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Predictors of sugar-sweetened carbonated beverage consumption and its effect on adiposity parameters of female Saudi students

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Abstract

The prevalence of obesity has recently increased, accompanied by a steep increase in the consumption of sugar-sweetened carbonated beverages (SSCBs). This cross-sectional study was conducted to evaluate the impact of SSCB consumption on adiposity parameters and to identify factors associated with increased SSCB intake among young adult females in Makkah, Saudi Arabia. A validated closed questionnaire including 2 sections, general socioeconomic and behavioral characteristics and anthropometric measurements, was used for data collection of female students (n = 1616) from Umm Al-Qura University, Makkah, Saudi Arabia. Furthermore, height, weight, body mass index (BMI), waist circumference (WC), hip circumference (HC), and body composition were measured using an Omron HBF-510 body composition analyzer. Overall, 30.2% of the study participants consumed soda regularly. However, the percentages of occasional and never/rare soda intake were 40.1% and 29.7%, respectively. The results showed that BMI, WC, HC, body fat, and visceral fat increased with increasing SSCB intake. Physical inactivity, low income, smoking, low daily water intake, and obesity were associated with increased consumption of SSCB. In conclusion, a high rate of SSCB consumption increased obesity and body fat content in young adult females in Makkah City. Physical inactivity, low income, smoking, low daily water intake, and obesity were identified as predictors of increased SSCB consumption. Specific health education programs and effective public awareness campaigns could be held to address unhealthy SSCB drinking patterns to help improve young women's health.

Abbreviations: 95% CI = 95% confidence intervals, BMI = body mass index, HC = hip circumference, MAC = mid-arm circumference, OR = Odds ratio, SSCBs = sugar-sweetened carbonated beverages, USD = US dollar, WC = waist circumference, WHR = waist-hip ratio.

Keywords: body composition, obesity, socioeconomic factors, soda, young adult females

1. Introduction

Since the last millennia, obesity has developed into a severe health issue affecting individuals of different ages. The prevalence of obesity has approximately tripled over the last 4 decades, and nearly 1 to 3rd of the world's population was classified as overweight or obese.[1] Obesity plays a critical role in the etiology of many diseases, which resulted in worldwide deaths of approximately 3 million every year.[2] Gulf countries, including Saudi Arabia, Kuwait, Bahrain, and United Arab Emirates, ranked among the top 10 countries globally in terms of obesity prevalence. It has been reported that 35.2% of Saudi Arabia's population is obese.[3]

Obesity is a multifactorial disease that might be attributed to dietary, behavioral, genetic, psychological, social, economic, and environmental factors.[4] The distribution of regional body fat can be determined by anthropometric measures, including waist, hip, and arm circumferences and their ratios. However, the assessment of fat mass was reported to be a better risk predictor of comorbidities than other conventional anthropometric parameters.[5] In addition, studying the development of body composition, lean mass, fat mass, and water content should be considered to better assess the effects of dietary habits and lifestyle patterns on the body structure.[6] Omron devices (such as HBF-510) are considered reliable, valid, and accurate tools for estimating body composition in healthy adult individuals.[7] However, one of the most important factors linked to obesity is the consumption of high-calorie, high-sugar foods and beverages, especially sugar-sweetened carbonated beverages (SSCBs), also known as soda.[8] SSCBs are typically poor in nutrients, but high in added free sugars, which supply empty calories and unhealthy energy-dense foods.[9]

AEH contributed equally to this work.

The authors have no conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

This study was approved by the Ethical Committee of the Faculty of Applied Medical Sciences at UQU (approval number AMSEC-9-754-2016), following the Declaration of Helsinki. Informed consent was obtained from all participants at the onset of the study. Participants were assured of confidentiality and their right to withdraw from the study.

