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Research Article
Preliminary Study: Sugar-sweetened Beverages (SSBs) Consumption Correlated with Body Mass Index (BMI)

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Abstract

Background and Objective: Over the past several decades, an increase in the consumption of sugar-sweetened beverages (SSBs) has coincided with rising rates of obesity. This study was conducted to evaluate the association between SSBs consumption and Body Mass Index (BMI) among female university students. **Materials and Methods:** An online structured survey form was used to collect the data on SSBs consumption and BMI in Saudi Arabia. **Results:** One way ANOVA found significant differences in mean BMI across various consumption frequencies of SSBs ($p<0.001$). An increased risk of being obese (high BMI: 30 or more) was associated with increased total consumption and consumption frequency of SSBs ($p<0.05$). **Conclusion:** This study found that mean BMI was positively associated with SSBs consumption. These significant results indicate that consumption of SSBs increases the risk of obesity.

Key words: SSBs, body mass index, cold drinks, obesity

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Sugar-sweetened beverages (SSBs) are liquids prepared for human consumption, including juices, soft drinks and carbonated drinks that usually contain carbonated water, sweeteners and natural or artificial flavors. The sweetener may contain sugar, high-fructose corn syrup, fruit juice, sugar substitutes (as in the case of diet drinks), or a combination of these ingredients. The SSBs may also contain caffeine, preservatives and other ingredients.

The SSBs contain various amounts of sugars, thus contain high total calories. It is reported that coca-cola (355 mL) and mountain dew (590 mL) contain 39 and 77 g of sugar, respectively[1]. Consumption of SSBs has become a controversial public health issue. Soft drinks are a major contributor to obesity and obesity is a leading cause of death worldwide[2-4]. Body mass index (BMI), which is expressed as weight/(height)^2 (kg m^{-2}) is commonly used to classify body weights. The categories are as follows: Underweight (<18.5), normal weight (18.5-24.9), overweight (25.0-29.9), class I obesity (30.0-34.9), class II obesity (35.0-39.09) and class III obesity or extreme obesity ($\geq$40)[5]. Although, several reasons have been suggested to explain the increase in obesity in the past couple of decades, the increasing consumption of SSBs appears to be the major cause.

Sugar-sweetened beverages are frequently consumed in Saudi Arabia, especially by children and youth. Saudi Arabia is the largest soft drink consumer in the Middle East[6]. A study conducted in Riyadh reported that the intake of soft drinks and juices constituted 51% of total fluid intake among a sample of 12-13 years old adolescents[7]. At the same time, obesity in Saudi Arabia is growing and has been reported to be one of the leading causes of preventable deaths in Saudi Arabia. In 2007, Saudi Arabia was ranked 29th on the list of countries with the highest rate of overweight/obesity[8]. A recent WHO report suggests that 43% of females and 30% of males are obese in Saudi Arabia[9].

Previous studies have investigated the relationship between SSBs consumption and obesity or BMI in children and adolescent populations[10]. However, only a few studies have examined adult populations, even though it has been shown that SSBs consumption is the highest among adults. The purpose of this study was to evaluate the association between SSBs consumption and BMI in the adult female university population.

MATERIALS AND METHODS

For data collection, an electronic form was designed on e-survey creator. Anthropometric measures (i.e., weight) were obtained using a scale (Healthometer, Inc, USA) and BMI was manually calculated using a formula weight/(height)^2 (kg m^{-2}). A questionnaire was designed to estimate the usual intake of SSBs. All analyses were applied to find out the consumption frequency and BMI.

Subjects: Data were collected from 2nd year students enrolled in the undergraduate medical program at Umm Al-Qura University, Makkah. One hundred students were sampled.

Questionnaire design: The study was designed as described by Malik *et al.*[10], with a few modifications in the questionnaire. In the present study, the questions on SSBs consumption provided the following categorical choices: (1) Never, (2) Once per month or less, (3) 2-3 times per month, (4) 1-2 times per week, (5) 3-4 times per week, (6) 5-6 times per week, (7) Once per day, (8) 2-3 times per day, (9) 4-5 times per day and (10) 6 or more times per day.

The questions were as follows: 1: How many glasses of water do you drink daily? 2: How often do you consume any soft drinks (juices or soda: Diet or sugar free) other than water? 3: How often do you notice or calculate the amount of drink consumed in milliliters? 4: How often do you calculate the amount of sugar present in the drink in grams? and 5: How often do you drink milk as a beverage (not in coffee/on cereals)?

Statistical analysis: Minitab 17 was used for statistical analysis. The control variables used were gender, age (years) and education level. The independent variable analyzed was beverage consumption frequency. The dependent variable was mean BMI (kg m^{-2}). For each variable analyzed, descriptive statistics were generated, including number of cases, unadjusted mean BMI and 95% confidence intervals. One way analysis of variance (ANOVA) was carried out to compare the mean BMI.

RESULTS

Figure 1 shows the daily consumption of water. It is observed that only 11 and 4% of the total subjects consume 8 and 10 glasses of water, respectively, whereas 30% of the total population consume 2-4 glasses of water per day.

