girls 3 412) aged 6-13 years were included in the final analysis.

The analysis found that 46.1% of the children regularly drank SSBs. The proportion of regular SSB consumption of the boys was higher than that of the girls. The children whose parent(s) reported a low education level were more prone to becoming regular SSBs drinkers. Children with a low family income had a higher proportion of regular SSBs consumption (Table 1).

Anthropometric, Blood Pressure, Glucose, and Lipid Profiles According to Different Beverage Categories

Regular SSB drinkers had significantly higher BMI (*P*=0.0023) and WC (*P*=0.0097) compared to regular milk drinkers, after adjustment for gender, age, feeding types, birth weight, parents' BMI, parents' educational level, and average family income per month per capita. The level of LDL-C among regular SSB drinkers was higher than that of regular milk drinkers (*P*=0.0498). No significant differences were found between different beverage categories for blood pressure, glucose, TC, and TG (Table 2).

Daily Dietary Intake

The 24-h dietary recall showed that the average daily caloric intake of 43±54 kcal (Boys 41±52 kcal, girls 46±55 kcal) from SSB consumption was lower than that of milk (89±58 kcal). However, the total energy intake of milk drinkers (1226±708 kcal) was lower than that of SSBs drinkers (1365±745 kcal).

Table 1. Characteristics of Children according to Regular Beverage Intake Categories [*n* (%)]

	Milk Beverage	Other Beverage	SSBs
Gender*			
Male	1169 (32.9)	536 (15.1)	1851 (52.1)
Female	1406 (41.1)	647 (18.9)	1365 (39.9)
Feeding patterns			
Breast	1798 (36.9)	810 (16.6)	2260 (46.4)
Artificial feeding	322 (36.1)	162 (18.2)	407 (45.7)
Mixed feeding	455 (37.4)	210 (17.3)	550 (45.3)
Birth weight*			
Low	377 (34.5)	177 (16.2)	540 (49.4)
Normal	1969 (37.7)	890 (17.0)	2362 (45.2)
High	229 (34.7)	116 (17.6)	314 (47.6)
Father's weight status			
Normal	1504 (36.8)	678 (16.6)	1902 (46.6)
Overweight	824 (37.8)	375 (17.2)	981 (45.0)
Obesity	247 (34.8)	130 (18.3)	333 (46.9)
Mother's weight status			
Normal	1607 (37.0)	724 (16.7)	2016 (46.4)
Overweight	868 (38.0)	384 (16.8)	1032 (45.2)
Obesity	100 (29.1)	75 (21.8)	169 (49.1)
Father's educational level*			
Illiteracy or primary	168 (33.8)	76 (15.3)	253 (50.9)
Junior middle school	845 (34.1)	399 (16.1)	1236 (49.8)
Senior middle/high school	786 (36.0)	397 (18.2)	1002 (45.9)
Technical school/ college	405 (40.9)	164 (16.5)	422 (42.6)
University or above	371 (45.2)	146 (17.8)	304 (37.0)
Mother's educational level*			
Illiteracy or primary	317 (35.9)	137 (15.5)	430 (48.6)
Junior middle school	852 (34.1)	421 (16.8)	1229 (49.1)
Senior middle/high school	743 (37.2)	348 (17.4)	907 (45.4)
Technical school/ college	390 (32.4)	164 (14.0)	425 (43.9)
University or above	274 (44.8)	113 (18.5)	224 (36.7)
Family monthly income per person*			
≤750 (RMB)	284 (34.9)	135 (16.6)	395 (48.5)
751- 1 500 (RMB)	830 (36.1)	407 (17.7)	1062 (46.2)
1 501-2 500 (RMB)	757 (39.9)	274 (14.4)	868 (45.7)
≥2 501 (RMB)	703 (35.8)	367 (18.7)	891 (45.4)

Note. *There was a significant difference between the different beverage categories using chi-square test with *P*<0.001. RMB, Renminbi, means Chinese Yuan.

