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Original Article

Added sugar: Nutritional knowledge and consumption pattern of a principal driver of obesity and diabetes among undergraduates in UAE

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ABSTRACT

Background: Recently, youth intake of added sugar has been growing. The incidence of obesity and type 2 diabetes Mellitus (T2DM) has risen dramatically in parallel with these changes. Excess added sugar is a key risk factor for weight gain and T2DM in many cohort studies. The current study was implemented to examine the nutritional knowledge, attitude and practice pattern among UAE undergraduates.

Method: Random sampling was used to approach 400 undergraduate students from UAE. The data analysis was performed by using SPSS version 24. A correlation analysis was performed using Pearson and Spearman correlation tests. Statistical analysis was conducted using Chi-square test, T-test, and Kruskal Wallis test.

Results: Added sugar consumption is widely prevalent among university students in UAE. Only 19% of the enrolled sample scored high nutritional knowledge level and 56% of the students were considered heavy consumers. White sugar was the preferred added sweeteners among 90% of the sample.

Conclusion: Our study outcomes recommend that strategies that can successfully reduce added sugar might be a significant stage concerning reversing the devastating escalating trends in diabetes, obesity, and promoting health of all populations in UAE.

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1. Introduction

Considerable lifestyle changes have occurred over the past three decades, affecting diet [1]. High-energy intake, saturated fats, sugars and fewer consumption of complex carbohydrates and fibers characterize the new dietary pattern [2], which plays a role in the predisposing chronic disease risk factor [2,3].

During processing or preparation, sugar can be added to food to enhance palatability, viscosity, texture, color, and durability [2]. The term added sugar point out to sugars that do not occur naturally in diets and consists primarily of sucrose and high fructose corn syrup (HFCS) [4]. Examples of syrup include corn, maple, high fructose corn and malt and sweeteners like white, brown and raw sugars; fructose, honey, molasses, anhydrous dextrose, and crystal dextrose are samples of added sugar [5]. Milk and fruit sugars, like lactose and fructose, are not considered added sugars [5,6].

Sweetened beverages (SBs) are America's leading source of added sugars [7–9]. Soda pop, sports refreshments, energy

beverages, sweetened tea, and fruit beverages are sweetened sugar beverages with a minimum value of nutrition [10]. Sweetened drinks and desserts inclined to possess a low nutrient density (nutrient-to-energy ratio) [5,11]. In contrast, nourishment and drinks that are the main provenance of natural sugars, such as fruits, have a high nutrient density [5]. Excess sugar nutrition was reported to diminish insulin sensitivity and insulin secretion in animal models and human researches [7]. In several recent epidemiological studies, increased consumption of SBs was correlated with an increased risk of type 2 diabetes Mellitus (T2DM) and insulin resistance [7,12].

The utilization of added sugars has dramatically enlarged worldwide [10,13]. Added sugar intake has expanded by 50% in the American diet since the 1970s [14]. Parallel to these fluctuations, the frequency of obesity and T2DM in USA has grown extremely [15]. Increased added sugar intake become a greatly visible and argumentative concern of community health and public strategies [16].

The American Heart Association (AHA) declared that adult males and females ingest up to 150 and 100 kcals per added sugar per day respectively [17,18]. This guideline indicates that greater added sugar quantities may rise the risk of cardiac disease [17].

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Reports of the negative health consequences from added sugar ingesting, particularly when consumed in bulk quantities were released [2,17,18]. Excess added sugar intake was identified as risk factors for cardiovascular disease (CVD), composing of high blood pressure, dyslipidemia, diabetes, non-alcoholic fatty liver illness, and even mental deterioration and malignancy [4,14,19]. Higher added sugar intake is accompanied with further calorie consumption, resulting in weight gain and increased threat of obesity [9]. Added sugar can have particularly hurtful outcomes on the liver, leading to resistance to hepatic insulin and metabolic syndrome [9].