Figure 2 illustrate the consumption of SSBs. Figure 2 indicates the majority of students consume juices. A total of 21 and 18% of subjects consume SSBs 1-2 times per week and 5-6 times per week, respectively, whereas 26 and 16% drink SSBs daily and 2-3 times per day, respectively. A small proportion of the subjects (only 3%) did not drink SSBs over the past year.

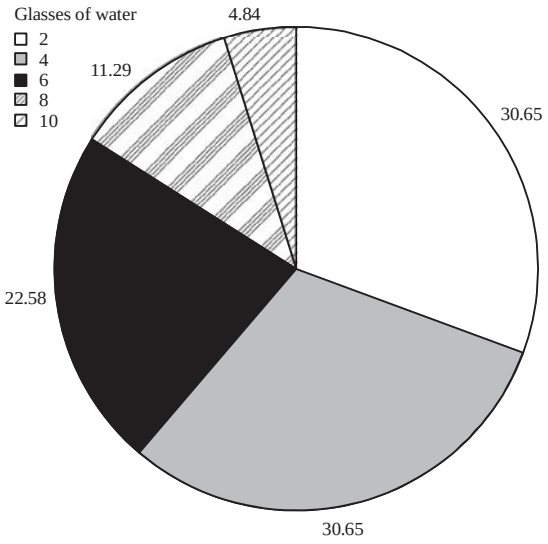

Fig. 1: Consumption of water

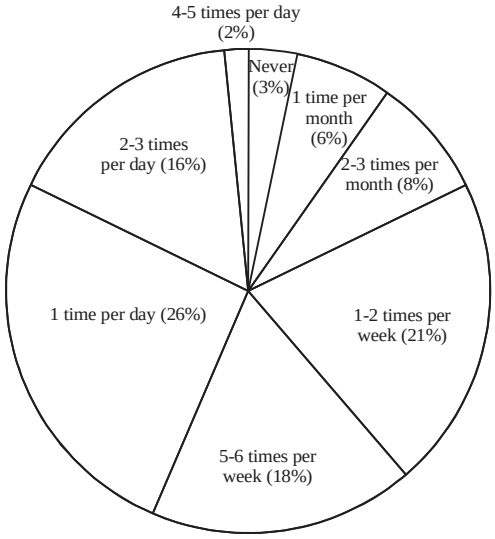

Fig. 2: How often did you drink any soft drinks (juices, soda drinks diet or sugar free) other than water

Figure 3 shows that 98% of adult subjects never noticed, whereas only 2% noticed the amount of SSBs they consumed in milliliters.

The results depicted in Fig. 4 demonstrated how often subjects calculate the amount of sugar (g) present in drinks (SSBs). Figure 4 showed that 97% of adult subjects never noticed, whereas only 3% always noticed the amount of sugar (g) in SSBs.

Figure 5 demonstrates the consumption of milk. The results indicate that the majority of subjects (21%) had never drink milk over the past 2 years, whereas only 10% drank milk daily.

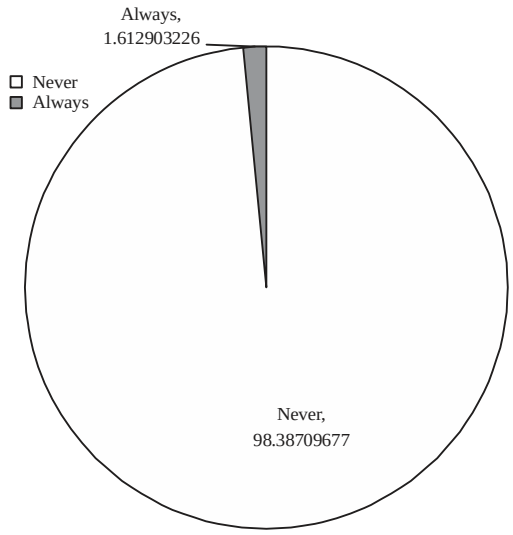

Fig. 3: How often did you notice or calculate the amount of drink consumed in milliliters

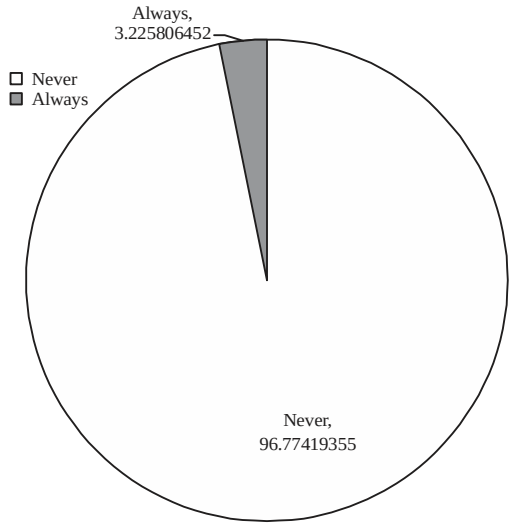

Fig. 4: How often did you calculate the amount of sugar present in drink in grams

One way analysis of variance (ANOVA) was carried out to compare the mean BMI across SSBs consumption frequency. The $p<0.05$ was considered as significant result.