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Soda intake is highly influenced by socio-environmental and individual factors, and increases with age.[10] Pengpid and Peltzer[11] summarized some of the factors that would increase the intake of SSCBs, such as male gender, low income, younger age, black people, low education, smoking, sedentary lifestyle, obesity, low fresh juice intake, and high fast food and snack intake. A recent study by Islam et al[12] showed that 17.2% of young Saudi adults consumed SSCBs 2 to 3 times per week. Another study in Saudi Arabia demonstrated that the majority (approximately 86%) of adults regularly consumed soda.[13] Furthermore, Saudi Arabia ranked the highest among Middle Eastern countries in terms of SSCB consumption, and is ranked as one of the top 5 consumers of sugar-sweetened beverages, globally.[13,14] Being the primary source of added sugars in the diet, SSCB consumption was shown to be positively correlated with excess body weight, obesity, and other lifestyle-related disorders, such as diabetes and metabolic syndrome, even at an early age of life.[15]

Although a variety of studies have drawn a link between regular consumption of SSCBs and obesity and how it would negatively affect individuals' health, research exploring ways to reduce consumption and increase citizens' awareness is still needed.[16] Additionally, Islam et al[12] reported that SSCB consumption was highly associated with certain socioeconomic factors among young Saudi adults. Thus, the current study was conducted to evaluate the impact of the consumption of SSCB on adiposity parameters among young adult females from Umm Al-Qura University, Makkah, Saudi Arabia. This study also aimed to identify socioeconomic and behavioral factors associated with increased intake of SSCB.

2. Methods

2.1. Study design and participants

This cross-sectional study included 1616 female students from Umm Al-Qura University, Al-Abdiah Campus, Makkah, Saudi Arabia, aged 18 to 24 years. Data were collected from March 2016 to February 2017, and stratified random sampling was implemented by department and class year with a response rate of 97%. The inclusion criterion was female university students who were symptomatically healthy. However, pregnant or breast-feeding females, females suffering from any chronic or metabolic disease(s), or those showing any other clinical abnormalities were excluded. In addition, we excluded the consumption of sugar-free soda drinks from our data, and the participants were informed to exclude it from their dietary intake before completing the questionnaire.

2.2. Data collection

The purpose of the research, methods, and potential contributions to the study program were explained to all participants before conducting the interviews. After participants signed a written consent form, semi-structured face-to-face interviews were conducted. The interviewers were trained by skillful dietitians, accompanied by a professor from the Department of Clinical Nutrition, Umm Al-Qura University. Participants' information were obtained through a validated closed questionnaire adopted from Al-Rethaiaa et al[17] that included general socioeconomic and behavioral characteristics, such as monthly family income, regular exercise, and smoking, in addition to anthropometric measurements. Two additional questions on the intake of water (cup/day) and soda (cup/week) were included based on a validated questionnaire from Ghaith and Ibrahim.[18] The participants were categorized into 3 groups according to the number of cups of soda consumed per week as follows: Less than or equal 1 cup/week as the "Never/Rarely" group; 2 to 5 cups/week as the "Sometimes" group, and; More than or equal 6 cups/week as the "Regularly" group. Similarly, daily water intake was categorized into 4 groups: 1 to 2 cups/day; 3 to 4 cups/day; 5 to 6 cups/day, and; > 6 cups/day.

Height, weight, waist circumference (WC), hip circumference (HC), and body composition were recorded as described by Azzeh et al[19] and Obeidat et al[20] Participants were asked to stand up straight and have light clothes and barefoot for all measurements. Height (cm) was measured using a Harpenden stadiometer (Holtain, Crymych, Wales, UK). Waist circumference (cm) and HC (cm) were measured using a metric measuring tape according to standard procedures. All measurements were recorded to the nearest 0.1 value. The waist-hip ratio (WHR) was subsequently calculated by dividing the WC by HC. The WHO female cutoff points for WC and WHR were 80 cm and 0.8, respectively.[21]

The mid-arm circumference (MAC) was measured using a measuring tape to the nearest centimeter. Triceps skinfold thickness, an established measure of fat stores, was measured to the nearest millimeter in the right arm using a skinfold caliper (Harpenden, HSB-BI, Baty International, Sussex, UK). The latter 2 measurements were performed as described by Azzeh et al.[19] Three measurements were taken for both the Triceps skinfold thickness and MAC, and the average values were calculated and recorded.

