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ARTICLE

Consumption of added sugars among undergraduate students at a South African university and its association with BMI

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Objectives: A study was undertaken to quantify added sugar intake; to show the association between added sugar intake and body mass index (BMI); and to identify determinants of added sugar and sugar-sweetened beverage (SSB) intake.
Design: This was a cross-sectional study.
Subjects: Non-probability sampling was used to recruit a sample of 387 undergraduate students, aged 18–25 years: 128 males and 259 females.
Setting: The study was conducted at the University of KwaZulu-Natal, Pietermaritzburg campus.
Outcome measures: BMI was calculated using weight and height. The mean added sugar and dietary energy intake was measured using a 24-hour dietary recall. The frequency and mean amount of added sugars consumed was analysed using a food frequency questionnaire.
Results: Females (66.1%), Black Africans (90.4%), and students living away from home (76.7%) formed the majority of the study sample. The prevalence of overweight and obesity was 19.1% and 8.5%, respectively, with 64.9% of students having a normal BMI. There was a significant association between the frequency of consuming flavoured milks, hot chocolate drinks, jam and chocolate bars and BMI. Female students and those living at home consumed added sugars significantly more frequently than their counterparts. Taste and price were significantly associated with purchasing/consuming SSBs.
Conclusion: A significant association between the frequency of consuming certain food items containing added sugar and the students' BMI was observed. Poor dietary habits could impact negatively on an individual's weight status, thus highlighting the need for strategies to promote healthier dietary and lifestyle behaviours among young adults.

Keywords: added sugar intake, obesity, overweight, sugar-sweetened beverages

Introduction

Worldwide, the increased prevalence of overweight and obesity has become a major health problem, accounting for approximately 2.8 million deaths each year.[1] According to a systematic analysis that was conducted on the prevalence of overweight and obesity among adults and children worldwide, the number of overweight and obese individuals had increased from 921 million to 2.1 billion between the years 1980 and 2013.[2] Being overweight or obese increases the risk of developing non-communicable diseases.[1] The prevalence of overweight and obesity has progressively increased among students attending national[3–6] and international universities.[7–9] A meta-analysis of 32 studies conducted among first-year university students found that more than half gained an average of 3.38 kg during their first year.[10] Similarly, a significant overall weight gain of 8.5 kg and a BMI increase of 3.3 kg/m^2 was observed among Malawian students.[11]

The causes of overweight and obesity are complex; however, recent studies have indicated that changes in dietary and lifestyle habits are often responsible for the increase in these conditions.[12] University students are vulnerable to these changes, as the transition to tertiary education requires various adjustments that have an impact on their dietary and lifestyle habits.[10] Students who live away from home are required to make their own dietary choices, but a lack of sound dietary knowledge can lead them to adopt poor dietary and lifestyle behaviours.[10] Previous studies conducted at South African universities have shown that students often adopt sedentary behaviour and consume a diet that is low in fruit and vegetables and high in added sugar and fat.[3,4] Various internal and external factors tend to influence the dietary and lifestyle habits of university students.[13] Therefore, in order to improve these habits, it is important to assess their dietary intake and determine the factors that influence their dietary and lifestyle habits.[13]

The increased consumption of sugar-sweetened beverages (SSBs) has raised much concern regarding their impact on health,[14] as they contain empty calories, have a low satiety and facilitate an increased intake of foods that have very little or no nutritional value.[15] Thus, the increased consumption of SSBs has been associated with the possible development of overweight and obesity.[14] Sugar-sweetened beverages contribute a significant amount of added sugars to the total energy intake,[16] as a 330 ml can of a carbonated beverage or fruit juice contains approximately 8–9 teaspoons of sugar.[16]

There is a dearth of literature discussing the dietary intake of added sugars among university students in South Africa. Although national[3–5] and international[7–9] studies have assessed the dietary habits of university students, only a few studies have specifically assessed the added sugar intake and its influence on their body mass index (BMI).

The purpose of this study was to determine the prevalence of overweight and obesity among undergraduate university students; to quantify their added sugar intake and any association between the frequency of consumption of added sugars and BMI; to determine the differences in added sugar intake across gender, race and place of residence; and

to determine the factors related to the purchase/consumption of SSBs.