For the subjects (29%) who always drank SSBs, the mean BMI (27.37 ± 2.19) was generally higher than those (58%) who consume sugar free drinks (mean BMI = 21.14 ± 4.239). The ANOVA found a significant difference in mean BMI between these 2 categories ($p<0.005$) as shown in Table 1.

The data show that the mean BMI differed across all categories as shown in Table 1. In all cases, BMI of the subjects who consume SSBs was greater than those who did not consume sugar in their drinks as shown in Table 1.

Table 1: Effect of soft drinks (with and without sugar) on BMI

	Soft drinks with sugar		Soft drinks without sugar	
Consumptions	Consumption (%)	BMI	Consumption (%)	BMI
Always	29	27.37±2.19	58	21.14±4.2*
1 time per month	9	23.57±3.02	29	19.89±2.9
2-3 times per month	14	29.02±4.91	12	23.70±3.4
1-2 times per week	4	27.16±9.10	25	22.23±5.7
5-6 times per week	8	31.38±9.30	8	23.85±5.9
Once a day	4	33.70±3.20[a]	6	21.78±3.6

Average±SD, *Indicates significant difference between soft drink with sugar and soft drink without sugar, [a]Indicates the difference between SSBs consumption once per month and once per day, BMI categories in adults 20 years of age and older, underweight: BMI ≤18.5, normal weight: BMI is 18.5-24.9, overweight: BMI is 25-29.9, Obese: BMI is ≥30

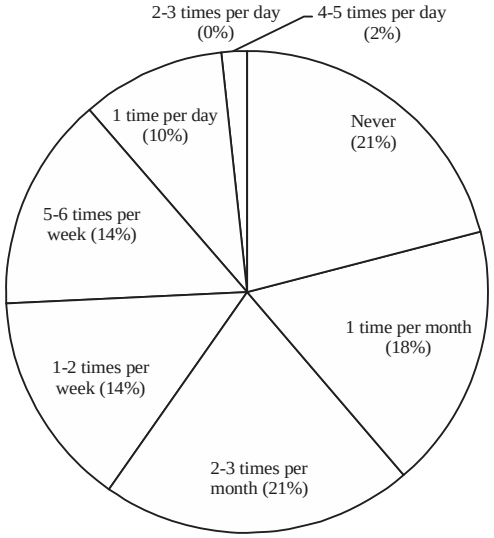

Fig. 5: How often did you drink milk as beverages (not in coffee/on cereals)?

Table 1 also shows that the frequency of SSBs consumption significantly affect the BMI. Mean BMI increased in general as the frequency of consumption increased. The BMI was significantly ($p<0.05$) higher in the subjects who drank SSBs once per day than those who consumed SSBs only once per month.

DISCUSSION

The present results suggested that water consumption is less frequent among Saudi students (second year medicine), as shown in Fig. 1. Water is necessary for life and in a hot climate, such as that of Saudi Arabia, up to 16 L day^{-1} may be required[11]. Previous studies have reported similar findings suggesting that children and adolescents do not consume enough water[12] and prefer to drink SSB_S beverages. Sugar-sweetened beverage (SSBs) consumption is associated with obesity[10,13] as we observed in the present study. Moreover, several studies suggest that drinking water helps to prevent obesity[14,15].

On the other hand, milk consumption is remarkably low in Saudi students. Dietary guidelines recommend three glasses of fat-free or low-fat milk for adults and children per day because milk is a source of calcium and vitamin D[16]. A study revealed an approximately 35% decline in total milk consumption[17]. Mrdjenovic and Levitsky[18] pointed out that SSBs caused replacement of milk in the diet.

The data analysis showed a significant, positive association between mean BMI and SSBs. The findings of this preliminary analysis are supported by Schulze *et al.*[19], who found a positive association between SSBs frequency and BMI. In this study, conducted by Schulze *et al.*[19], it was found that increase in BMI was highest for participants who increased frequency of soft drink intake and lowest for participants who decreased the frequency of soft drink intake. Different studies also found a positive association between sugar-sweetened beverage consumption and increased body weight[14,20,21].

CONCLUSION AND FUTURE RECOMMENDATIONS

Due to increase in the rate of obesity in Saudi Arabia, this study suggests to minimize the consumption of certain foods that contain excessive sodium, saturated fats, trans fats and cholesterol, subjects should take action to minimize the consumption of sugar-sweetened beverages. It is suggested that eating whole fruits is better than drinking juices and SSBs. In fact, several studies have been carried out to investigate the effects of reduced sugar-sweetened beverage consumption on obesity. Finally, it is recommended that:

- Always check the nutrition facts label and calories before drinking SSBs
- Always select the small size of a sugar-sweetened beverage
- Try to drink healthy and fresh beverages without sugar

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