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Association Between Consumption of Sugar-sweetened Beverages and Childhood Obesity and Overweight

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Objectives: This paper aims to study how consumption of beverages relates to the body weight of children and adolescents in Mongolia. **Methods:** A cross sectional survey was conducted between 2015 and 2016. A group of 353 relatively healthy children and adolescents aged 6-16 were selected from ger districts of Ulaanbaatar, Mongolia. Descriptive statistics were used to summarize the data. Chi-squared analysis was conducted to evaluate the association of categorical variables with body mass index (BMI) z-score subgroups. T-test or two-way ANOVA was performed to compare means. Beverage consumption was presented as means with standard deviation (SD) among sex and age groups. **Results:** The data from 347 children and adolescents were analyzed. Boys represented 50.1% (n =174) and the mean age ± SD was 10.0 ±2.9 years. Tea was the main beverage type in all age and sex groups compared to other types of beverages. Girls aged between 10 and 13 years old had the highest consumption of sugar-sweetened beverages (SSB). And there was a markedly high consumption of SSB among overweight and obese children. **Conclusion:** Significantly higher consumption of SSB was seen among overweight and obese children. Detailed household and school-based observational and interventional studies should be performed using these findings to help policy makers to make evidence-based decisions about SSB.

Keywords: Beverages, Childhood Obesity, Weight Gain

Introduction

One of the main public health issues in developed countries is risk factors for chronic diseases, particularly overweight and obesity [1-4]. These risk factors are also a main problem in Mongolia. The collaboration of the Mongolian government and international non-governmental organizations (NGO) has introduced new strategies and programs to reduce obesity and overweight [5-7].

However, obesity became more prevalent in Mongolia during the past three decades. A recent population-based survey concluded that 39.8% of the Mongolian population aged 15-64 years old is overweight and the prevalence of obesity among this age group is 12.5%, whereas it is 11.4% among 13-17 year-olds [8, 9].

Children who suffer with obesity and overweight are more likely to become obese later in life and are at a high risk to develop obesity-related chronic conditions in adulthood [10-12]. Overweight and obesity are caused by an unhealthy lifestyle such as being sedentary, having an uncontrolled diet, and using excess sugar-sweetened food and sugar-sweetened beverages (SSB). Many researchers have investigated the association between obesity and unhealthy lifestyle. Some of them concluded that there is a positive relationship between obesity and SSB [11, 13-18]. SSB are composed of energy containing sweeteners including sucrose (50% glucose, 50% fructose), high-fructose corn syrup (HFCS; approximately 45% glucose, 55% fructose). Recent systematic reviews and meta-analyses support that SSB provide little nutritional effect and increase body mass which further associates with development of type 2 diabetes, fractures and dental caries [19, 20]. Also, many prospective cohort studies that followed children and adolescents for 1 to 10 years have found significant association between SSB consumption and weight gain [21-32].

Globally, consumption of SSB has been increasing, due to urbanization and heavy marketing in low- and middle-income countries [33]. Researchers reported that consumption of carbonated soft drinks increased by 61% during the last five decades in the United States of America. [34] The World Health Organization (WHO) has recommended to reduce intake of free sugars throughout one's life course and to reduce intake of free sugars to less than 10% of total energy intake. [35]

In the case of Mongolia, currently there is no study that has investigated total intake of water and beverages, daily beverage intake composition, and the association between weight status and consumption of SSB. Therefore, this paper aims to examine how consumption of SSB affects the body weight of children and adolescents in Mongolia.

Materials and Methods

A cross sectional household survey was conducted between 2015 and 2016. A group of 353 relatively healthy children and adolescents aged 6-16 years old were selected using a multi-stage random sampling method in Ulaanbaatar, Mongolia.

1. Data collection

A questionnaire with 13 questions including general information of study participants was collected after taking informed consent from parents. Parents of children under age 9 who participated in the survey were asked to recall water and beverage consumption over the past 24 hours, while children over 9 years old answered the questions themselves. Trained researchers measured their body weight and height.

The 24-hour recall beverage intake data was collected to determine frequency and main types of water and beverage consumption, the use of added sugar and salt, and the exact time of consumption. Exclusion criteria was set as the following: (1) if parents refused participate, (2) if the child had a special diet or had a chronic condition that limited their total intake of fluid, (3) if the child was taking medication which would impact the total intake of fluid, (4) if data was incomplete, (5) if total fluid intake during 24 hours was <400 mL or >4000 mL.