Weight and body composition analyses were performed using the Omron HBF-510 Body Composition Analyzer (Kyoto, Japan). The device, with footpad and handlebar electrodes, estimated various body composition variables such as body weight (kg), body fat (%), visceral fat level, water (%), and skeletal muscle (%). The body mass index (BMI) was calculated as body weight in kg divided by height in square meters (kg/m^2), and then the following BMI groups were created: Underweight (<18.5 kg/m^2); Normal weight (18.5 to <25 kg/m^2); Overweight (25 to <30 kg/m^2); Obese class-I (30 to <35 kg/m^2); Obese class-II (35 to <40 kg/m^2), and; Obese class-III (≥40 kg/m^2).[22]

2.3. Statistical analysis

Statistical package for the social sciences software (SPSS; version 20, IBM, NY) was used for statistical analysis. Statistical significance was set at $P < .05$. Continuous data were presented as means and standard deviations (mean ± SD), whereas non-continuous data were presented as frequencies and percentages. *P*-values were determined by ANOVA followed by Games-Howell post hoc analysis for continuous variables. The Chi-squared test was used to determine significant differences for non-continuous variables. Multinomial logistic regression was applied to obtain the odds ratio (OR), which was presented with a 95% confidence interval (95% CI) to determine the independent variables as predictors for increased soda intake.

3. Results

3.1. Characteristics of the study participants

A total of 1616 female students were recruited for this study. The characteristics of the study sample, as shown in Table 1, revealed that the mean age of the participants was 20.7 ± 1.2 years. The mean and standard deviation for BMI was 23.1 ± 5.4 kg/m^2, WC was 72 ± 10.8 cm, HC was 98.4 ± 11.2 cm, WHR was 0.73 ± 0.06, MAC was 26.6 ± 4.6 cm, and TSF was 20.2 ± 11.6 mm. It is worth noting that all values were within the normal range. In addition, body fat percentage, skeletal muscle percentage, water percentage, and visceral fat level also showed normal values of 32.6 ± 7.2%, 37.5 ± 6%, 48.2 ± 7.1%, and 4 ± 1.7, respectively.

Table 1

Characteristics of study participants (n = 1616).

Parameter	Mean ± SD
Age (yrs)	20.7 ± 1.1
Weight (kg)	56.9 ± 14
Height (cm)	156.9 ± 5.3
BMI (kg/m^2)	23.1 ± 5.4
WC (cm)	72 ± 10.8
HC (cm)	98.4 ± 11.2
WHR	0.73 ± 0.06
MAC (cm)	26.6 ± 4.6
TSF (mm)	20.2 ± 11.6
Fat (%)	32.6 ± 7.2
Skeletal muscle (%)	37.5 ± 6
Water (%)	48.2 ± 7.1
Visceral fat	4 ± 1.7

Normal anthropometric values for females aged 18–24 years are as follows: WC < 80 cm; WHR < 0.8; body fat percentage: 21–32.9%; skeletal muscle percentage: >24%; water percentage: 45–60%; and visceral fat level: <9 (Azzeh et al 2017).
BMI = body mass index, HC = hip circumference, MAC = mid-arm circumference, TSF = triceps skinfold, WC = waist circumference, WHR = waist-to-hip ratio.

3.2. Participants' distribution according to BMI classifications

Figure 1 illustrates the distribution of participants according to BMI categories. Most of the participants had normal weight (52%), and 18.1% were overweight. The overall prevalence of obesity was 10.9%. Amongst the obese participants, the percentages of obese class I, class II, and class III were 6.2%, 3.5%, and 1.2%, respectively. The percentage of underweight participants was 19.1%.

