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Original article

Nutrition Education Intervention to Limit Added Sugar Intake among University Female Students

Walaa A. Mumena[1], Fatima A. Abdulhakeem[1], Najwan H. Jannadi[1], Shatha A. Almutairi[1], Sara M. Aloufi[1], Abeer A. Bakhishwain[1], Hebah A. Kutbi[2]

[1]Clinical Nutrition Department, College of Applied Medical Sciences, Taibah University, Madinah, Kingdom of Saudi Arabia
[2]Clinical Nutrition Department, Faculty of Applied Medical Sciences, King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia

Summary. *Background/Aim:* To evaluate the effectiveness of a nutrition education intervention to limit added sugar intake among undergraduate female students. *Material and Methods:* This is a quasi-experimental pretest-posttest control group study that was conducted among 46 healthy participants who were selected in random (23 each in intervention and control groups). All participants were undergraduate students at Taibah University, Madinah, Saudi Arabia. The intervention included two face-to-face educational sessions and weekly messages during the 8-week study period provided information about the definition, health consequences of excessive intake, food sources, label reading, and healthy alternatives to foods containing high amounts of added sugar. Dependent variables were dietary data and anthropometrics. Independent variable was the group assignment. *Results:* In the intervention group, reduction of 58.3% of added sugar intake occurred, and added sugar contributed to 4.95% of the total energy. In the control group, it contributed to 10.7% of the total energy. *Conclusion:* The nutrition education intervention was effective in reducing over half the students' added sugar consumption in the intervention group. The used nutrition education intervention could be adopted effectively in the community to limit added sugar intake.

Key words: Nutrition education; intervention; added sugar; dietary intake; students

Introduction

In the last few decades, remarkable lifestyle changes have affected the dietary habits and overall health of many individuals. People are shifting from traditional diets to more westernized ones that are high in energy, saturated fats, added sugar, and low in many essential micronutrients (1, 2). Added sugar refers to sugar that is being added at the table or during the preparation and processing of food (3). The consumption of added sugar has increased globally (4); however, individuals in developing countries are at greater risk to consume excessive amounts of added sugar owing to the increased exposure to sugary foods (5, 6). In Saudi Arabia, a study reported that the majority of university students exceeded the World Health Organization (WHO) recommendation of added sugar intake (above 5% of total energy) (7). Similar study among undergraduate students in the United Arab Emirates reported frequent consumption of sugar-sweetened beverages (SSBs) (8).

Several factors are associated with high consumption of added sugar. Young populations specifically are at risk to consume large quantities of added sugar because of stress, moods, lower cost, and lack of knowledge regarding added sugar (8, 9). Among low-income populations, influence of the cost of food on dietary practices is clearly explained by the price per calorie of sugary foods compared with that of healthier food

options (10). Limited knowledge about added sugar recommendations, food sources, and label reading is linked to high consumption of SSBs among populations in developed and developing countries (8, 11).

Excessive intake of added sugar is of concern, as it is linked to a number of health consequences, including diabetes mellitus, cardiovascular disease, hypertension, dyslipidemia, metabolic syndrome, depression, and liver and kidney diseases (12-16). Furthermore, higher added sugar consumption has been linked to greater caloric intake, resulting in weight gain and/or replacement of many essential micronutrients, leading to a lower dietary quality (17-21). In contrast, a link between added sugar intake and being underweight has been suggested (7, 22).

The excessive intake of added sugar and the health consequences related to this trend led health organizations and researchers to take an action to limit the intake of added sugar. Community interventions, such as taxing of SSBs, as recommended by the WHO, were successfully implemented in many settings (23-25). However, educational interventions remain very important to improve the level of nutritional knowledge and create awareness. Several nutrition education interventions have been implemented in developed countries to improve the dietary quality of individuals (26, 27). Successful interventions that aimed to improve nutritional knowledge involved many approaches, including telephone-based counseling with a healthcare team (28), increasing awareness about the nutritional facts label (29, 30), focus groups (31), use of mobile phone applications (32), and web-based educational sessions (33-35). However, nutrition education interventions have not been reported previously in the Middle East. Thus, this study aimed to assess the effectiveness of an 8-week nutrition education intervention, targeted at limiting the intake of added sugar among Taibah University female students.