One constituent of the Gulf Cooperation Council (GCC) is the United Arab Emirates (UAE) [19,20]. After Saudi Arabia and the Sultanate of Oman, it is the third largest in size (land area) [19]. The UAE ranks among the top countries in the prevalence of T2DM and metabolic syndrome, and as the rate of obesity in the UAE is increasing, comorbidities in the region are expected to increase [21]. The influx of Western lifestyles is one of the common reasons for obesity in UAE [22]. This lifestyle has led to changes in behavioral patterns and habits of food consumption [23]. The traditional eating style and food was replaced by processed food like soda, high sugar, and fatty food [24]. UAE is the world's fifth largest importer of refined sugar (\$ 222.20 million = 816.59 million AED) [20]. The effect of knowledge on the consumption of added sugar can be examined in diverse populations, amongst university students, which symbolize a remarkable sample for numerous motives. The group of college age is an integral part of the society and a segment of educated members that have better access to healthcare related information. Studies revealed an increase in added sugar intake, especially among young people [2]. Therefore, there is a need to know the knowledge, determinants and practice pattern of added sugar consumption among the university students to develop appropriate educational, regulatory and administrative measures to raise awareness of added sugar impact on health. When the knowledge of dietary guidance increases, positive choices, and patterns of healthy eating appear among college students. Students with higher nutritional knowledge were better eaters. There is no data available on the status of added sugar consumption among UAE university students. The current study aimed to identify the nutritional knowledge, attitude, and practice pattern of added sugar consumption between undergraduates at UAE.

2. Materials and methods

2.1. Study design

Descriptive cross-sectional study was implemented amongst university students in UAE from September 2018 to May 2019.

2.2. Sampling method

The inclusion criterion included the following: students at university, residence in UAE, the inclusion of both genders, willingness to participate in the study and students with age between 18 and 26 years. On the other hand, the study excluded graduate students, non-residents who were not willing to take part in the study, and those under the age of 18 or over 26. Three hundred and eighty four students were calculated as a representative sample using the online sample size calculator Rao-soft [22]. To overcome non-response, the final selected sample size was 400.

2.3. Research tool

The questionnaire was adapted by referring to previous literature [26]. The questionnaire has been modified to suit university students in UAE and to be answered within 15 min. The

questionnaire consists of five sections: the first section consists of six questions covering social and demographic features. The second section includes 16 items to evaluate the nutritional knowledge of the participants. The third section of the questionnaire includes 20 items to evaluate the consumption attitude to added sugar. The fourth section consists of three questions representing the consumption pattern of added sugar. The fifth section of the study aimed to identify preferred sugary ingredients by participants.

2.4. Statistical analysis

Data analysis was conducted using version 24 of SPSS. To analyze social and demographic data, descriptive analysis was used. Mean, standard deviation and frequency were included in the descriptive statistics. Chi-square test, Kruskal–Wallis test, and T-test have also been used. $P < 0.05$ is considered significant.

2.5. Ethical approval

A study permit has been requested and obtained from the Ethics Committee at Ajman University (P-F-H-19-01-23). Participants had obtained informed consent prior to the study. Participants' confidentiality has always been preserved. Participants' information obtained from the questions was kept confidential. Participants were informed of voluntary participation and might disengage from the study at any time.

3. Results

3.1. Socio-demographic data of the respondents

Four hundred students enrolled in the current study. The response rate was 94.25% with a total of 377 useable data that completed with analysis. Half of the participants were female ($n = 191, 50.7\%$) and 186 males (49.3%). Half of the participant's age was between 20 and 21 years, and 66.6% were living with their parents. Most of the participants were in their third and fourth year. Only a few of the study sample were athletes (5.3%) or own memberships of a fitness club (29.4%). The majority of students (79.3%) did not attend nutrition classes, and only 20% of the participant had a nutrition class during their studies. Detailed are shown in Table 1.