Table 2. Anthropometric, Blood Pressure, Glucose, and Lipid Profiles of Children according to Regular Beverage Intake Categories

	Milk Beverage (*n*=2 575)	Other Beverage (*n*=1 183)	SSBs (*n*=3 216)
Age (yrs.)*	9.7±1.2[a]	9.6±1.2[a]	9.5±1.2[b]
Height (cm)	138.0±8.7	137.5±8.7	136.8±8.7
Weight (kg)	33.0±8.7	33.2±9.0	32.8±9.1
Body-mass index (kg/m^2)*	17.1±3.0[a]	17.3±3.1[b]	17.3±3.3[b]
Waist circumference (cm)*	58.4±8.5[a]	58.8±8.9[a]	58.9±9.2[b]
Blood pressure (mm Hg)			
Systolic	100.4±11.1	100.3±11.1	100.7±10.8
Diastolic	64.0±9.1	64.4±9.4	64.1±9.2
Glucose (mmol/L)	4.51±0.55	4.5±0.53	4.53±0.58
Cholesterol (mmol/L)			
Total	4.07 ± 0.78	4.13±0.81	4.05±0.79
LDL-C*	0.79 ± 0.42[a]	0.81±0.42[a]	0.83±0.50[b]
HDL-C	2.08 ± 0.64	2.11±0.66	2.08 ± 0.67
Triglycerides (mmol/L)	1.49 ± 0.31	1.49±0.32	1.49±0.31

Note. *There was a significant difference between the different beverage categories after adjustment for school in center, feeding types, birth weight, parents' weight, parents' educational level, and average family income per month per capita, gender and age using mixed model with *P*<0.001.[ab]Values in the same row with different superscript letters are significantly different, according to Tukey's post-hoc test with *P*<0.05.

Prevalence of Obesity and Obesity-related Cardiometabolic Disorders According to Different Beverage Categories

The prevalence of obesity for regular SSB drinkers (11.6%) and other beverages drinkers (10.1%) was significantly (*P*=0.0001) higher than regular milk drinkers (7.6%), after adjustment for gender, age, feeding types, birth weight, parents' BMI, parents' educational level, and average family income per month per capita and random effects. The prevalence of abdominal obesity for regular SSB drinkers was significantly higher than regular milk drinkers (16.0% vs. 12.6%, *P*=0.0005), after adjustment for confounding factors and random effects. The crude odds ratio (OR) (95% CI) for obesity, was 1.60 (1.34, 1.90) in regular SSB drinkers, compared to regular milk drinkers. After adjustment for gender, age, feeding types, birth weight, parents' BMI, parents' educational level, average family income per month per capita and random effects, the OR was attenuated but remained significant [OR (95% CI): 1.46 (1.21, 1.75)]. There were no significant differences in the prevalence of high blood pressure, hypercholesterolemia, elevated glucose level, MetS, and dyslipidemia between the different beverage categories (Table 3).

Prevalence of Obesity and Abdominal Obesity According to Different Beverage Categories

After adjustment for gender, age, feeding types, birth weight, parents' BMI, parents' educational level, and average family income per month per capita and random effects, the prevalence [Adjusted OR (95% CI)] of obesity was 7.6% (ref.), 16.8% [2.00(1.31, 3.07)], 12.7% [1.52(1.23, 1.88)], 11.5% [1.52(1.18, 1.95)], and 10.4% [1.41(1.03, 1.94)], for children who regularly drank milk beverages, sports/caloric beverages, carbonated beverages, sweet tea and plant protein beverages, respectively. After adjustment for confounding and random effects, the prevalence [Adjusted OR (95% CI)] of abdominal obesity among children who regularly drank sweet tea, fruit/vegetable juices, carbonated beverages and milk, was 17.7% [1.55(1.26, 1.90)], 16.2% [1.36(1.09, 1.70)], 15.3%[1.24(1.03, 1.50)], and 12.8% (ref.), respectively (Table 4).