Method

Study design, sampling and sample size determination

A cross-sectional study was conducted on undergraduate students of all races, aged between 18 and 25 years, attending the University of KwaZulu-Natal (UKZN), Pietermaritzburg, in 2016. Students were selected on the following basis: Did they consume foods and beverages containing added sugar and were they involved in purchasing the foods and beverages that they consumed? Non-probability sampling was used to recruit the students from a sampling frame of 2 253 registered students.[17] Students were recruited by word-of-mouth and flyers that were distributed around the campus. The sample size was calculated using Cochran's sample size formula[18] (with the correction for population size) for categorical data. Convenience sampling was thereafter used to obtain the required sample number (n_0) as calculated. This formula uses a 95% confidence interval with an accepted margin error of 0.05 (d), alpha at 0.05 $(t)^2$, with the population number being used for the calculation.

$$n_0 = \frac{(t)^2(p)(q)}{(d)^2}$$

p = maximum possible proportion (0.5); q = one minus maximum possible proportion ($1 - p = 0.5$).

$$n_1 = \frac{n_0}{(1 + n_0 / \text{population size})}$$

n_1 = final sample size; n_0 = sample size according to Cochran's formula; population size = actual population size from which the sample will be drawn ($n = 2\ 253$).[17]

An estimated sample size of 329 was obtained and 20% was added to this figure to compensate for those with incomplete data ($n = 395$). Of the original sample of 395 students who agreed to participate, eight did not complete the questionnaire; therefore, the results from 387 students were included in the analysis.

Data collection

Data were collected using a three-part questionnaire that consisted of open-ended and closed questions. Part One of the questionnaire consisted of three sections: Section One was used to assess the students' weight and height, with measurements being taken and recorded by trained fieldworkers. Sections Two and Three were completed by the students: Section Two assessed the students' demographics and Section Three assessed the factors relating to the purchases/consumption of SSBs. Parts Two and Three assessed the dietary intake of the students using a Food Frequency Questionnaire (FFQ) and a 24-hour dietary recall. The students completed the FFQ and the trained fieldworkers administered the 24-hour dietary recall.

The FFQ consisted of two sections: the first section measured the amount of added sugars consumed and the second measured the frequency of their consumption. A total of nine food and beverage groups were included, and 50 items were listed. This list was based on the food items that were sold at, or around, the university; as well as data obtained from a narrative review that assessed the dietary habits of South African adults between the year 2000 and 2015;[19] and food items that were listed in studies conducted at local universities.[3,4] The FFQ was constructed under the guidance of a statistician and the layout was based on published studies that assessed the dietary intake of university students.[3,4,11]

The 24-hour dietary recall consisted of three meals and three snacks, with students reporting the type and amount of foods and beverages consumed, as well as the preparation method. A list of food groups (starch, starchy vegetables, breakfast cereals, vegetables, fruit, dairy, meat and meat substitutes, hot and cold beverages, sauces, oils, spreads, table sugar and milk flavourings, confectionery items, sweets, chocolates, savoury snacks and chips, and desserts) were included in the 24-hour dietary recall to assist with reporting and to ensure that students recorded all items consumed. The 24-hour dietary recall was constructed under the guidance of a statistician with the layout being based on published studies that assessed the dietary intake of university students.[3,4] For the purpose of this study, a single 24-hour dietary recall was used to assess the mean added sugar intake; dietary energy intake; percentage contribution of added sugars to the total dietary energy intake; differences in the mean consumption based on gender, race and place of residence; and differences in the mean consumption across individual students' BMI.

Food groups included in the FFQ and 24-hour dietary recall were adapted from the South African Food Based Dietary Guidelines[20] as well as the Diabetic Exchange List, compiled by the American Dietetic Association.[21] Students were also provided with a pictorial representation of various foods and beverages to assist with quantifying portion sizes while completing the FFQ and 24-hour dietary recall. The pictorial guide was designed using household food measurements found on MRC Food Finder 3 (Medical Research Council, South Africa), as per quantities found in the MRC Food Quantities Manual.[22]

