Knowledge, Attitude, and Practices Towards Added Sugar Consumption among Undergraduate Female Students in Madinah, Saudi Arabia: A Cross-Sectional Study

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Abstract

Background: Intake of added sugar among populations in developed countries is linked to the increased prevalence of many non-communicable diseases; however, data regarding added sugar intake in developing countries are still lacking. This study aimed to evaluate knowledge, attitude, and practices towards added sugar intake and the associations with nutrient intake and weight status. **Methods:** This cross-sectional study was conducted among 190 healthy undergraduate female students of Taibah University, Madinah. Demographics, dietary intake, and anthropometrics (height, weight, and waist circumference (WC)) were collected during face-to-face interviews. **Results :** Even though 55.8% of students (n=106) were aware about the health consequences of excessive intake of added sugar, only 32.6% (n=62) made an effort to reduce their added sugar intake. Nine percent of students (n=16) consumed carbonated soft drinks daily, while 16.1% of students (n=30) consumed fruit drinks daily. Eighty-two percent (n=155) of the sample exceeded the recommendation of added sugar of <5% of total energy intake. Students who exceeded the recommendation of added sugar consumed lower quantities of protein, iron, and vitamin D. Added sugar intake was linked to nutrient intake, but not the weight status. **Conclusions :** Our findings indicated excessive intake of added sugar among young females. The observed inverse relationship between added sugar and macro- and micronutrient intakes highlight the urgent need for expanded efforts to limit the added sugar and to improve dietary quality of young population in Saudi Arabia.

Introduction

The dietary pattern of many populations has been shifted to be more Westernized; and the population of Arab countries, including the Saudi population, is no exception. Westernized diets are typically associated with high added sugar, salt, and fat [1]. Added sugar is the type of sugar added to foods and beverages during cooking or manufacturing [2]. Most of the added sugar consumed by Americans is coming from liquid sources, such as sugar-sweetened beverage (SSB) and fruit drinks [3]. Sugar-sweetened beverage are drinks that contain high caloric value all of which are coming from added sugar (sucrose, high fructose corn syrup, glucose, and other sweeteners), with no nutritional value [4, 5]. Young adults were reported to be the highest consumers of SSB [6, 7].

Added sugar intake has been of a concern since evidence showed a negative association between added sugar intake and the intake of fresh foods, such as fruits, vegetables, and milk among adults [8, 9]. In fact, it has been suggested that high intake of added sugar can be an indication of lower dietary quality, as the majority of high added sugar consumers tend to exceed their energy requirements in addition to consuming inadequate quantities of a number of nutrients, including fiber, calcium, and zinc [8, 10, 11]. Additionally, excessive intake of added sugar has been linked to a number of chronic diseases, including obesity, cardiovascular diseases, and diabetes [12, 13]. The data obtained from the National Health and Nutrition Examination Survey III reported a positive association between added sugar intake and increased risk of cardiovascular diseases mortality [14]. Furthermore, a systematic review and meta-analysis of prospective studies investigated the dietary factors of diabetes risk found a significant association between intake of SSB and diabetes risk [15].

Due to the excessive intake of added sugar among Americans and its link to lower diet quality and health problems, a number of national organizations have established recommendations of added sugar intake. For example, the Dietary Guidelines for Americans 2015–2020 recommends consuming less than 10% of total calorie from added sugar [3], while the American Heart Association limits the amount of calories consumed from added sugar to 100 calories/d for female and 150 calorie/d for male [16]; The World Health Organization (WHO)

has established a maximum limit of added sugar intake as an effort to reduce the intake at the global scale. The WHO recommends limiting the daily added sugar intake to less than 10% of total energy, highlighting that a further reduction to less than 5% of total energy intake would improve the health status [2]. Despite these recommendations, data reported by National Health and Nutrition Examination Survey 2011–2014 indicated high consumptions of added sugar among American adults, with an estimated average intake of 335 kcal/day in males and 239 kcal/day in females coming from added sugar [17].