3.3. Anthropometric and body composition characteristics of participants according to SSCB consumption

The anthropometric and body composition characteristics of participants according to their SSCB consumption are shown in Table 2. The table shows that 29.7% of the participants (n = 480) were considered never/rare consumers, 40.1% (n = 648) were considered occasional consumers, and 30.2% (n = 488). Hip circumference, WHR, body weight, MAC, TSF, and visceral fat level were found to have a significant ($P < .05$) association with SSCB consumption. Furthermore, WC, BMI, body fat percentage, and body water percentage were significantly ($P < .001$) associated with SSCB consumption. However, no significant relationship was observed between height and skeletal muscle mass with SSBC consumption. The post hoc analysis showed that participants who were considered never/rare consumers of SSCB had significantly ($P < .05$) lower anthropometric and adiposity measurements and significantly ($P < .05$) higher water percentage than participants who were considered occasional or regular consumers of SSCB.

3.4. Association between socioeconomic, behavioral, and anthropometric characteristics and SSBC consumption

The associations between socioeconomic and behavioral factors and SSCB consumption are shown in Table 3. Income was significantly ($P < .05$) associated with soda consumption. Additionally, SSCB consumption was negatively ($P < .001$) associated with regular exercise and daily water intake. However, SSBC consumption was positively ($P < .001$) associated with smoking habits BMI categories, and WC classification. Our results showed no association between SSBCs consumption and WHR ($P = .081$).

From Table 3, it was observed that females who consumed < 1 cup of soda per week had significantly ($P < .05$) higher percentages of daily exercise and drinking > 6 cups of water per day than females who consumed soda > 2 cup per week. Moreover, the former group had significantly ($P < .05$) lower percentages of smoking, obesity, and increased WC than the latter 2 groups. With respect to family income, percentages of low and medium income (monthly earn < 8000 Saudi riyals ~ 2160 USD) were significantly higher ($P < .05$) for females who were considered regular or occasional consumers of SSCB than for females who were considered never/rare consumers of SSCB.

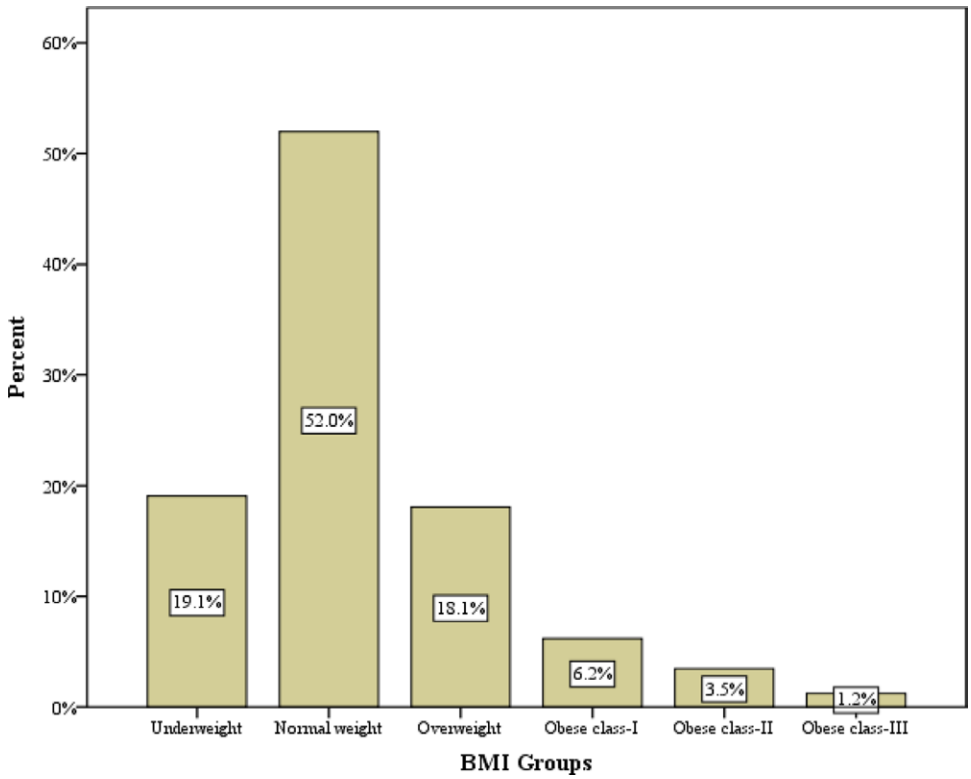

Figure 1. Distribution of BMI groups in the sample. BMI = Body mass index.