2. Variables

Types of fluid consumed within 24 hours by study participants were classified into five groups. These were (1) water, (2) tea (all kinds of teas, including black tea, Georgian green tea, green tea, Mongolian milk tea), (3) milk (including milk, milk with water), (4) fruit drink and soft drink (all kinds of soft drinks, including fruit juice, fruit concentrate, carbonated soft drinks), (5) coffee (all kinds of coffee, including instant and brewed).

According to the WHO growth chart, age and sex specific body mass index (BMI) z-scores were determined. According to z-scores, children were divided into 4 subgroups: underweight (-1 to -2), normal weight (-0.99 to 0.99), overweight (1 to 2) and obese (>2) [36].

3. Data analyses

Data were analyzed using MS Excel 2010 and SPSS statistical package 17.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to summarize the data. Chi-squared analysis was conducted to evaluate the association of categorical variables on BMI z-score subgroups. Beverage consumption was presented as means with SD among BMI categories. Two-way ANOVA by sex and age group were calculated to compare SSB consumption.

4. Ethical aspects

Research study methodology was approved by the ethical committee of the Mongolian National University of Medical Sciences. Parents and caregivers gave written informed consent after the study goal and procedures were explained to them.

Results

A total of 347 children and adolescent's data were analyzed. The descriptive result is shown in Table 1. The boys represent 50.1% (n = 174), mean age ±SD was 10.0 ±2.9 years, while 49.9% (n = 173) were girls and their mean age ±SD was 10.0 ±2.9 years (p = 0.844).

After analyzing BMI z-score it was clear that the percentage of overweight and obese children was higher than underweight children. Table 1 shows that the percentage of normal weight children was 69.7% (n = 242), overweight and obese was 16.7% (n = 58), and underweight was 13.5% (n = 47). In addition, 6-9 year-olds were more likely to be overweight and obese (63.8%, n = 37) than other age groups (p = 0.024). With respect to sex, there was no statistically significant difference (p = 0.563).

Tea was the main beverage type in all age and sex groups comparing to other types of beverages, while water consumption was 304-397 mL per day (Table 3). The mean volume of fruit juice and SSB was 109.5 mL (maximum = 1400 mL, minimum = 10 mL). Importantly, our result showed there was frequent consumption of tea with sugar or salt. Therefore, research combined cases of tea with sugar into the SSB subgroup, and re-analyzed the BMI z-score, age group and sex. The result shows that there was a markedly high consumption of SSB among overweight and obese children (Table 3).

Table 1. Median (minimum and maximum) values of water and beverage intake and mean (SD) BMI z-score and age of study participants

Variable	Girls (n = 174)	Boys (n = 173)	Total (n = 347)	p-value
Descriptive characteristics (mean (SD))				
BMI z-score	0.0 (0.77)	0.10 (0.84)	0.05 (0.81)	0.233
Age (years)	10.0 (2.9)	10.0 (2.9)	10.0 (2.9)	0.971
Beverage types (median (min-max))				
Water (mL)	250 (0-1650)	300 (0-1600)	250 (0-1650)	0.611
Tea (mL)	750 (0-2250)	750 (0-3150)	750 (0-3150)	0.586
Milk (mL)	0 (0-800)	0 (0-800)	0 (0-800)	0.668
SSB (mL)	0 (0-1250)	0 (0-175)	0 (0-1750)	0.335
Coffee (mL)	0 (0-750)	0 (0-750)	0 (0-750)	0.373
Total (mL)	1200 (500-3300)	1250 (550-3600)	1200 (500-3600)	
Beverage intake (number per day)	5 (2-9)	5 (2-11)	5 (2-11)	0.731

Total volume and type of consumed beverage within age group and sex are presented in Figure 1. As mentioned above tea, was the main beverage type among all age groups. Furthermore, Figure 1 describes that 14-16 year-old boys had the highest consumption of water and beverages per day, while girls in this age group had the lowest consumption. There was a tendency for adolescent girls to drink coffee. In addition, 10-13 year-old girls had the highest consumption of SSB, however there was no statistically significant difference between age groups and sex (p = 0.354). Noticeably, intake of dairy milk was significantly low in all sex and age groups.