Chi-square test, T-test and Kruskal–Wallis test were conducted to explore the socio-demographic factors affecting knowledge, attitude, and practice (KAP) score. There was a significant difference between KAP scores of different years of study ($p = 0.003$), participants' age ($p = 0.016$) and the participants' living status ($p = 0.027$). On the other hand, there was no significant difference between being an athlete or not on KAP scores of the participants.

3.2. Knowledge data of the respondents about added sugar consumption

Approximately 19% ($n = 71$) received a high degree of knowledge while 81.2% ($n = 306$) had a low degree of knowledge. Knowledge score ranged from the lowest score of one (0.3%) to the highest score of 14 (0.8%) with Mean \pm (SD) = $5.79 \pm (2.30)$. Only one respondent received the lowest grade, one, while most participants received a score of five (20.7%). Details of responses are shown in Table 2.

Regarding students' knowledge about various types of added sugars on diet and drink labels, sucrose was found to be the most well-known (69%), followed by fructose (68%). Some students (16%) supposed that a monosodium glutamate salt is an example of added sugar.

Table 1
Socio-demographic data of the respondents.

Variables	Sub variables	N	%	KAP	Knowledge Attitude Practice		
					P- Value (Chi-square)		
Study year	First year	48	12.7	0.003 ^{*k}	0.0825	0.0161 [*]	0.321
	Second year	70	18.6				
	Third year	79	21.0				
	Fourth year	98	26.0				
	Fifth year	80	21.2				
	Sixth year	2	0.5				
Age	18–19	102	27.1	0.016 ^{*k}	0.066	0.057	0.009 [*]
	20–21	189	50.1				
	22–23	62	16.4				
	24–26	24	6.4				
Gender	male	186	49.3	0.413 ^t	0.360	0.793	0.018 [*]
	female	191	50.7				
Living during the academic year	My parents	252	66.6	0.027 ^{*k}	0.114	0.218	0.367
	Other relatives	16	4.2				
	Host family	80	21.2				
	Campus housing	29	7.7				
College athlete	Yes, I am	20	5.3	0.359 ^k	0.602	0.440	0.498
	No, but I go to the gym	111	29.4				
Nutrition class	No, I am not	246	65.3	0.679 ^t	0.91	0.929	0.019 [*]
	Yes	78	20.7				
	No	299	79.3				

* = significant P value (<0.05).

^k= Kruskal–Wallis test.^t = T-test.**Table 2**
Knowledge of the respondents about added sugar consumption.

Questions	Good knowledge	
	%	N
The sugar quantity usually mentioned in grams on food labels. How much is 4g sugar?	41.1	155
The American Heart Association (AHA) states that in one day you should eat the extreme quantity of added sugars:	25.5	96
We must border our total daily intake of added sugar by referring to the 2015–2020 Dietary Guidelines to:	21.5	81
The recommendations of the World Health Organization (WHO) In 2015, suggested that the quantity of added sugar be limited to less than 5% of calories per day.	43.8	165
Do you think cigarettes contain sugars?	25.7	97
Fruit-flavored beverages usually contain a very slight fruit and are great in added sugar.	79.3	229
100% fruit juices comprise a great quantity of fiber.	29.7	112
100% fruit juices are an extra intense origin of simple sugars than entire fruits	37.9	143

3.3. Attitude data of the respondents about added sugar consumption

Seventy-seven percent (n = 291) of participants had a positive attitude, while 22.8% (n = 86) had negative attitude regarding the consumption of added sugar. Attitude score ranged from the lowest score of six (1.1%) to the highest score of 16 (0.8%) with Mean ± (SD) = 11.002 ± (2.008).

Four respondents (1.1%) received the lowest score of 6 while most respondents (21.2%, n = 80) had a score of 12. Details of the responses are listed in Table 3.

About 40% of participants showed that appetite and/or taste sometimes influence their intake for added sugar. Also, 47.7% of respondents stated mood or stress caused sometimes a reason for consumption of added sugar, while almost 50% stated that attitudes, beliefs, or knowledge were sometimes playing a role when selecting food and beverages. Meanwhile, half of the responses said that cost sometimes is an important factor when they come to choose what to or not to eat.