Material and Methods

Subjects

Participants in this quasi-experimental pretest-posttest control group study were recruited using the convenience sampling technique; Letters of invitation were sent in Jan 2019 to the vice-deans of all faculties at the university, who in turn forwarded the invitation to undergraduate female students aged 19 to 24 years. Invitations were also sent through WhatsApp groups of the undergraduate students. Altogether, 116 students responded to the invitation, and face-to-face interviews were scheduled. We excluded students who were pregnant or lactating, had a history of chronic diseases, or were on special diets or medication. Students who were willing to attend two educational sessions were allocated to the intervention group. The final sample included 23 students each in the intervention and the control groups (**Figure 1**). Rates of dropouts were 41% and 25.8% for the control and intervention groups, respectively.

Ethical approval was obtained from the Ethical Committee of the College of Applied Medical Sciences at Taibah University. Written informed consent was obtained from all the participants before participating in this study.

Procedures

Initial face-to-face interview was conducted with each student to collect demographic data, anthropometric measurements, dietary data, and information regarding added sugar intake and the ability to attend two educational sessions.

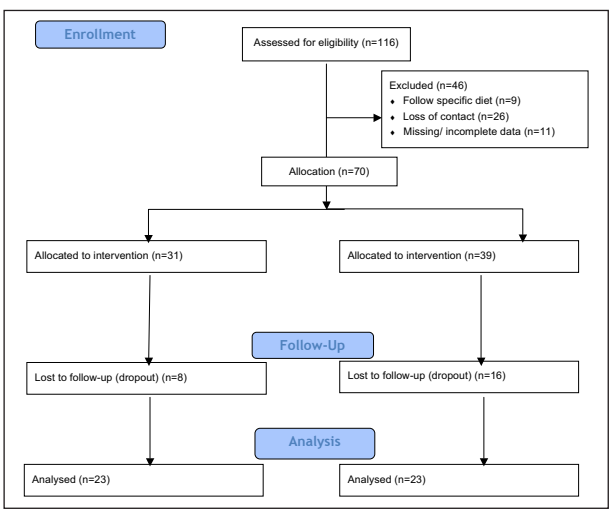

Figure 1. Flow diagram of the study sample.

Anthropometric Measurements

Anthropometric data were collected using a standardized procedure. Heights of the students were measured by a wall mounted measuring tape and rounded to the nearest 0.5 cm. Weights were measured using an electronic scale (Beurer GS14). Weight status was assessed based on the WHO criteria for body mass index (BMI) "underweight if BMI is < 18.5 kg/m^2; healthy weight if BMI is between 18.5–24.9 kg/m^2; overweight if BMI is between 25–29.9 40 kg/m^2; and obese if BMI is > 30 kg/m^2" (36). Waist circumference was measured using a tape.

Dietary Data

The students were asked about the frequency of consumption of soft drinks, sugary drinks, and sweets (chocolate, cookies, candies, cakes). Information regarding the average consumption of table sugar in tea, coffee, or other drinks during the day was also collected. Dietary intake was determined via two 24-h dietary recalls to estimate the usual intake of the students at baseline and follow-up. At each time point, data were collected for one weekday and one weekend. For the first recall, students were asked about the food they consumed within the last 24 hours, whereas the second recall was conducted over the phone during the weekend. At follow-up, baseline procedure was followed to collect two 24-h dietary recalls. During the face-to-face interview, standardized plates and measurement cups were used to help in portion size estimation. For dietary data collected over the phone, pictures of standardized plates and measurement cups were sent through WhatsApp privately, to help in estimating the portion sizes. Dietary data were analyzed using the Nutritics software® (version 5.09, Dublin, Ireland). If data of added sugar content were unavailable in Nutritics, then the sugar content was determined from the nutritional facts label of that specific food product, and manually entered into Nutritics. Local food recipes were also manually entered into Nutritics. Nutrient density of the diet was calculated for macronutrients and for added sugars as percent of the total energy intake, whereas nutrient density for micronutrients was calculated as nutrient intake in appropriate units divided by 1,000 kcal.