DISCUSSION

The recent increase in SSB consumption has coincided with the increased prevalence of obesity. The association between SSB consumption and obesity has attracted the attention of researchers worldwide. A number of studies reported that the excess intake of sweetened beverages increases the risk of overweight and obesity[6,26-29] and that a reduction in the consumption of SSBs was associated with weight loss[26-27,30]. However, a quantitative meta-analysis and qualitative review by Richard et al. suggested that the association between SSB consumption and BMI was close to zero[25]. The current study revealed that regular SSB consumption in children elevated the value of BMI, WC, and the risk of obesity (including abdominal obesity). These findings are consistent with those of previous studies[26-30]. It has been suggested that contributing

Table 3. Prevalence and Odds Ratio (OR) of Obesity and Obesity-related Cardiometabolic Disorders of Children according to Regular Beverage Intake Categories

	Milk Beverages (*n*=2 575)			Other Beverages (*n*=1 183)			SSBs (*n*=3 216)		
	Prevalence (%)	Crude OR (95% CI)	Adjusted OR (95% CI)	Prevalence (%)	Crude OR (95% CI)	Adjusted OR (95% CI)	Prevalence (%)	Crude OR (95% CI)	Adjusted OR (95% CI)
Obesity*	7.6	1.00	1.00	10.1	1.43(1.09,1.87)	1.36(1.07,1.74)	11.6	1.60(1.34,1.90)	1.46(1.21,1.75)
Abdominal Obesity*	12.6	1.00	1.00	14.9	1.11(0.87,1.40)	1.20(0.98,1.47)	16.0	1.32(1.15,1.53)	1.36(1.17,1.59)
Dyslipidemia	14.6	1.00	1.00	17.1	1.02(0.81,1.28)	1.18(0.98,1.43)	15.0	1.01(0.88,1.17)	1.09(0.94,1.26)
Elevated Glucose Level	2.4	1.00	1.00	1.7	0.94(0.73,1.22)	0.69(0.41,1.45)	2.7	0.96(0.82,1.13)	1.21(0.86,1.69)
Hypertension	11.5	1.00	1.00	12.5	0.74(0.41,1.35)	1.09(0.87,1.33)	11.4	1.11(0.80,1.81)	1.05(0.89,1.24)
Hypercholesterolemia	7.6	1.00	1.00	9.5	1.07(0.80,1.43)	1.24(0.97,1.59)	7.5	0.94(0.78,1.13)	1.09(0.89,1.33)
Hypertriglyceridemia	3.3	1.00	1.00	4.1	0.87(0.55,1.38)	1.24(0.86,1.78)	4.4	1.28(0.99,1.66)	1.35(1.03,1.79)
MetS	0.9	1.00	1.00	1.2	1.31(0.61,2.81)	1.33(0.68,2.61)	1.2	1.21(0.73,2.00)	1.36(0.79,2.32)

Note. Logistic regression random-effects model was used to calculate the OR with the children who regularly drank milk as the reference category, with adjustment for gender, age, feeding types, birth weight, parents' BMI, parents' educational level, and average family income per month per capita. *There was a significant difference between the different beverage categories, after adjustment for confounding factors, with the school in center treated as a random effect variable. The values in bold mean significantly different compared with the milk beverages group.

Table 4. Contribution of Different Beverages to the Prevalence of Obesity and Abdominal Obesity in Children

Types of Beverages	*n*	Obesity			Abdominal Obesity		
		Prevalence (%)	Crude OR (95% CI)	Adjusted OR (95% CI)	Prevalence (%)	Crude OR (95% CI)	Adjusted OR (95% CI)
Milk beverages	2821	7.6	1.00	1.00	12.8	1.00	1.00
Plant protein beverages	534	10.4	1.41 (1.03, 1.92)	1.41 (1.03, 1.94)	14.8	1.18 (0.91, 1.54)	1.18 (0.91, 1.55)
Powder	114	8.1	1.07 (0.53, 2.15)	1.02 (0.50, 2.06)	10.8	0.83 (0.45, 1.52)	0.85 (0.46, 1.58)
Coffee	101	14.0	1.97 (1.10, 3.53)	1.77 (0.98, 3.21)	13.1	1.03 (0.57, 1.87)	1.06 (0.58, 1.93)
Fruit/Vegetable juices	797	8.8	1.17 (0.88, 1.55)	1.23 (0.93, 1.65)	16.2	1.32 (1.06, 1.64)	1.36 (1.09, 1.70)
Carbonated beverages	1473	12.7	1.76 (1.43, 2.17)	1.52 (1.23, 1.88)	15.3	1.23 (1.03, 1.47)	1.24 (1.03, 1.50)
Sweet tea	951	11.5	1.58 (1.24, 2.02)	1.52 (1.18, 1.95)	17.7	1.47 (1.2, 1.79)	1.55 (1.26, 1.90)
Sports/Caloric beverages	183	16.8	2.44 (1.61, 3.70)	2.00 (1.31, 3.07)	17.4	1.44 (0.96, 2.16)	1.49 (0.99, 2.25)