3.4. Practice data of the respondents about added sugar consumption

Fifty-six percent of participants (n = 221) achieved a high

degree of consumption practice while 44% (n = 166) had a low degree of consumption practice. Practice score ranged from the lowest score of zero (11.4%) to the highest score of three (23.6%) with Mean ± (SD) = 1.684 ± (0.958). Most of the respondent receiving a score of two (32.6%).

Twenty-five percent of the participants stated that they consume sugar-sweetened soda pop/soft drinks 1 to 2 times per week, while another quarter takes sugar-sweetened soda pop/soft drinks 1–3 times per month. However, only about 4% of participants consume them on daily basis (Fig. 1). On the other hand, 25% of the students answered that they drink sugar-sweetened beverage other than soda pop/soft beverages 1 to 2 times per week. Meanwhile, just 2% stated that they drink them once a day.

Around half of the participant (55%) consume 8 oz. (1 cup) of soda pop/soft drinks, followed by 20% consuming 24 oz. (Medium fast food cup), and 18% of the participant drink about 12 oz. (1.5 cups) of sodas. Many students (42%) consume two packets of sweetener per day, followed by 33% consuming only one packet of sweetener per day, while only 10% stated they use three packets per day.

3.5. Preferred added sugar in participants' diet

Some students identified different added solid caloric

Table 3
Attitude of the respondents about added sugar consumption.

Questions	Positive attitude answer	
	N	%
To decrease the entire quantity of calories I eat the low-calorie sweetener	203	53.8
To avoid an upcoming health disorder, I take low-calorie sweetener.	89	23.6
To cope a current health illness, I eat low-calorie sweetener.	127	33.7
Taste preference I consume low-calorie sweetener.	298	79
For other reasons, I consume low-calorie sweetener.	295	78.2
To what degree do you attempt to take or escape added sugar?	277	73.5
Choose products based on the type of sweetener used	101	24
Pay more attention to total calories than the number of carbohydrates or sugar.	203	54
Choose the option labeled 'sugar -free' or 'unsweetened'.	158	42
Pay more attention to the total carbohydrate content than sugar content.	100	27
To aid preserve an ideal weight I take care of sugars and/or carbohydrate ingredients in food and drinks.	247	44
I don't think of sugars/carbohydrate content of the food and beverages I buy	5	1
To help provide energy/fuel for the physical activities I take sugars and/or carbohydrate content.	122	32
To stop an upcoming health illness or cope a present health disorder	98	26
Because I've received that individuals must take care to the sum of sugar they ingest	81	21

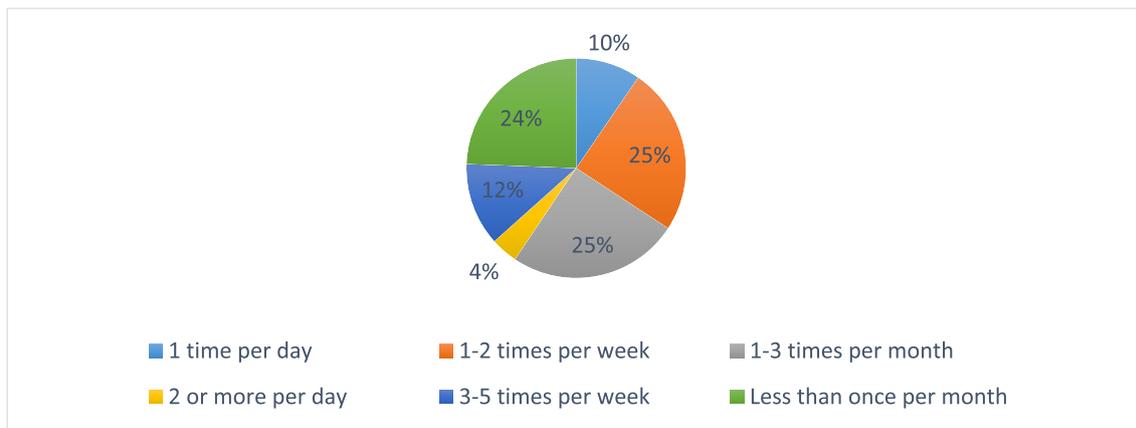


Fig. 1. The Consumption of Sugar-Sweetened Beverages Soft-drinks among participants.