Dietary pattern and attitude of individuals towards the consumption of added sugar are proposed to be linked with several factors. For instance, the limited knowledge of what added sugar is and what are the health consequences that may result in excessive intake of added sugar. Limited knowledge of dietary sugar and sweetener classification on food labels (natural sugar, added sugar, and artificial sweetener) was evident in Ireland, as only 4% of the study sample were able to correctly classify 10 or more ingredients from a list that contained 13 items. The study also reported that only 35% of the study sample were aware of the added sugar recommendation made by the WHO [18]. Additionally, the price per calorie for foods that are high in added sugar is lower compared to the price per calorie for healthy food options [19]. In the United States, intake of added sugar was found to be higher among low-income individuals [20]. Also, another study conducted in the United States reported that individuals of lower socioeconomic and educational status tend to consume higher amount of SSB, consequently resulting in higher intake of added sugar [6]. However, the relationship between added sugar intake and socioeconomic status in high income developing countries might be very different.

As an effort towards reducing obesity and comorbidities, the WHO recommended limiting added sugar intake by taxing of sugary drinks and indicated that 20% reduction in sugary drink consumption can result from taxing sugary drinks to raise prices by 20% [21]. In the United States and recently in Saudi Arabia, taxes of all sugary drinks were raised in order to increase price per calorie and to reduce accessibility of these sugary drinks among several high risk groups, including low-income individuals and children.

Despite the effort made by the Saudi government to reduce added sugar intake, factors contributing to excessive intake are important to be identified in order to reduce the consumption of added sugar and to improve the nutritional health of individuals. Due to the lack of data available regarding added sugar intake in relation to the nutritional health of populations residing in high-income developing countries, this study aimed to evaluate knowledge, attitude, and practices towards added sugar intake and the associations with diet and weight status of young females in Madinah city.

Methods

Study population

This was a cross-sectional study of 201 healthy undergraduate female students of Taibah University, Madinah, Saudi Arabia. The sample size of this study was determined based on a standard deviation (SD) of 1.4 [22], a total width of 0.5, a confidence level of 95%, and a standardized width of the confidence interval of 0.36. Data were collected between January and March 2019. Using a random convenience sampling method, students were recruited from different colleges in Madinah (Medicine, Dentistry, Pharmacy, Nursing, Computer Science, Business Administration, and Family Sciences). Students with medical conditions that may affect weight and food intake, pregnant students, and students who were following any special diet were excluded.

Participants were invited to participate in the study after explaining the objectives of the study. Contact information were collected to schedule a face-to-face interview for data collection. On the day of the interview, all participants were asked to sign a consent form and to answer questions asked by the researcher to complete the study questionnaire, which was consisting of 20 items. The questionnaire collected data regarding demographics (age, major, semester level, parents-education, marital-status, number of children and income), medical history, anthropometrics (weight, height, waist circumference (WC)), dietary intake (via 24-hr dietary recall). Also, the questionnaire included questions regarding the knowledge of what is added sugar; if the participants believe they understand what added sugar is; if the participants know what are the negative health consequences resulting from consuming extensive amount of added sugar; if participants are making an effort to reduce added sugar.

Anthropometric and dietary data

Anthropometric measurements were assessed using a standardized procedure. Height was measured in centimeter by a measuring tape on straight wall shoeless, while weight was measured using a digital scale (Beurer). Body mass index (BMI) was calculated as weight in kilograms divided by squared height in meters [23]. Each student's BMI was classified based on the WHO classification into four categories: underweight (≤ 18.5 kg/m²), healthy weight (18.5 and 24.9 kg/m²), overweight (25.0 and 29.9 kg/m²), and obese (≥ 30 kg/m²) [24]. Waist circumference was measured in centimeters at the midpoint between the last costal margin and the iliac crest by using a flexible measuring tape to assess abdominal obesity. Height and WC measurements were adjusted to the nearest 0.5 cm. The WHO cutoff of 88 cm for female was used to assess WC [25].