Table 2

Anthropometric and body composition characteristics of participants and SSCB consumption groups.

	SSCB intake groups Mean ± SD			
Parameter	**Regularly**	**Sometimes**	**Never/Rarely**	***P*-value**
WC (cm)	73.1[a] ± 11.6	72.3[a] ± 10.7	70.6[b] ± 9.7	**.001****
HC (cm)	98.8[a] ± 12.1	99.2[a] ± 11.6	97.1[b] ± 9.4	**.005***
WHR	0.74[a] ± 0.06	0.73[b] ± 0.06	0.73[b] ± 0.06	**.002***
Weight (kg)	57.7[a] ± 15.7	57.3[a] ± 13.7	55.4[b] ± 12.6	**.021***
Height (cm)	156.8 ± 5.4	156.7 ± 5	157.2 ± 5.6	.252
BMI (kg/m^2)	23.6[a] ± 6.1	23.4[a] ± 5.3	22.3[b] ± 4.7	**<.001****
MAC (cm)	26.9[a] ± 4.9	26.8[a] ± 4.9	26[b] ± 3.9	**.004***
TSF (mm)	20.5[a] ± 12	20.7[a] ± 12	19.1[b] ± 10.7	**.04***
Fat (%)	33.6[a] ± 7.3	33[a] ± 7.5	31[b] ± 6.4	**<.001****
Skeletal muscle (%)	37.5 ± 6.6	37.4 ± 6	37.5 ± 5.4	.944
Water (%)	47.6[b] ± 6.8	47.8[b] ± 7.7	49.4[a] ± 6.6	**<.001****
Visceral Fat	4.1[a] ± 1.7	4.1[a] ± 1.6	3.8[b] ± 1.6	**.014***

P-values were determined by the ANOVA test. Bold results are considered statistically significant at * $P < .05$ and ** $P < .001$.

Different letters in the same row are statistically significant according to Games-Howell post hoc test.

BMI = body mass index, HC = hip circumference, MAC = mid-arm circumference, SSCB = sugar-sweetened carbonated beverage, TSF = triceps skin fold, WC = waist circumference, WHR = waist-to-hip ratio.

Table 3

Associations between socioeconomic, behavioral, and anthropometric characteristics and SSCB intake groups.

	SSCB intake groups Frequency (%)			
Parameter	**Regularly (n = 488)**	**Sometimes (n = 648)**	**Never/Rarely (n = 480)**	***P*-value**
Income (Saudi Riyals)				**.027***
<4000	216 (44.3%)	288 (44.4%)	208 (43.3%)	
4000–8000	52 (10.7%)	80 (12.3%)	52 (10.8%)	
8000–15,000	116 (23.8%)	112 (17.3%)	120 (25%)	
>15,000	104 (21.3%)	168 (25.9%)	100 (20.8%)	
Regular exercise				**<.001****
None	208 (42.6%)	276 (42.6%)	128 (26.7%)	
Once a week	120 (24.6%)	128 (19.8%)	128 (26.7%)	
2–4 times a week	124 (25.4%)	180 (27.8%)	148 (30.8%)	
Daily	36 (7.4%)	64 (9.9%)	76 (15.8%)	
Smoking				<**.001****
Yes	32 (6.6%)	24 (3.7%)	8 (1.7%)	
No	456 (93.4%)	624 (96.3%)	472 (98.3%)	
Daily water intake (cups/d)				<**.001****
1–2	200 (41.0%)	244 (37.7%)	84 (17.5%)	
3–4	136 (27.9%)	148 (22.8%)	136 (28.3%)	
5–6	104 (21.3%)	116 (17.9%)	112 (23.3%)	
>6	48 (9.8%)	140 (21.6%)	148 (30.8%)	
BMI categories				<**.001****
Underweight	96 (19.7%)	116 (17.9%)	96 (20%)	
Normal weight	236 (48.4%)	324 (50%)	280 (58.3%)	
Overweight	84 (17.2%)	132 (20.4%)	76 (15.8%)	
Obese	72 (14.8%)	76 (11.7%)	28 (5.8%)	
WC status				<**.001****
Normal	368 (75.4%)	512 (79%)	420(87.5%)	
Higher than normal	120 (24.6%)	136 (21.0%)	60 (12.5%)	
WHR status				.081
Normal	468 (95.9%)	628 (96.9%)	472 (98.3%)	
Higher than normal	20 (4.1%)	20 (3.1%)	8 (1.7%)	