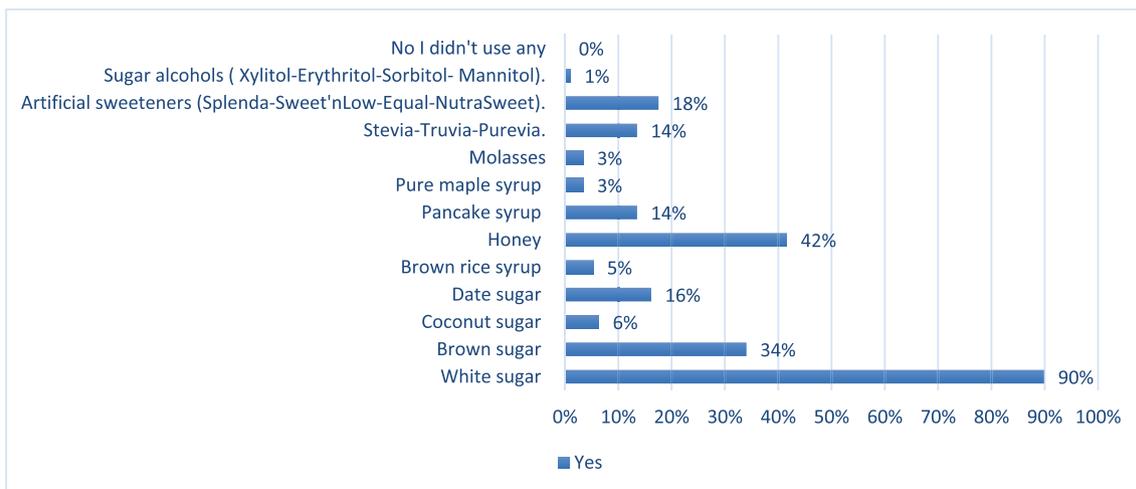


Fig. 2. Kinds of added sweeteners used in food or beverages used by participants.

sweeteners used in the last 12 months (Fig. 2). White sugar was the most famous type of added solid caloric sweeteners (90%). Yet, only 1% of participants were aware that sugar alcohols (Xylitol-Erythritol-Sorbitol- Mannitol) are considered added solid caloric sweeteners.

Surprisingly, many participants (49%) were focusing on the amount of protein when they read the food or beverage label. On the other hand, refined carbohydrates, complex carbohydrates, or total carbohydrates were not the major attention for the participant when reading food and beverage label. Details illustrated in Fig. 3.