Nutrition Education Intervention

The nutrition education intervention comprised two educational sessions aimed to limit added sugar intake by improving the level of knowledge among the students regarding definition and food sources of added sugar, health-related consequences of excessive intake of added sugar, label reading, and healthy alternatives to foods containing high amounts of added sugar. Research assistants conducted the first educational session 1 week after the baseline data collection, whereas the second session took place 1 week after the first session. Educational sessions were conducted through separate focus groups (3 to 12 participants per group). Detailed information of the intervention is described in the Lesson Plan (**Figure 2)**. Summarily, the first session was aimed to introduce the definition of added sugar and its types, sources, and to explain the WHO recommendation of added sugar. The second session was held to discuss the health-related consequences of excessive added sugar intake, learn to read nutritional facts labels, introduce healthier alternatives of food sources and beverages that are high in added sugar, and discuss the benefits of reducing added sugar consumption. A WhatsApp group was created to further motivate and support the intervention group 24-h daily, 7 d a week for the 8-week study duration. Students in the intervention group asked questions regarding nutritional facts labels, names of added sugars, and healthy food alternatives they can consume. Eight educational messages, one per week, were delivered to participants in the WhatsApp group. After 8 weeks, all participants were contacted via WhatsApp messages to arrange for a second session and to collect the follow-up data (weight, waist circumference, and two 24-h dietary recalls).

Figure 2. Lesson plan for the delivered nutrition education intervention for university female students.

A. Face-to-face sessions

Two sessions delivered to participants at the university campus by the research team.

Session #1	**Title**	Principles of added sugar
	Target Group	Students aged 19–24 years
	Date of Delivery	January 22–29, 2019
	Duration	60 min
1	**Learning Objectives**	1. Explain what is added sugar 2. Describe types and food sources of added sugar. 3. Discuss the recommendations of added sugar.
	Methods	Persuasive discussion Information Increase commitment Stories telling Counselling
	Materials	Picture from the Saudi Food and Drug Association (SFDA) about the definition of added sugar https://www.sfda.gov.sa/ar/food/PublishingImages/Suger/1.jpg Picture from the SFDA about the recommendation of added sugar https://www.sfda.gov.sa/ar/food/PublishingImages/Suger/4.jpg Picture from the American Heart association (AHA) about the recommendation of added sugar https://www.heart.org/-/media/data-import/images/sugarrec-ucm_470043.jpg?h=238&w=300&la=en&hash=C44D112161DF48B58A63DE24E8AFB919D2D77DA8 Plastic and prepackaged food to be used as models Printable nutrition fact label for some usually consumed products Food scale, spoons, sugar, and plates
	Resources	SFDA: Sugar https://www.sfda.gov.sa/ar/awareness/Campaigns/Pages/SUGAR.aspx AHA: Added sugars https://www.heart.org/en/healthy-living/healthy-eating/eat-smart/sugar/added-sugars Added sugar in the diet https://www.hsph.harvard.edu/nutritionsource/carbohydrates/added-sugar-in-the-diet/
	Activities	Open discussion took place to improve the participants' awareness of what is added sugar. Picture that contains the definition of added sugar was shown to participants to help them understand the concept of added sugar. Interactive classification game was played using food samples to help participants differentiate between the different types of sugar as well as distinguish between foods that contain natural sugar and foods that contain added sugar. Pre-packaged food models were shown to participants to help them recognize the content, types, and food sources of added sugar. How to read nutritional fact label session was held for participants focused on the understanding the added sugar content in different pre-packaged food products. Talked about sugar sweeten beverages and discussed the difference between juice, nectar and drink. Open discussion took place to on the recently added sugar recommendations with participants and examples were used to help them estimate the daily limit of added sugar. Added sugar intake of one of the research teams in the last 24 h was estimated. The total amount of added sugar for the full day was collected in a colored plate to be shown to the participants. The total amount of added sugar was estimated in grams using table spoon to compare it to that of the recent recommendations of added sugar. Open discussion took place to identify wrong perceptions on added sugar, types and sources, and how to correct it. Shared real-life stories of people who were able to limit their added sugar intake successfully.