Note. Logistic regression random-effects model was used to calculate the OR with the children who regularly drank milk as the reference category, with adjustment for gender, age, feeding types, birth weight, parents' weight, parents' educational level, and average family income per month per capita. The school in center was treated as a random effect variable. The values in bold mean significantly different compared with the milk beverages group.

factors to this relationship maybe the high fructose content in SSBs which if consumed in excess and over extended time periods could result in additional fat stored in body[31]. Also the 24-h dietary recall over three consecutive days showed that regular SSB consumption can increase the total daily energy intake. Both increased fructose and caloric intake may contribute to the development of obesity[32-33]. We also found that children who regularly consumed carbonated beverages, sweet tea, and sports/caloric beverages were more prone to becoming obese (including abdominal obesity), compared to children who regularly consumed milk. This can be explained, in part, by the increased caloric content of SSBs, specifically carbonated beverages, sweet tea, and sports/caloric beverages.

The present study found that regular SSB consumption significantly elevated the level of LDL-C, which was consistent with a previous study performed in adults[34]. Regular SSB drinkers also had an increased risk of developing hypertriglyceridemia compared to regular milk drinkers while there were no significant differences in the prevalence of dyslipidemia, elevated glucose level, and MetS. Previous studies reported that SSB consumption was associated with high blood pressures, MetS, and type 2 diabetes in adults[35-39]. However, this relationship in children is yet to be identified. The low prevalence of chronic disease in children in China may have contributed to the non-significant relationship in the present study.

The present study showed that 46.1% of the children regularly consumed SSBs. Children whose parents had a low education level or whose family had a low income were more prone to becoming regular SSBs drinkers. It has been suggested that this finding maybe because children of a low socio-economic status do not receive health related nutrition at home, but have easy access to SSBs supplied by their parents[17]. Despite the finding that the average daily caloric intake (43.2 kcal/day) from SSB consumption in our participants was below the 190 kcal/day of children in United States[40], regular SSB consumption was associated with the prevalence of obesity (including abdominal obesity) among Chinese children.

SSB consumption has become a highly visible and is a controversial public health and policy issue worldwide[41]. To reduce the prevalence of overweight and obesity, more than 30 national governmental bodies have made efforts to restrict the availability of soft drinks[40]. The United States has proposed taxation[40,43], and most states have adopted laws that regulate the availability of SSBs in school settings as a means of reducing the risk of childhood obesity[42,44]. China is undergoing a nutrition and lifestyle transition. SSB consumption is increasing among Chinese children and adolescents[17] and therefore it is urgent that China develops policies to control SSB consumption.

There were a number of limitations in the present study. First, the self-reported questionnaire used to record the SSs consumption frequency may have been affected by memory bias and did not ask enough detail about SSB consumption. Second, participant energy expenditure was not considered when analyzing the association between beverage energy intake and obesity as well as obesity-related disorders. However, information on physical activity level was not obtained in our study. Finally, the current study was cross-sectional that precludes causal inferences regarding the relation between SSB consumption and obesity.

In conclusion, SSB consumption was associated with obesity in Chinese children. This finding indicates that more attention should be paid to SSB consumption in Chinese children and its effects on their health. A longitudinal study should be performed to investigate the extent to which SSB consumption affects, or is affected by obesity and related chronic diseases.

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