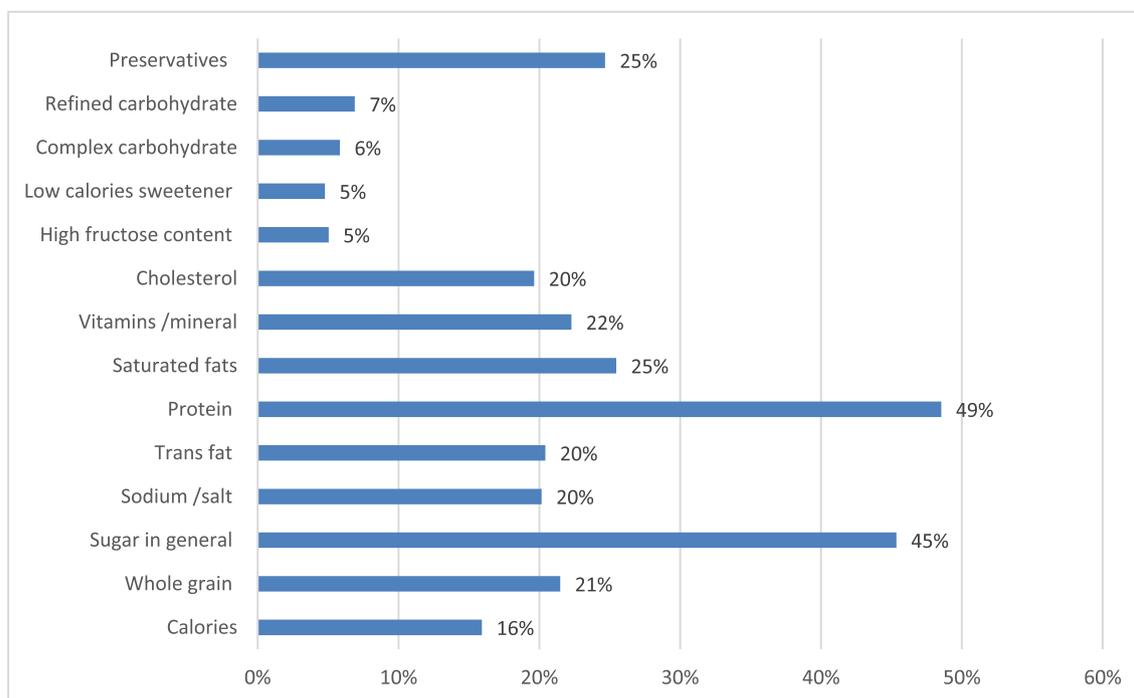


Fig. 3. Ingredient's patterns when buying packaged food or beverages.

4. Discussion

Added sugar consumption has become a community health and public strategy concern that is highly visible. Many consider added sugar intake a key contributor to obesity and connected well-being concerns, therefore, have been considered as a mean of helping to restrict the increasing incidence of obesity and diabetes. To our knowledge, this study is the first in UAE aimed to examine the level of awareness of college students towards added sugars and to explore their intake habits.

The study results revealed that the students' knowledge was fluctuating regarding sugar-related information in diet including how much calories are in each gram of sugar (41.1%), daily intake limits (25.5%), sugar constituents in cigarettes (25.7%), and composition of fruit juices (29.7%). Only one response indicated high knowledge regarding fruit-flavored drinks that are higher in added sugars than fruits (79.3%). A similar study agreed that students were aware that fruit juices contain sugars but little to no fibers, even though whole fruits are good sources of dietary fibers [23]. Actions in nutritional education are essential, targeting early years of school and public through all socioeconomic divisions. Some actions may help to develop healthy adult eating behaviors. In addition, to help people choose healthier food, the quantity of added sugars must be involved in the food labels.

Students were non-familiar with different sugar names on labels, with fructose (68%) and sucrose (69%) were the most known. Surprisingly, 16% of the students assumed that monosodium glutamate is an added sugar. To be noticed, Monosodium glutamate (MSG) is the salt of glutamate, an amino acid [24]. It is a food additive that works as a flavor enhancer in different types of food, yet its safety is still controversial must be listed on the label according to the FDA [25]. Including the nature and type of the ingredients listed in any food labels was suggested previously. Such policies could be promising strategies for reducing unnecessary intakes of calories.

In addition, this study revealed that 99% of the students were not familiar with sugar alcohols. Sugar alcohols, also called polyols,

are poorly edible carbohydrates formed by replacing an aldehyde group with a hydroxyl group [26]. Although they have fewer calories than sugar, they are not classified as low-calorie sweeteners [27]. They can exist naturally in fruits and specific types of vegetables and mushrooms [26]. According to the European Union legislation, there are seven authorized sugar alcohols: sorbitol, mannitol, isomalt, maltitol, lactitol, xylitol, and erythritol [28]. Sugar alcohols do not need or need very little, insulin for metabolism [29]. Since they are slowly and not fully absorbed from the intestinal tract, they are metabolized indirectly through fermentative degradation by the microflora, resulting in short chain fatty acids and gases [26]. They may also cause excess water to be drawn into the intestines [29]. Accordingly, when consumed in excess amounts, they produce a potent laxative effect, flatulence, bloating, and abdominal discomfort [30]. For products that contain above 10% of alcohol sugars, it must be stated that it might induce laxative effects upon excessive consumption [26]. With erythritol being well-tolerated as an exception, tolerance towards these sugars is improved with continuous use [31].