Session #2	**Title**	Are foods with added sugar good for your health? What are the healthier food options?
	Target Group	Students aged 19–24 years
	Date of Delivery	February 2–6, 2019
	Duration	60 min
1	**Learning Objectives**	1. Discuss the health consequence of high intake of added sugar. 2. Identify the common health benefits of limiting added sugar consumption 3. Label reading 4. Introduce healthier alternative of high added sugar foods and beverages.
	Methods	Persuasive discussion Information Increase commitment Story telling Counselling
	Materials	Real food models that contain no- or little- added sugar Picture on the health consequences of added sugar https://www.nm.org/-/media/Northwestern/healthbeat/images/healthy-tips/nutrition/nm-truth-about-added-sugar-infographic.jpg?h=11800&w=1560&la=en&hash=615BE15FDB458E1CC19DB33B05AE840152141A6A Picture on how to reduce sugary drinks https://www.heart.org/-/media/aha/h4gm/infographics/sip-smarter-eng.jpg?la=en&hash=94055AA86FCBA7CD0733E4F9E79718506284B484 Picture of some tips that may help in reducing added sugar https://www.heart.org/-/media/aha/recipe/article-images/life-is-sweet-infographic-eng.jpg?h=1551&w=1200&la=en&hash=C46E45D857E7D50D6686A1FDD904A034CDC90247 Picture of how to read nutritional fact label https://www.fda.gov/food/new-nutrition-facts-label/how-understand-and-use-nutrition-facts-label
	Resources	SFDA: Sugar https://www.sfda.gov.sa/ar/awareness/Campaigns/Pages/SUGAR.aspx AHA: Added sugars https://www.heart.org/en/healthy-living/healthy-eating/eat-smart/sugar/added-sugars Sugar reduction http://www.ift.org/knowledge-center/focus-areas/food-health-and-nutrition/sugar-reduction.aspx Food evolution; Artificial sweeteners https://foodrevolution.org/blog/sugar-substitutes/ Sugar Association https://www.sugar.org/diet/role-in-food/ The USA Food and Drug Association https://www.fda.gov/food/new-nutrition-facts-label/how-understand-and-use-nutrition-facts-label
	Activities	Open discussion took place to help participants overcome difficulties that may limit their ability to reduce added sugar intake. Asked participant to share their personal experience of added sugar reduction in the past days and whether they notice any difference in their health. Open discussion took place to help participants recognize the health consequences of high intake of added sugar and the benefit of limiting added sugar intake. Pictures were presented to participants to help explain the health consequences of high added sugar intake and the benefits of limiting the intake of added sugar.

	Activities	Provided healthier option of some commonly used food products that contain less added sugar content and discussed the supermarket where they can get it. Described how to choose less added sugar products while in the supermarket and compare between ingredients and nutritional fact labels to select the best healthy food item. Explained how to read nutritional fact label with students practicing on reading nutritional fact labels of some food items. No-added sugar recipes were shared with participants as an alternative to some recipes that contain high amounts of added sugar. Discussed whether artificial sweeteners have the same effect as the natural sugar. Personal stories of people who successfully reduced their added sugar intake and the health benefits they experienced were shared to motivate participants to limit their added sugar intake.
	Notes	At the end of each session participants were asked if they had any questions or if anything were not clear, followed by the educator responding to all the students' questions

B. Educational messages

Eight educational messages sent to participants in the intervention group via the WhatsApp group. Messages were sent during the weekend to ensure the availability of participants.