P-values were determined by Chi-square test. Bold results are considered statistically significant at * $P < .05$ and ** $P < .001$.

1 Saudi riyal equals 0.27 USD.

Normal anthropometric values for females aged 18–24 years are: WC < 80 cm; WHR < 0.8.

BMI = Body mass index, SSCB = sugar-sweetened carbonated beverage, WC = Waist circumference, WHR = waist-to-hip ratio.

3.5. Socioeconomic, behavioral, and anthropometric characteristics as predictors of SSCB consumption

Table 4 displays the socioeconomic, behavioral, and anthropometric characteristics as predictors of SSCB consumption. Regarding the regular SSCB consumption group, no regular physical activity (OR:3.431, 95% CI:2.18–5.399), smoking (OR:4.14, 95% CI:1.888–9.081), daily water intake (1–3, 2–4, and 3–5 cups/day; ORs:7.341, 3.083, and 2.863, respectively), obesity (OR:3.051, 95% CI:1.9080–4.879), and abnormally high WC (OR:2.283, 95% CI:1.625–3.207) were positively ($P < .001$) associated with high SSCB consumption. Participants who performed physical exercise "once a week" or "2 to 4 times a week" were significantly

Table 4

Socioeconomic, behavioral, and anthropometric characteristics as predictors of SSCB consumption.

Variable	SSCB intake groups OR (95% CI)	
	Regularly	Sometimes
Income (Saudi Riyals)		
<4000	0.999 (0.715–1.395)	0.824 (0.607–1.118)
4000–8000	0.962 (0.6–1.542)	0.916 (0.597–1.405)
8000–15,000	0.929 (0.639–1.352)	**0.556 (0.389–0.794)****
>15,000	1	1
Regular exercise		
None	**3.431 (2.18–5.399)****	**2.561 (1.728–3.793)****
Once a week	**1.979 (1.239–3.161)***	1.188 (0.786–1.795)
2–4 times a week	**1.769 (1.113–2.81)***	1.444 (0.971–2.149)
Daily	1	1
Smoking		
Yes	4.14 (1.888–9.081)**	2.269 (1.01–5.096)*
No	1	1
Daily water intake (cups/day)		
1–3	**7.341 (4.855–11.1)****	**3.071 (2.188–4.31)****
2–4	**3.083 (2.06–4.614)****	1.15 (0.829–1.597)
3–5	**2.863 (1.879–4.362)****	1.095 (0.773–1.550)
≥6	1	1
BMI category		
Underweight	1.186 (0.852–1.653)	1.044 (0.763–1.430)
Normal weight	1	1
Overweight	1.311 (0.919–1.871)	**1.501 (1.085–2.076)***
Obese	**3.051 (1.9080–4.879)****	**2.346 (1.478–3.723)****
WC classification		
Normal	1	1
Higher than normal	**2.283 (1.625–3.207)****	**1.859 (1.337–2.586)****

The reference category is the "Never/Rarely" SSCB consumption group.

Bold results are considered statistically significant at * $P < .05$ and ** $P < .001$.