Table 2. BMI z-score of the study participants, by sex, age group and education and employment status of the head of household

Variables	Underweight z<-1 (n (%))	Normal w eight -1<z>1 (n (%))	Overweight and obese z>1 (n (%))	Total (n (%))	p-value
Total	47 (13.5)	242 (69.7)	58 (16.7)	347 (100)	0.024
Girls	16 (9.3)	121 (69.9)	26 (15.0)	173 (49.9)	
6-9 years	12 (14.0)	57 (66.3)	17 (19.8)	86 (49.7)	
10-13 years	12 (20.3)	40 (67.8)	7 (11.9)	59 (34.1)	0.173
14-16 years	2 (7.1)	24 (85.7)	2 (7.1)	28 (16.2)	
Boys	21 (12.1)	121 (69.5)	32 (18.4)	174 (50.1)	
6-9 years	3 (3.7)	57 (71.3)	20 (25.0)	80 (46.0)	
10-13 years	12 (17.4)	49 (71.0)	8 (11.6)	69 (39.7)	0.010
14-16 years	6 (24.0)	15 (60.0)	4 (16.0)	25 (14.4)	
Highest educational level of householder					
Total	41 (13.1)	220 (70.3)	52 (16.6)	313 (90.2)	
No education	0	3 (1.4)	1 (1.9)	4 (1.3)	
Primary school	0	7 (3.2)	2 (3.8)	9 (2.9)	
Middle school	6 (14.6)	22 (10.0)	4 (7.7)	32 (10.2)	0.556
High school	23 (56.1)	140 (63.6)	30 (57.7)	193 (61.7)	
College	3 (7.3)	15 (6.8)	8 (15.4)	26 (8.3)	
University	9 (22.0)	33 (15.0)	7 (13.5)	49 (15.7)	
Employment status of householder					
Total	29 (12.3)	169 (71.9)	37 (15.7)	235 (67.7)	
Unemployed	2 (6.9)	14 (8.3)	8 (21.6)	24 (10.2)	0.117
Employed	26 (89.7)	140 (82.8)	26 (70.3)	192 (81.7)	
Disabled/in pension	1 (3.4)	15 (8.9)	3 (8.1)	19 (8.1)	

Table 3. Water and beverage type and volume (in mL) by BMI z-score

Beverage group	Mean volume (95% confidence interval) (mL)			p-value
	Underweight z<-1	Normal weight -1>z<1	Overweight and obese z>1	
Water	304.3 (198.0-410.6)	383.9 (335.5-432.3)	396.6 (293.0-500.1)	0.382
Tea	848.9 (707.1-990.8)	759.9 (696.5-823.3)	791.9 (671.1-912.7)	0.510
Milk	24.5 (0.0-57.3)	23.8 (11.9-35.6)	34.5 (0.0-69.1)	0.775
Fruit juice, soft drinks	116.0 (46.8-185.2)	120.3 (90.5-150.0)	59.5 (22.3-96.7)	0.172
Coffee	15.0 (0.0-37.8)	18.4 (6.9-29.8)	14.9 (0.0-37.8)	0.631
Total beverage intake	1308.5 (1166.2-1450.8)	1307.2 (1238.2-376.3)	1287.6 (1157.0-1418.2)	0.967
Total SSB[a]	94.7 (46.9-142.4)	149.3 (116.7-181.9)	222.5 (127.4-317.7)	0.047

[a]Total SSB consists of all kinds of sugar added drinks and fruit drinks

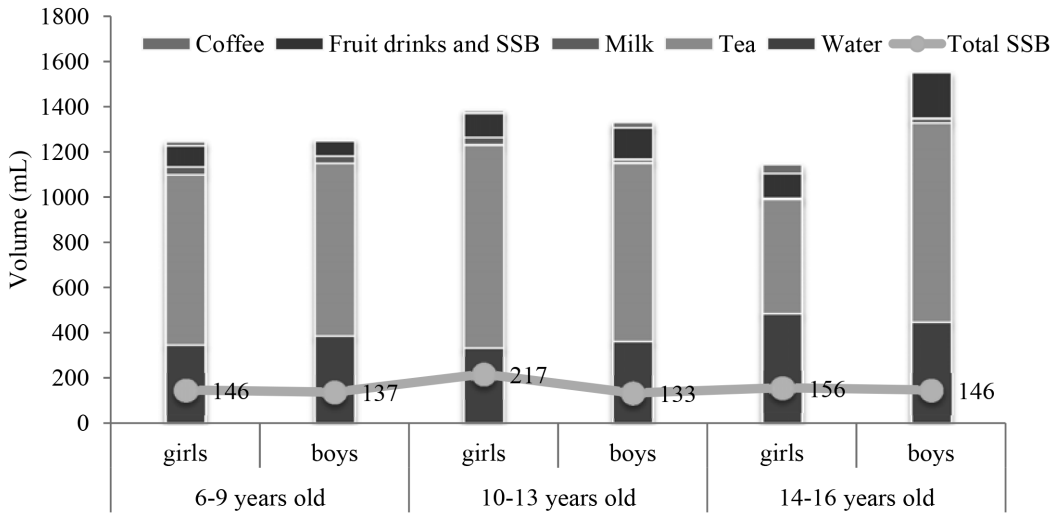

Figure 1. Total intake and types of water and beverages consumed per day, by sex and age groups.