Week	Objectives	Content of message
One	The purpose of the message was to help participants understand the concept of added sugar and recognize food sources of added sugar.	• Pictures contain the definition of added sugar and the possible forms of added sugars including sugar sweetened beverages and other foods that are high in added sugar.
Two	The purpose of the message was to help participants understand how to determine the amount of energy and added sugar in specific food products using the nutritional food label provided in prepackaged foods and compare the amount of energy and added sugar between different food products.	• A picture of nutritional food label. • A picture of how to read nutritional food label. • Text explaining how to determine the amount of energy and added sugar in specific food products using the nutritional food label provided in prepackaged foods.
Three	The purpose of the message was to help participants understand the health consequences of high consumption of added sugar and choose healthier food alternatives.	• An educational video about added sugar and the adverse effect of added sugar on health as well as examples of healthy alternatives of foods that are high in added sugar.
Four	The purpose of the message was to help participants understand what sugary drinks are and the health consequences related to high consumption of these drinks and recognize the daily limit recommended by a number of health organizations.	• An educational video about sugary drinks, non-caloric drinks, and its relationship to a number of chronic diseases, such as diabetes mellitus, heart diseases, and cancer. This video also included an explanation of the recommended amount of added sugar per day.
Five	The purpose of the message was to encourage participants limit their added sugar intake and increase adherence to the targeted diet plan that is limited in added sugar.	• Text included two personal stories of people who successfully reduced their added sugar intake and the health benefits they experienced.
Six	The purpose of the message was to remind participants what are sugary drinks and sugar sweetened beverages and the health consequences related to the high consumption of these beverages.	• An educational video about the amount of added sugar included in sugar sweetened beverages and the negative health consequences resulting from high consumption of these beverages.
Seven	The purpose of the message was to encourage participants limit their added sugar intake and increase adherence to the targeted diet plan that is limited in added sugar.	• An open discussion session was implemented concerning healthy food alternatives of sweets and candies. This session included pictures of these food items, shared by participants and the group coordinator.
Eight	The purpose of the message was to encourage participants limit their added sugar intake and increase adherence to the targeted diet plan that is limited in added sugar.	• General advices for long-term commitment to the targeted diet plan that is limited in added sugar.

Statistical Analysis

The sample size was determined based on a two-sided test, confidence level of 95%, effect size of 6.2, standard deviation (SD) of 1.4 (37), and power of 90%. Descriptive data were presented as frequency (percentage) and mean ± SD. The association between two categorical variables, including major and family income were investigated using Fisher's exact test. A comparison of means of all continuous variables, including demographics and anthropometric measurements, among the intervention and control groups after normalizing all asymmetric distributions by taking the log or square root function were examined using Student's t-test. Mann-Whitney U test was used to examine the difference in nutrient intake between participants in the intervention and control groups. Statistical tests used in this study were two-tailed, and significance level of $p < .05$ was used. To correct for multiple comparisons, the Bonferroni method was used by dividing .05 by the number of tested nutrients; accordingly, a significance level of $p < .003$ was used to infer significance of dietary data. All data were analyzed using SAS software version 9.4 (2013, SAS Institute Inc., Cary, NC, USA).

Results

Mean age of students was 20.6 ± 1.10 years with 96% being single. Students in the intervention and control groups had similar demographic characteristics (see Table 1). Students' mean BMI at baseline was 22.0 ± 4.94 kg/m^2. Results of the comparison of anthropometric measurements between the intervention and control groups are provided in Table 2.

Dietary intake of students in the intervention and control group was similar at baseline and follow-up. Added sugar intake at baseline was similar among the intervention and control groups ($p = .36$) contributing to 11.9% of the total energy in both groups. At follow-up, the intervention group consumed significantly lower quantities of added sugar compared with that at baseline ($p = .001$), whereas students in the control group consumed similar quantities at baseline and follow-up ($p = .16$). Among the intervention group, a reduction of 58.3% of added sugar was found. Added sugar contributed to 4.95 ± 3.84% of the total energy of students in the intervention group, and 10.7 ± 7.47% ($p = .001$) in the control group. Intake of all other nutrients was similar between the two groups, at both time points. Nutrient densities of the students' diets stratified by nutrition education intervention are described in Table 3.

Discussion

Limited number of studies have explored the intake of added sugar in the Middle East, and these mainly focused on the frequency of consumption of SSBs (8), whereas data of added sugar intake among several populations in the developed countries have been investigated (37-39) . This present study indicated high consumption of added sugar among the participants. At baseline, all students exceeded the WHO recommendations of greater than 5% of energy intake from added sugar.

The nutrition education intervention used in this study was effective in reducing added sugar consumption by the students in the intervention group by over half. Nutrition education interventions are effective in making lifestyle changes when compared with diet regimens alone. Restricting certain foods from the diet without imparting knowledge regarding the excessive consumption of those foods, may lead to an overconsumption of the restricted foods after the diet period is over. A study conducted in the USA found that after following a diet low in added sugar for a duration of 1 week, value of high added sugar foods increased significantly among all participants included in the study (40).