Single 24-hour dietary recall of a weekday was collected from the total sample. Additional 24-hour dietary recall of a weekend day was collected from a subsample of 25% (48 participants) to adjust for within person variations in order to estimate the usual intake of the students included in this study. Participants were encouraged to remember the foods that were consumed during the last 24 hours. Real life-size replicas food models were used to assess students to estimate the proper quantities of the food consumed. Dietary data were entered in Nutritics software® (version 5.09), Dublin. When added sugar content of foods were not available in Nutritics, the number was determined from the nutrition fact label and entered into the software. Ethical approval of this study was obtained from the Ethical Committee of the College of Applied Medical Sciences at Taibah University (CLN201811).

Statistical analysis

Descriptive data were presented as means $\pm$ standard deviations (SDs), and frequency (percent). The added sugar intake categorized into two groups based on the recommendation of <5% or >5% of total energy intake. Fisher's exact test was performed to test the association between the groups of added sugar intake and all categorical variables included in this study. Independent t-test was performed to test the difference in mean BMI, WC, and nutrient intake across the two added sugar groups. Variables with skewed distribution, including protein, added sugar, saturated fat, trans fat, calcium, iron, zinc, vitamin D, and B₁₂, were normalized by taking the log or square root function then t-test was performed. In cases where distributions were not normalized using the log or square root function, non-parametric tests were used to test for differences in means across the different groups. A multiple linear regression model was performed to determine the association between added sugar intake and all of the macro- (energy, protein, fat, saturated fat, trans fat, carbohydrates and fiber) and micro-nutrients intake (calcium, iron, zinc, vitamin B₁₂, sodium, potassium and vitamin D). All regression models were adjusted for

energy intake. Statistical tests were performed using SAS® software version 9.4 (2013, SAS Institute Inc., Cary, NC, USA). All tests were two-tailed with a significant level of 95%.

Results

A total sample of 190 female participants were included in this study after excluding 11 participants, flowchart of selection criteria of participants is provided in Fig. 1. When added sugar intake was compared to the recent recommendation of < 5% of the total energy intake coming from added sugar, 81.6% of the sample (n = 155) exceeded the daily recommendations of added sugar. Based on the WHO criteria to define the weight status, 23.2% (n = 44) of the participants were underweight with mean BMI of $16.7 \pm 1.05 \text{ kg/m}^2$, while 11.6% (n = 22) were overweight with mean BMI of $27.1 \pm 1.15 \text{ kg/m}^2$, and 4.21% (n = 8) were obese with mean BMI of $34.3 \pm 3.41 \text{ kg/m}^2$. Demographic characteristics of students included in this study are described in Table 1. All demographic characteristics were similar across the different groups of added sugar intake, except age. Students who exceeded the recommendation were significantly younger.

Table 1

Demographic characteristics of Taibah University Saudi female students by quartile of added sugar intake

	Added sugar intake ≥ 5% (n = 155)	Added sugar intake < 5% (n = 35)	Total	p
Age, year, mean ± SD	20.7 ± 1.55	21.6 ± 1.87	20.9 ± 1.64	0.006*
Major, n (%)				
Health science	47 (30.3)	7 (20.0)	54 (28.4)	0.638
Science	54 (34.8)	13 (37.1)	67 (35.3)	
Other	54 (34.8)	15 (42.9)	69 (36.3)	
Parents' education, n (%)				
Mother				
≤Intermediate	47 (30.3)	10 (28.6)	58 (30.5)	0.999
Secondary	39 (25.2)	9 (25.7)	49 (25.8)	
University	69 (44.5)	16 (45.7)	83 (43.7)	
Father				
≤Intermediate	28 (18.1)	7 (20.0)	35 (18.4)	0.431
Secondary	49 (31.6)	7 (20.0)	56 (29.5)	
University	78 (50.3)	21 (60.0)	99 (52.1)	
Marital status, n (%)				
Single	144 (92.9)	31 (88.6)	175 (92.1)	0.126
Income, SR, n (%)				
< 10000	61 (39.4)	18 (51.4)	79 (41.6)	0.426
≥ 10000	94 (60.6)	17 (48.6)	111 (58.4)	
* Significant level of 95%				