Anthropometric measurements

Weight and height were taken using a standardised procedure[23] with each measurement repeated three times and the mean calculated. Bodyweight was measured using a calibrated, portable SECA 813 electronic flat scale (Seca GmbH, Hamburg, Germany), and recorded to the nearest 0.1 kg. Height was measured using a calibrated free-standing, portable SECA 213 height measure, and recorded to the nearest 0.5 cm. The BMI was calculated using mean weight and height measurements and was categorised as follows: Underweight (BMI < 18.5 kg/m^2), Normal Weight (BMI 18.5–24.9 kg/m^2), Overweight (BMI 25–29.9 kg/m^2), Obese Class I (BMI 30–34.9 kg/m^2), Obese Class II (BMI 35–39.9 kg/m^2) and Obese Class III (BMI $\geq$ 40 kg/m^2).[13]

Ethical considerations

Ethics approval was received from the Human and Social Sciences Research Ethics Committee (HSS/0175/016M) and gatekeeper's approval was obtained from the UKZN Registrar. Only students who provided written informed consent were included in this study.

Statistical analysis

The data were analysed using the Statistical Package for Social Sciences Version 21 (IBM Corp, Armonk, NY, USA). The results were presented as percentages, frequencies and means. A p-value of less than 0.05 was considered to be statistically

significant. The chi-square test of independence was used to determine the association between the place of residence and the demographic characteristics of the students as well as the association between the BMI categories and gender.

MRC Food Finder 3 was used to quantify the added sugar intake from the 24-hour dietary recall. Descriptive statistics was used to determine the frequency of consuming each item listed in the FFQ using the responses under the section titled 'How often consumed'. The mean consumption of each item listed in the FFQ was calculated using grouped data for each of the responses under the section titled 'How much consumed'.

The independent sample t-test was used to determine whether the mean added sugar intake, dietary energy intake and percentage contribution of added sugars to the total dietary energy intake differed significantly across gender. Analysis of variance (ANOVA) was used to determine whether the mean added sugar intake, dietary energy intake and percentage contribution of added sugars to the total dietary energy intake differed significantly for the categories of race and place of residence. The consumption frequency of added sugars across each demographic variable was quantified in order to calculate a mean rank. Wilcoxon's signed rank test was then used to investigate whether the mean rank of consumption of the food and beverage groups was significantly different for the categories of gender and place of residence. The Kruskal–Wallis test was used to investigate whether the mean rank of consumption of the food and beverage groups differed significantly across the categories of race.

ANOVA was used to determine whether the mean added sugar intake, dietary energy intake and percentage contribution of added sugars to the total dietary energy intake was significantly different across the students' BMI categories. The chi-square test of independence was used to determine whether there was any significant association between the BMI categories and the frequency of consuming food items containing added sugar.

A one-sample t-test was used to determine if significant importance was given to the factors that relate to the purchases/consumption of SSBs, and mean scores were used to determine which factors were considered more important when purchasing/consuming SSBs. The chi-square goodness-of-fit test was used to determine which, if any, of the consumption characteristics were selected significantly more than the others.

Results

Demographic characteristics

Data from 387 students were analysed in this study. Most of the students were female (66.9%, $n = 259$) and from the Black African race group (90.4%, $n = 350$) (Table 1). More than half of the students were reported to live away from home (76.7%, $n = 297$) during the semester. A significantly greater proportion of students lived at residences on campus (47.3%, $n = 183$, chi-square (3) = 126.230, $p < 0.05$) than at home or in other accommodation.

There was no significant difference between the distribution of male and female students according to their place of residence. Across race and the place of residence, a significant proportion of Indian and Coloured students reported living at home, while a significant proportion of Black African students reported living in a residence on campus, and a significant proportion of White students lived in a type of lodging that consisted of a room with shared facilities.[24]

Body mass index of the students

A significant proportion of the students were classified as having a normal BMI (64.9%, $n = 251$, chi-square (3) = 695.217, $p < 0.0005$), rather than being underweight (7.5%, $n = 29$), overweight (19.1%, $n = 74$) or obese (8.5%, $n = 33$). A significantly higher proportion of male than female students had a normal BMI classification (77.3%, $n = 99$ and 58.7%, $n = 152$, respectively), and the prevalence of overweight and obesity was significantly higher among the female than male students (22.0%, $n = 57$; 11.6%, $n = 30$ and 13.3%, $n = 17$; 2.3%, $n = 3$, respectively) ($p = 0.001$). The proportion of underweight students was similar across both genders (males: 7.0%, $n = 9$ and females: 7.7%, $n = 20$).