The duration of the intervention may play an important role in the long-term effectiveness of an intervention. The intervention used in this study was for 8 weeks, which has been used in a number of intervention studies among university students (41, 42). Duration of interventions has been specified based on the objective of the intervention. A review conducted by Lua and Elena in 2012 reported a duration of nutrition education interventions among university students of mostly between 2 and 12 weeks (26). The approach adopted to deliver any nutrition education

Table 1. Demographics Characteristics of Students in the Intervention and Control Groups.

	Intervention (n=23)	Control (n=23)	Total (n=46)	*P**
Age, years, mean ± SD	20.5 ± 1.18	20.6 ± 1.02	20.6 ± 1.10	.69
Major, n (%)				
Health Science	10 (43.5)	12 (52.2)	22 (47.8)	.51
Science	9 (39.1)	5 (21.7)	14 (30.4)	
Other	4 (17.4)	6 (26.1)	10 (21.7)	
Maternal Education, n (%)				
≤ Elementary	2 (8.70)	5 (21.7)	7 (15.2)	.45
Intermediate/Secondary	8 (34.8)	8 (34.8)	16 (34.8)	
University	13 (56.5)	10 (43.5)	23 (50)	
Paternal Education, n (%)				
≤ Elementary	1 (4.35)	3 (13.0)	4 (8.70)	.63
Intermediate/Secondary	10 (43.5)	8 (34.8)	18 (39.1)	
University	12 (52.2)	12 (52.2)	24 (52.2)	
Income, SR, n (%)				
< 6000	6 (26.1)	5 (21.7)	11 (23.9)	.75
6000-9999	5 (21.7)	3 (13.0)	8 (17.4)	
10000-14999	7 (30.4)	7 (30.4)	14 (30.4)	
>15000	5 (21.7)	8 (34.8)	13 (28.3)	

SR= Saudi Riyal
* A *P* value < .05 was considered statistically significant
Student's t-test was used to examine the association of age across the intervention and control group
Fisher's exact test was used to examine the association of categorical variables across the intervention and control group

Table 2. Anthropometrics of Students in the Intervention and Control Groups.

	Intervention (n=23)	Control (n=23)	Total (n=46)	*P**
BMI, (kg/m^2), mean ± SD	21.6 ± 19.3	22.3 ± 20.3	22.0 ± 4.94	.57
Weight Status, n (%)				
Underweight	8 (34.8)	3 (13.0)	11 (23.9)	.18
Healthy weight	11 (47.8)	15 (65.2)	26 (56.5)	
Overweight	3 (13.0)	3 (13.0)	6 (13.0)	
Obese	1 (2.17)	2 (8.70)	3 (6.52)	
Waist circumference, (cm)	69.3 ± 9.93	74.2 ± 8.71	71.7 ± 9.56	.08
Weight difference, (kg)	-0.93 ± 1.15	0.37 ± 3.29	-0.28 ± 2.53	.48
Waist circumference difference, (cm)	-1.28 ± 2.90	-0.97 ± 3.00	-1.13 ± 2.93	.72

BMI= body mass index
* A *P* value < .05 was considered statistically significant
Student's t-test was used to examine for association of BMI, waist circumference, weight difference, and waist circumference difference across the intervention and control group
Fisher's exact test was used to examine for association of weight status across the intervention and control group

Table 3. Nutrient Density of Students' Diet in the Intervention and Control Groups in Follow-up.