Assessment of knowledge about added sugar indicated that 31.6% of participants (n = 60) were unable to recognize the correct definition of added sugar. Misunderstanding of the correct definition of added sugar was significantly higher among students who exceeded their recommendation > 5% of total energy intake. Furthermore, more than half of the students (55.8%, n = 106) were aware of the health consequences of consuming high quantities of added sugar. Despite of this level of awareness, only 32.6% of participants (n = 62) made an effort to limit their consumption of added sugar (see Table 2).

Table 2
Knowledge and attitude regarding added sugar based on groups of added sugar intake

	Added sugar intake ≥ 5% (n = 155)	Added sugar intake < 5% (n = 35)	Total	p
Misunderstanding of what added sugar is, n (%)	42 (22.1)	18 (9.47)	60 (31.6)	0.001*
Real understanding of what is added sugar, n (%)	15 (7.89)	5 (2.63)	20 (10.5)	0.290
Understanding of the health consequences of added sugar consumption, n (%)	88 (46.3)	18 (9.47)	106 (55.8)	0.895
Effort to reduce added sugar intake, n (%)	48 (25.3)	14 (7.37)	62 (32.6)	0.126
* Significant level of 95%				

Approximately 9% (n = 16) of the participants reported daily consumption of carbonated soft drinks, while 16.1% (n = 30) reported consumption of fruits drinks on a daily basis. Based on the analysis of dietary intakes, underweight students consumed 13.7% of their total energy intake from added sugar with mean intake of 49.5 ± 48.1 g/day, while healthy weight participants had 12.3% of their total energy intake from added sugar with mean intake of 49.0 ± 41.1 g/day. The intake of overweight students was 8.63% of their energy intake coming from added sugar with mean intake of 31.6 ± 26.2 g/day, and obese students consumed 9.86% of their energy coming from added sugar with mean intake of 39.7 ± 37.9 g/day. However, linear regression analysis showed no link between added sugar intake in relation to BMI and WC. In fact, only 3.76% (n = 7) had WC > 88 cm.

Dietary intake of all macro- and micronutrients were compared among students who consumed quantities of added sugar within the recommendation vs. students who exceeded the recommendations. The data indicated that the latter group consumed significantly lower quantities of protein, iron, and vitamin D, see Table 3. In addition, multiple linear regression analysis was performed to determine the associations between added sugar intake and all of the macro- and micronutrient intake included in the analysis, adjusting for energy intake. Results showed significant associations between added sugar intake and all nutrients included in this study except trans-fat and vitamin D. Carbohydrate, fat, saturated fat, calcium, and potassium were positively associated with added sugar intake, while protein, fiber, sodium, iron, zinc, and vitamin B₁₂ were negatively associated with added sugar intake, see Table 4.