BMI = body mass index, CI = confidence interval, OR = odds ratio, SSCB = sugar-sweetened carbonated beverage, WC = waist circumference.

1 Saudi riyal = 0.27 American dollar.

($P < .05$) more likely to have high SSCB intake (OR:1.979, 95% CI:1.239–3.161, and OR:1.769, 95% CI:1.113–2.810, respectively) than participants who exercised daily.

In the occasional SSCB consumption group, a high household monthly income (8000–15,000 Saudi riyals ~ 2160–4050 USD) was significantly ($P < .05$) associated with a lower likelihood of SSCB intake (OR:0.556, 95% CI:0.389–0.794). Furthermore, other significant odds values for high SSCB intake were observed for non-regular exercise (OR:2.561, 95% CI:1.728–3.793), smoking (OR:2.269, 95% CI:1.01–5.096), daily water intake (1–3 cups/day; OR:3.071, 95% CI:2.188–4.31), being overweight (OR:1.501, 95% CI:1.085–2.076), obesity (OR:2.346, 95% CI:1.478–3.723), and higher than normal WC (OR:1.859, 95% CI:1.337–2.586).

4. Discussion

This study was conducted to evaluate the effect of consumption of SSCB on obesity and body composition in young adult females from Makkah City, Saudi Arabia, and to determine the socioeconomic and behavioral factors associated with increased soda intake. The current data demonstrated that the mean values of BMI, WC, HC, WHR, body fat percentage, and visceral fat were significantly ($P < .05$) lower in participants who were never/rare consumers of SSCB than participants who were occasional or regular consumers of SSCB. Additionally, obesity percentage was higher ($P < .05$) in participants who were considered regular consumers of SSCBs (> 6 cups/week) than for those who consumed less than 6 cups/week. Low income, lack of regular exercise, smoking, and low water intake were associated ($P < .05$) with higher SSCB consumption.

Our study showed that 70.3% of young adult females consumed more than or equal to 2 cups of SSCBs per week. This high rate of consumption could be attributed to the hot weather, the high percentage of youth among the Saudi population, and changes in eating patterns influenced by Western culture. Islam et al[12] found that healthy young adult Saudis, on average, consumed 1.5 L of SSCBs weekly, amounting to an average of 225 ml and approximately 50 Kcal daily. Currently, there WHO strongly recommends the reduction of free sugar intake, and that free sugars derived from foods or beverages should not represent more than 10% of the total consumption of energy; specifically, the daily recommended intake of free sugars should not exceed 50 g daily.[23]

Consumption of SSCB would increase overall body energy intake and might result in replacing high-quality foods from the diet, which would potentially lead to body weight gain and an increase the risk of non-communicable diseases.[24] Additionally, it might have a higher and unique role in stimulating reward centers in the brain compared with other foods, or its role in the obesity crisis may simply be a result of it being one of the most available, popular, and promoted components of hyper-palatable food environments.[24] The current study showed that obese and overweight participants were more likely to consume SSCBs than lean participants. Conversely, prevalence of obesity increased as a result of high consumption of SSCB, which would result in an increase in SSCB demand, creating a vicious cycle that would aid obesity spread.[9] Duca et al[25] reported that more frequent use of SSCBs was linked to a higher WC, which was in line with the findings of this study. A study in the United States found that greater consumption of SSCB was linked to a higher risk of abdominal obesity in adults, and daily consumption of SSCB increased the risk of abdominal obesity by 76% compared to non-consumption.[26] Furthermore, SSCB increased the incidence of abdominal obesity when it substituted healthier drinks such as whole milk and juice in an individual's diet.[26]

The current study showed that high consumption of SSCB was associated with high total body fat percentage and higher

measurements in other adiposity indices as well. These findings were consistent with those of similar studies.[9,25,26] Previous studies have found that incidence of general obesity increased in tandem with the prevalence of abdominal obesity. However, a 1.1 cm rise in WC was reported for each 100 kcal increase in soda consumption.[26]