Added sugar intake

The mean added sugar and dietary energy intake from the 24-hour dietary recall was 56.8 g and 6 796.0 kJ, respectively. On average, added sugars contributed 14.2% to the total energy intake.

A total of 50 foods and beverages containing added sugars were used to analyse the frequency and mean consumption of added sugars. Table 2 represents only those food/beverage items that were consumed by a larger proportion of the students. Each response listed under the section titled 'How often consumed'

Table 1: Students' place of residence across their demographic characteristics

Variable category (*n*)	At home		Residence on campus		Lodging with shared facilities		Private accommodation		
	n	%	*n*	%	*n*	%	*n*	%	*p*-value
Gender:									
Male ($n = 128$)	30	23.4	65	50.8	28	21.9	5	3.9	0.286
Female ($n = 259$)	60	23.2	118	45.6	57	22.0	24	9.3	
Race:									
Indian ($n = 27$)	25	92.6	0	0.0	0	0.0	2	7.4	< 0.0005*
Black African ($n = 350$)	61	17.4	181	51.7	82	23.4	26	7.4	
Coloured ($n = 8$)	4	50.0	2	25.0	1	12.5	1	12.5	
White ($n = 2$)	0	0.0	0	0.0	2	100	0	0.0	
Total ($n = 387$)	90	23.3	183	47.3	85	22.0	29	7.5	

*Significant association between the places of residence across the categories of race.

Table 2: Frequency and mean amount of added sugars consumed from the items listed in the FFQ

	Frequency of consumption*						
	Low frequency of consumption*		High frequency of consumption*		Mean amount consumed per serving (ml or g)		
Food and beverages	***n***	**%**	***n***	**%**	***n***	**%**	**Grouped mean****
Beverages (ml):							
100% fruit juices	204	52.7	183	47.3	343	88.6	250–500
Juice concentrates	135	34.9	252	65.1	319	82.4	250–500
Carbonated soft drinks	126	32.6	261	67.4	358	92.5	250–500
Energy drinks	312	80.6	75	19.4	237	61.2	250–500
Flavoured water	308	79.6	79	20.4	234	60.5	250–500
Sugar, milk flavouring or powders (g):							
Table sugar	82	21.2	305	78.8	354	91.5	6–12
Sauces (g):							
Tomato sauce	189	48.8	198	51.2	287	74.2	7–14
Mayonnaise	154	39.8	233	60.2	306	79.1	7–14
Breakfast cereals (g):							
Cornflakes	131	33.9	256	66.1	305	78.8	55–110
Spreads (g):							
Peanut butter	235	60.7	152	39.3	247	63.8	20–40
Desserts (g):							
Ice cream	257	66.4	130	33.6	330	85.3	50–100
Custard	353	91.2	34	8.8	204	52.7	100–200
Flavoured yoghurts	224	57.9	163	42.1	308	79.6	100–200
Cakes and biscuits (g):							
Doughnuts, plain medium size	303	78.3	84	21.7	214	55.3	25–50
Cakes, plain, 5 cm square	224	57.9	163	42.1	325	84.0	30–60
Muffins, plain, mini	240	62.0	147	38.0	301	77.8	17–34
Biscuits with filling	227	58.7	160	41.3	300	77.5	30–45
Plain biscuits	256	66.1	131	33.9	270	69.8	20–30
Chocolates (g):							
Bars (17–62 g)	304	78.6	83	21.4	110	28.4	30–60
Cadbury/Beacon slab	294	76.0	93	24.0	237	61.2	30–60
Sweets (g):							
Soft sweets	286	74.0	101	26.0	209	54.0	20–25
Hard-boiled sweets	308	79.6	79	20.4	151	39.0	20–30
Marshmallows	309	79.8	78	20.2	210	54.3	20–25

*Number of students who consumed (monthly, weekly, daily) or did not consume (never) the items containing added sugars. Low frequency of consumption: consumption once a month or less or not consuming them at all. High frequency of consumption: consumption daily or once a week or more.
**Mean amount (grouped data) consumed per serving in millilitres or grams.