It was unexpected from this study to reveal the wide habitual use of low-calorie sweeteners. The majority of the students (79%) indicated the use of sweeteners for taste preferences. Low-calorie sweeteners are chemicals that provide much more intense sweetness per gram than caloric sweeteners like sugar, with few to no calories at all [32]. They are also categorized as non-nutritive sweeteners, artificial sweeteners, sugar alternatives, and-intensity sweeteners [33]. There are numerous low-calorie sweeteners, yet only six are approved by the FDA: Aspartame, Acesulfame-K, Saccharin, Sucralose, Neotame, and Advantame [34]. Non-natural sweeteners are hundreds of times, and can drastically reach to 20,000 thousand times, sweeter than table sugar [35]. Food and beverages containing low-calorie sweeteners are usually labeled as 'diet' or 'sugar-free' [34].

On the other hand, honey was the topmost used natural sweetener by students (42%) after the non-natural sweetener, white sugar (90%). Honey has been used as a nutrient, ointment, and medicinal product since very ancient cultures [36]. In 2009, the

annual production of honey reached about 1.2 million tons, which is still below 1% of the sugar manufacture [37]. Honey is composed of not less than 181 substances, with fructose constituting around 38% and glucose around 31% of total weight [38]. The wide variation of substances includes, but is not limited to, enzymes like amylase, vitamins like thiamin, riboflavin, pyridoxine, and niacin, and minerals like calcium, magnesium, zinc, copper, and iron, in addition, polyphenols that vary with the variation of the floral source [37]. For a very long time, honey was used as a therapy for cataracts, ulcers, burns, and wound curing since it has a soothing outcome when placed on open wounds [38]. Intensive researches on honey have revealed its antibacterial, antioxidant, antimutagenic, anti-tumor, and anti-inflammatory activity [37]. It has also been found effective in intestinal infections, gastritis, and gastric ulcers, as well as ameliorating cardiovascular risks [38]. In one study, consumption of honey reduced total cholesterol, LDL cholesterol, triglycerides, fasting blood glucose, and C-reactive protein, while it raised HDL cholesterol [38].

In this study, when students were asked about what influences their consumption of added sugars, access time and/or skills was leading (51.1%) followed by cost (50.6%), then by attitudes, beliefs, and/or knowledge about food (49.8%) and 40.3% of the students selected the taste preferences. In contrast, other studies reported taste preference and cost as the major factors affecting consumption pattern from the participants' point of view [23,39]. Health authorities must, therefore, devote resources to raise the awareness of added sugar intake among students and the general public in order to ultimately improve their attitudes towards the pattern of consumption.

5. Conclusion

The results of our study which was conducted among undergraduate students at UAE University provide evidence that the majority of the students are a heavy consumer for added sugar. The respondent shows low nutritional knowledge towards added sugar. The study will be useful in providing baseline data on prevalence and the consumption pattern of added sugar. It helps to conduct counseling programs on the potential risk of added sugar that can help prevent future overuse harms. This study shows the need to raise public awareness about the health effect of added sugar. Similar study type can be carried out on a large scale in different settings. It may also be helpful if the concepts and principles of nutrition can be included in UAE universities' formal curricula. Restricting the sale of food containing highly added sugar and beverages can be effectively implemented through monitoring systems between the major stakeholders. In addition to viewing this is an actual complication that should not be disregarded, our study has also created gateway for additional investigation in this matter.

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