Table 3 Nutrient intake of participants based on added sugar intake recommendation			
Nutrient intake	Added sugar intake < 5% (n = 35)	Added sugar intake $\geq$ 5% (n = 155)	p
Energy, kcal	1499 $\pm$ 510	1523 $\pm$ 642	0.839
Carbohydrate, g	206 $\pm$ 120	195 $\pm$ 89.2	0.529
Protein, g	57.2 $\pm$ 20.6	49.0 $\pm$ 21.2	0.042*
Fat, g	52.0 $\pm$ 24.4	54.1 $\pm$ 27.4	0.681
Saturated fat, g	18.2 $\pm$ 11.3	19.9 $\pm$ 11.9	0.273
Trans fat, g	0.25 $\pm$ 0.38	4.58 $\pm$ 52.5	0.782
Fiber, g	15.5 $\pm$ 11.0	12.5 $\pm$ 8.09	0.080
Sodium, mg	2583 $\pm$ 1612	2274 $\pm$ 1534	0.120
Potassium, mg	1483 $\pm$ 839	1340 $\pm$ 841	0.132
Calcium, mg	611 $\pm$ 386	500 $\pm$ 342	0.133
Iron, mg	13.3 $\pm$ 16.9	8.06 $\pm$ 5.31	0.012*
Zinc, mg	5.97 $\pm$ 7.41	4.15 $\pm$ 2.50	0.168
Vitamin D, μ g	6.36 $\pm$ 14.4	1.75 $\pm$ 4.03	0.027*
B ₁₂ , μ g	1.41 $\pm$ 1.28	1.37 $\pm$ 1.31	0.404
* Significant level of 95%			
* Significant level of 95%			

Table 4 Multiple linear regression analysis between nutrient intake and added sugar consumption in grams				
Nutrient intake	B	SE	R-square	p
Carbohydrate, g	0.10	0.08	0.83	< 0.000*
Protein, g	-0.15	0.03	0.55	< 0.000*
Fat, g	0.04	0.03	0.72	< 0.000*
Saturated fat, g	0.04	0.02	0.47	< 0.000*
Trans fat, g	0.06	0.10	0.01	0.280
Fiber, g	-0.04	0.02	0.27	< 0.000*
Sodium, mg	-5.63	3.03	0.22	< 0.000*
Potassium, mg	0.77	1.53	0.33	< 0.000*
Calcium, mg	0.48	0.68	0.25	< 0.000*
Iron, mg	-0.08	0.02	0.26	< 0.000*
Zinc, mg	-0.03	0.01	0.17	< 0.000*
Vitamin D, µg	-0.03	0.02	0.02	0.154
Vitamin B ₁₂ , µg	-0.002	0.003	0.06	0.003*

Discussion

Assessment of dietary intake revealed high consumptions of added sugar among female students. Over half of the students included in this study recognized major health consequences of excessive intake of added sugar, but only a small proportion of the students made an effort to reduce their intake of added sugar. The limited healthy options offered on campus might explain the lower tendency of the students to reduce added sugar intake. Limited awareness of the correct definition of added sugar among the participants was also observed. A similar finding was reported among population of developed countries, including Ireland [18]. Influence of the social media on the nutritional knowledge of young adults has been suggested previously [26]; however, true definition of added sugar can be difficult to be understood through the social media.

A number of food products contain high quantities of added sugar, but data from the Dietary Guidelines for Americans 2015–2020 showed that the majority of added sugars came from liquid sources [3]. In this study, carbonated soft drinks and fruits drinks were consumed on a daily basis among students (8.60% and 16.3%,

respectively). A study conducted among students of the University of KwaZulu-Natal reported similar findings [27]. High consumption of sugary drinks among university students might also be an indication of high availability and affordability of these drinks on campus. As high consumption of added sugar from a liquid source may increase risk of obesity [28], interventions aiming to reduce availability of such food options on campus may be effective in improving the diet quality and weight status of university students living in Saudi Arabia.

In this study, added sugar intake was negatively associated with age. Students who exceeded the recommended amount of added sugar tended to be younger. This could be an indication of improved diet quality as students get older. However, added sugar intake was not linked to income or education level. These findings are consistent with findings of a cross-sectional study conducted among undergraduate students in South Africa [27], although other studies conducted in developing countries reported a positive association between intake of added sugar and socioeconomic status [29]. On the other hand, studies performed in developed countries, including the United State and the Netherlands, found that added sugar intake was negatively associated with income and educational level [20, 22]. The lack of the association between added sugar intake with income and educational level in this study could be due to the low variability in socioeconomic status among the majority of students. It is evident that individuals living in low and middle-income developing countries are at higher risk of consuming high quantities of added sugar as compared to individuals living in developed countries [2], while the situation in high-income developing countries might be very different.