Discussion

The Mongolian STEPwise approach to Surveillance survey (STEPS) on the prevalence of non-communicable disease and injury risk factors showed that 52.3% of the population aged 15-64 had overweight and obesity [9]. Moreover, a global school-based student health survey by the WHO revealed that 11.4% of adolescents aged 13-17 suffer from overweight and obesity and 34% of them drink SSB at least once in a day [8]. Our recent study found a similar result with the WHO study, which is that 11.3% of 14-16 year-olds had overweight and obesity. Overall in Mongolia, 16.7% of study participants had overweight and obesity. Most of them were 6-9 year-old children, therefore showing a tendency of an increased number of overweight and obese in this age group.

The present study found that an average of 250 mL of water was consumed by the study population, which is similar to results from other foreign studies. For instance, Senterre et al. found that 8 year-old Belgian children consume 215-333 mL of water per day, whereas Turrini et al. showed that 9-13 year-old Italian children drink 298-344 mL water per day [37, 38]. Relatively low frequency and amount of water consumption in these studies raised questions about availability and accessibility of drinking water at home as well as at school environment.

All kinds of SSB accounted for 6.4-13.1% of total intake of fluid. The highest consumption was reported in 14-16 year-old boys, the mean volume of SSB being 204 mL per day (13.1% of total intake). Similarly, Turrini et al. cites that fruit juice and SSB make up 12.3 and 16.6% of total consumption [38].

The findings of these analyses support previous observational and experimental studies by Perez et al. and Bray et al. that SSB consumption of overweight and obese children is markedly higher than normal and underweight children [17, 39]. SSB can lead to weight gain through their high added sugar content, low satiety, and an incomplete compensatory reduction in subsequent meals after intake of liquid calories [19]. Furthermore, Odegaard et al. found by their cross-sectional study that increased SSB consumption was associated with adverse abdominal adipose tissue deposition [40]. Some researchers suggested that sugar-containing food and beverages can be addictive under certain circumstances which further contributes to obesity and eating disorders [41]. They have proposed a neurochemical hypothesis that may explain sugar dependency. According to their hypothesis, intermittent sugar intake can result in various behaviors that are related to those observed in drug-dependent animals [41].

Our analyses suggest that school children and adolescents drink less dairy milk (14.1-20.0 mL per day) than other countries. A study of from the Nutrition Research Center of the Public Health Institute of Mongolia found a similar result that only 1

out of 20 pupils (5%) drink dairy milk at school and 66% of 1408 study participants drink SSB at school [42]. In contrast, the DONALD cohort study found that German adolescents consume 144-203 mL milk per day [43]. However, since the consumption of Mongolian milk tea was included under the tea category rather than the milk category, the actual consumption of milk in all forms would be higher than the result obtained for the milk category alone.

The current study has several strengths. First, we attempted to determine 24-hour total volume of consumed water and beverages of children and adolescents for the first time in ger districts in the capital city of Mongolia. Second, trained researchers collected anthropometric measurements by standardized methodology, not by self-reporting.

We also acknowledge some limitations to the present study. The beverage consumption data of study participants were obtained by a 24-hour water and beverage consumption recall. This method is a time-saving and inexpensive way to determine the usual beverage consumption pattern of children. However, this method requires that children and caregivers remember the time, type of beverage and amount of beverage, which could result in recall bias. To minimize recall bias, we used show cards with beverage types and amount of fluid. Another limitation of the present study was the relatively small sample size with 347 children. This sample size can represent only 6 to 16 year-old children from ger districts in Ulaanbaatar, but not fully represent all Mongolian children.

Based on this study, more observational and interventional studies should be performed to investigate the relationship between SSB consumption and childhood health outcomes in the household and school environment. This can then help policy makers develop evidence-based prevention strategies about SSB and weight gain.

Conflict of Interest

The authors state no conflict of interest.

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