It has been suggested that the likely mechanism by which SSCBs would lead to body weight gain and increased risk of adiposity is the high fructose content in the corn syrup of soda.[27] Conversely, some studies have found that fructose is digested, absorbed, and metabolized differently than glucose, favoring *de novo* lipogenesis without stimulating insulin secretion or increasing the production of leptin, both afferent signals involved in the regulation of food intake and body weight.[25] A noteworthy finding is that soda intake induced the consumption of high-calorie food. This finding raised the possibility that the consumption of SSCB might increase hunger, decrease satiety, or simply calibrate people to a high level of sweetness that generalizes to preferences in other types of food.[28]

A recent study by Laohasiriwong et al[29] specifically described the association between socioeconomic characteristics and soda consumption among adult Cambodians. They noticed that low-income families (<300 USD per month) were substantially associated with increased consumption of SSCB. Meanwhile, the present study revealed that higher-income participants who earned 8000 to 15,000 Saudi riyals (~2160–4050 USD) per month were less likely to consume SSCB. This could be attributed to the high level of knowledge and education in high-income families and their desire for healthy dietary patterns and low soda intake. Consistently, Pengpid and Peltzer[11] confirmed the finding that households with lower annual incomes were more likely to consume soda than households with higher annual incomes. Furthermore, soda consumption was higher than recommended in many high-income countries and was increasing in low-income and middle-income countries worldwide.[8] They attributed this transition in consumption patterns to urbanization and economic development.[29,30]

This study showed that less physical activity and frequent smoking were significantly related to increased consumption of SSCB. Pengpid and Peltzer[11] also reported that consumption of SSCB increased with increasing sedentary time. Bibiloni et al[31] reported that inactive adolescents consumed higher amounts of soda than active participants. Additionally, the study results found that smokers were more likely to consume soda than nonsmokers. Consumption of SSCBs has been linked to smoking in young adults, and these age groups are more vulnerable to unhealthy dietary and lifestyle patterns.[32,33] Qobadi et al[34] concluded that inactivity and smoking were positively associated with increased intake of SSCB. They further suggested that this association could be related to the psychological state of smokers and/or inactive individuals that might drive them towards unhealthy and low-quality dietary habits; however, this possibility needs further investigation.

Results of this study demonstrated that low water intake would increase the consumption of SSCB. Rosinger et al[35] compared the total energy intake from sugar-sweetened beverages, including soda drinks, with different daily water intake among children and young adult Americans. This national survey concluded that children and young adults who did not consume water daily preferred to maintain hydration from sugar-sweetened beverages, and these beverages caused the caloric intake to increase by at least 2 times. Such high consumption of sugar-sweetened beverages by consumers who replaced water with soda meant that their sugar intake is likely to exceed the WHO recommendation of consuming not more than 50 g sugar per day. A recent systematic review encouraged water consumption to reduce the consumption of all types of sugar-sweetened beverages in young populations.[36] Conducting educational programs on a national scale to highlight the importance of maintaining adequate hydration through water consumption rather than SSCBs could help reduce intake of SSCB in young adults.

This study had a limited scope as it involved an all-female study sample, specific age groups (young adults), and cross-sectional study design. Future studies on SSCB intake among the youth must include other socio-demographic factors, such as family size, ethnicity, and dietary patterns. Additional confounders affecting adiposity indices might be considered in further studies, including sleeping patterns, psychological status, and supplementation intake.

5. Conclusion

This study concluded that almost 1 to 3rd of young healthy adults from Makkah City regularly drink SSCBs (> 6 cups weekly). Strong evidence existed for an etiological relationship between the consumption of SSCB and body weight gain and increased levels of adiposity. Increased consumption of SSCB was associated with lack of regular physical activity, frequent smoking, low daily water intake, obesity, and low income. Specific health education programs and effective public awareness campaigns could be held to address unhealthy SSCB drinking patterns and promote the adoption healthy lifestyle changes such as quitting smoking, exercising regularly, maintaining a healthy weight, and increasing water intake.

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