('Never', 'Less than once a month', 'About once a month', '1–2 times per week', '3–6 times per week', 'Daily, but just once a day' and 'Daily, but more than once a day') were quantified in order to determine the frequency of consumption. The mean amount (grouped mean) consumed by the students was quantified using the responses under the section titled 'How much consumed'. Each food and beverage group consisted of appropriate household food measures, which were quantified in order to calculate the mean amount of each item that was consumed per serving.

Carbonated soft drinks and juice concentrates were most frequently consumed by the students, and of those that consumed these beverages, almost one-third consumed juice concentrates (29.2%, $n = 113$) on a daily basis and carbonated soft drinks (29.5%, $n = 114$) on a weekly basis. Carbonated soft drinks, 100% fruit juices and juice concentrates were consumed by most of the students, the mean amount being 250–500 ml.

Table sugar was the most frequently consumed item in the table sugar and milk powder group, with 46.0% ($n = 178$) reporting that they consumed it on a daily basis. On average the students consumed 6–12 g of table sugar per serving. In the sauce group, mayonnaise and tomato sauce were consumed by most of the students, and on average the students consumed 7–14 g per serving. Cornflakes was the most frequently consumed breakfast cereal, and 28.2% ($n = 109$) reported that they consumed it on a daily basis. On average the students consumed 55–110 g per serving. A low frequency of consumption was observed for the items listed under the spreads, desserts, cakes and biscuits, chocolates, and sweets groups.

Association between added sugar intake and BMI

The mean added sugar intake, dietary energy intake and percentage contribution of added sugars to the total dietary intake across the BMI categories is presented in Table 3. Underweight students had a higher mean added sugar intake as well as percentage contribution of added sugars to the total dietary energy

Table 3: Mean added sugar intake, energy intake and percentage contribution of added sugars to the total dietary energy intake across the BMI categories

	Added sugar intake (g/day)*, mean ± SD	Total energy intake (kJ/day)*, mean ± SD	Added sugar contribution to the total daily energy intake (%)**, mean ± SD
BMI categories			
Underweight ($n = 29$)	60.68 ± 48.73	6891.35 ± 3374.85	14.97 ± 8.57
Normal ($n = 251$)	51.32 ± 49.84	6644.21 ± 3008.42	13.13 ± 10.33
Overweight/obese ($n = 107$)	55.81 ± 47.19	7017.24 ± 4963.56	13.52 ± 9.94

*The mean was calculated using the 24-hour dietary recall. SD = standard deviation.
**These percentages were calculated using the mean added sugar intake and the mean total dietary energy intake.

intake, and the overweight/obese students had a higher mean dietary energy intake. However, the mean added sugar intake ($p = 0.511$), dietary energy intake ($p = 0.668$) and percentage contribution of added sugars to the total dietary energy intake ($p = 0.639$) did not differ significantly across the BMI categories (underweight, normal, overweight/obese).

A significant relationship was found between the BMI categories and the frequency of consuming the food and beverage items listed in Table 4. A significant proportion of those who consumed flavoured milk 'at most once a month' were underweight, while a significant proportion of those who consumed this beverage 'daily' had a normal BMI. With regard to hot chocolate drinks, a significant proportion of those that consumed it 'weekly' were underweight, while a significant proportion of those that consumed these drinks 'at most once a month' were overweight/obese. A significant proportion of the students who consumed jam 'daily' were either underweight or overweight/obese. A significant proportion of the students who consumed chocolate bars 'at most once a month' were underweight, while a significant proportion of those who consumed these chocolate bars 'weekly' were overweight/obese.

Added sugar intake across the demographic characteristics of the students

The mean added sugar intake ($p = 0.129$) and percentage contribution of added sugars to the total dietary energy intake ($p = 0.653$) did not differ significantly across gender. However, the mean dietary energy intake was significantly higher among the male (7374.31 ± 3508.23 kJ/day) than female students (6510.11 ± 3708.91 kJ/day) ($p = 0.029$). With regard to race, a comparison could not be made as only 2 White, 8 Coloured and 27 Indian students participated in the study; therefore, the statistical power was insufficient for group comparisons. The mean added sugar intake ($p = 0.456$), dietary energy intake ($p = 0.880$) and percentage contribution of added sugars to the total dietary energy intake ($p = 0.125$) did not differ significantly across the students' place of residence.