Dietary nutrient intake	Intervention (n=23)	Control (n=23)	*P**
Energy, kcal/day	1285 ± 464	1300 ± 355	.89
Carbohydrate (% EI)	49.6 ± 8.68	46.9 ± 6.07	.23
Protein (% EI)	16.0 ± 3.20	15.5 ± 6.20	.21
Fat (% EI)	31.3 ± 8.54	35.2 ± 6.78	.06
Added sugar (% EI)	4.95 ± 3.84	10.7 ± 7.47	.001*
Total sugar, g/1000 kcal	36.6 ± 16.4	48.3 ± 28.8	.44
Saturated fat, g/1000 kcal	11.9 ± 5.36	14.9 ± 4.87	.02
Trans fat, g/1000 kcal	0.38 ± 0.69	1.03 ± 2.04	.90
Fiber, g/1000 kcal	10.9 ± 4.19	8.06 ± 3.00	.010
Potassium, mg/1000 kcal	987 ± 411	960 ± 413	.90
Vitamin D, µg/1000 kcal	1.64 ± 1.95	1.39 ± 1.66	.41
Calcium, mg/1000 kcal	336 ± 134	433 ± 268	.31
Iron, mg/1000 kcal	6.95 ± 3.90	5.72 ± 2.01	.48
Zinc, mg/1000 kcal	3.40 ± 1.82	3.20 ± 1.52	.86

EI= energy intake 1kcal=4.184kj
* A *P* value < .003 was considered statistically significant
Mann-Whitney U test was used to examine the difference in nutrient intake between intervention and control groups
Data presented in table are mean ± standard deviation

intervention program is also critical. It has been reported that web-based and online nutrition education interventions can be successful in enhancing diet and weight status of university students (33-35). Online interventions may be useful to encourage the participants to adhere to the diet, and work as a reminder of the importance of the intervention. The use of online support groups were found to be effective in lifestyle modifications (43, 44). In fact, in our study, students in the intervention group were very active in participating in the WhatsApp support group used in this intervention. Several questions were addressed in the group daily and students were encouraged to avoid added sugar foods. Students shared their experience on how they felt after replacing added sugar foods with healthier options. In addition, they shared many recipes and ideas of homemade snacks free from added sugar. Although traditional education sessions and courses were found to be successful in improving diet and weight status in some settings (45-46), a combination of traditional educational sessions alongside with the online interventions were found to be more effective among university students (47) .

A limited number of interventions aimed specifically at limiting added sugar intake and were mostly conducted among children (52-54) . One study conducted in the USA used two types of community behavioral interventions (SSB reduction intervention and physical activity intervention). This study reported a significant decrease in intake of SSBs among the SSB intervention group owing to a significant reduction in the intake of empty calorie foods (energy-dense-nutrient-poor foods), increased intake of vegetables, and an improved overall diet (using Health Index score), compared with participants in the physical activity intervention group (48).

Despite the observed reduction in added sugar intake among the intervention group, the total energy and carbohydrate intake did not show any significant changes, which may be an indication of the replacement of sugar with other carbohydrate food sources that do not contain added sugar. Similarly, the weight status among participants in the intervention group remained unchanged; however, as the intervention program of the present study did not deliver direct messages aimed at weight reduction, it is possible

that replacing the sources of added sugar was the only concern of the participants. In addition, the duration of intervention may have been inadequate to observe changes in weight status, as the WHO has recommended > 8 weeks of intervention to limit added sugar intake, in order to observe weight changes among participants (55).

Nutrition education interventions commonly focus on improving dietary quality by increasing the consumption of fruits, vegetables, and dairy products (34, 45,46) . However, because of the high consumption of added sugar among many populations, an urgent intervention is needed to eliminate energy-dense nutrient-poor foods, including sugary drinks, foods, and snacks.

Limitations

Findings of this study may be generalizable only in female students in Saudi Arabia or the Middle East. The nutrition education program comprising of traditional sessions and a web-based support group was found effective among the Saudi university female students. Hence, this method could be adopted to encourage positive eating behaviors and increase awareness on important nutrition topics based on up-to-date evidence, among undergraduate female students.

Conclusion

The nutrition education intervention used in this study could be adopted effectively in schools, universities, workforce, and community centers to limit the added sugar intake. Introducing healthier food options to replace sugary foods should be included in all interventions that aim to improve the dietary quality in individuals. Long-term nutrition education is recommended to achieve the optimal effect of the interventions.

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Correspondence:
Walaa A. Mumena, PhD
Clinical Nutrition Department, College of Applied Medical Sciences, Taibah University, P.O. Box 344, Madinah, 42353, Kingdom of Saudi Arabia
Tel: +966530819399
E-mail: wmumena@taibahu.edu.sa