Despite the high consumption of added sugar observed among students in this study, added sugar intake was not linked to BMI, weight status, or WC; this could be explained by the high prevalence of underweight females observed among the study sample (23.2%).

Dietary intake of added sugar has been reported to be positively associated with energy intake, as well as poor consumption of some nutrients [8, 10]. In this study, students who consumed higher quantities of added sugar (> 5% of total energy per day) consumed less quantities of protein, iron, and vitamin D. Additionally, the multiple regression analysis revealed a positive association between added sugar intake and energy, and nutrient intake, including carbohydrate, fat, saturated fat, calcium, and potassium. The added sugar intake was also found to be negatively associated with intakes of a number of nutrients, including protein, fiber, sodium, zinc, iron, and vitamin B₁₂. Similar findings were reported by several studies conducted in developed countries, including Germany and Australia [10, 11]. These associations may indicate poor quality of diet resulting from the added sugar replacement of important nutrients in the diet, which has been reported previously [8]. Even though a significant difference in vitamin D intake has been observed between students who consumed quantities of added sugar within the recommendation and those who exceeded the recommendation, the regression analysis indicated lack of association between added sugar and vitamin D intake. The lack of the association might be due to low intake of vitamin D among the study sample. Due to the high prevalence of vitamin D deficiency in Saudi Arabia [30], fortification programs are suggested to be implemented at the national level. Previous studies conducted in developed countries has reported inverse association between calcium and added sugar intake [10, 11]. Unexpectedly, calcium intake among our sample was positively associated with added sugar intake. This association could be explained by the frequent use of milk as an ingredient in many traditional dessert recipes. In fact, compared to the RDA, students in our sample consumed lower quantities of fiber, potassium, calcium, iron, zinc, and vitamins D and B₁₂, while consumption of sodium was higher than the RDA recommendation [31]. High

consumption of sodium might be the result of frequent consumption of salted chips and snacks offered on campus as a result of the abundancy of vending machines.

This study has a number of strengths. To our knowledge, the present study was the first to evaluate the intake of added sugar among the Saudi Arabian students and investigate the association of added sugar intake with the weight status and dietary intake. However, our study is limited by its cross-sectional design, which did not allow to determine causality between added sugar, weight status, and dietary intake. Findings of this study might be generalizable to the young population in Saudi Arabia.

Conclusions

High consumption of added sugar was reported among female students in Saudi Arabia, despite the high level of awareness regarding the health consequences of excessive intake of added sugar among this group. In addition, high added sugar intake was associated with higher energy intake and lower dietary intake of many important nutrients. This indicates the need for expanded efforts to reduce added sugar intake and to improve eating habits of the young population in Saudi Arabia.

List Of Abbreviations

BMI	Body mass index
FFQ	Food frequency questionnaire
NHANES	National Health and Nutrition Examination Survey
SD	Standard deviation
SSB	Sugar sweetened beverage
WC	Waist circumference
WHO	World Health Organization

Declarations

Ethics approval and consent to participate

Ethical approval of the study was obtained from the Ethical Committee of the College of Applied Medical Sciences, Taibah University, certificate number [CLN201811]. Informed consent forms were signed by all participants before data collection.

Consent for publication

Not applicable

Availability of data and materials

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

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

WM and HK were responsible for study conception and study design. AA, AM, BA, JA, and MH were responsible for data collection. WM, AA, AM, BA, JA, and MH were responsible for data coding, cleaning. WM was responsible for analysis and interpretation of data. WM, AA, AM, BA, JA, and MH generated the first draft of the manuscript. WM and HK critically revised the content of the manuscript and had primary responsibility for final content. All authors read and approved the final draft of the manuscript.

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Figures

Figure 1

Flowchart of participant selection