The frequency of consuming the desserts ($p = 0.003$), cakes and biscuits ($p = 0.013$), chocolates ($p = 0.001$), and sweets

Table 4: Frequency of consumption of added sugars from the FFQ across the BMI categories

	Underweight ($n = 29$)		Normal ($n = 251$)		Overweight/obese ($n = 107$)		
Foods and beverages	***n***	**%**	***n***	**%**	***n***	**%**	***p*-value***
Beverages—flavoured milk:							
Never ($n = 237$)	13	5.5	150	63.3	74	31.2	0.033
At most once a month ($n = 91$)	11	12.1	54	59.3	26	28.6	
Weekly ($n = 42$)	4	9.5	33	78.6	5	11.9	
Daily ($n = 16$)	1	6.3	13	81.3	2	12.5	
Sugar, milk flavouring or powders—hot chocolate drinks:							
Never ($n = 216$)	10	4.6	148	68.5	58	26.9	0.008
At most once a month ($n = 98$)	10	10.2	52	53.1	36	36.7	
Weekly ($n = 60$)	9	15.0	40	66.7	11	18.3	
Daily ($n = 13$)	0	0.0	11	84.6	2	15.4	
Spreads—jam:							
Never ($n = 222$)	16	7.2	149	67.1	57	25.7	0.020
At most once a month ($n = 96$)	8	8.3	58	60.4	30	31.3	
Weekly ($n = 60$)	3	5.0	43	71.7	14	23.3	
Daily ($n = 9$)	2	22.2	1	11.1	6	66.7	
Chocolate bars:							
Never ($n = 298$)	18	6.0	204	68.5	76	25.5	0.036
At most once a month ($n = 58$)	8	13.8	30	51.7	20	34.5	
Weekly ($n = 27$)	3	11.1	13	48.1	11	40.7	
Daily ($n = 4$)	0	0.0	4	100	0	0.0	

*Significant association between frequency of consumption of added sugars and BMI categories.

Table 5: Level of importance of each factor in the purchases/consumption of SSBs

Factors	Level of importance							
	Low		Moderate		High		Mean* (*t*-value of 3)	*p*-value**
	n	%	*n*	%	*n*	%		
Taste	19	4.9	41	10.6	327	84.5	4.42	0.001
Price	52	13.4	64	16.5	271	70	4.00	0.001
Marketing and labelling	160	41.3	109	28.2	118	30.5	2.84	0.023
Social influences (family and friends)	207	53.5	83	21.4	97	25.1	2.54	0.001

*Mean importance rating. This was tested against a central value of '3' to determine the significant level of importance. If < 3, the mean rating is showing a significant low importance. If > 3, the mean rating is showing a significant high importance. **Factors considered as being significantly important.

($p = 0.017$) groups was significantly higher among the female than the male students. Students living at home consumed spreads ($p = 0.003$) and desserts ($p = 0.023$) significantly more frequently than those living away from home. A comparison could not be made regarding race as the statistical power was insufficient for group comparisons.

Factors related to the consumption/purchases of SSBs

Table 5 indicates the students' ratings for the factors that could be related to the purchases/consumption of SSBs. Students were required to rate how important these factors were when purchasing/consuming SSBs. A rating scale from 1 to 5 was used, where Rating 1 was considered to be not important at all and Rating 5 was considered to be extremely important. Taste and price were considered as factors of significant importance when purchasing/consuming SSBs, and factors relating to the marketing and labelling of the product as well as social influences (friends and family) were shown to be of significantly lower importance.

This study also investigated the association with price increases as a result of an impending sugar tax on the students' intention to purchase/consume SSBs. A significant proportion of the students ($n = 150$; 38.8%), chi-square (3) = 43.605, $p < 0.05$) indicated that if the price of such beverages increased, they would purchase and/or consume them less often and only 17.8% ($n = 69$) reported that they would purchase and/or consume healthier alternatives (Figure 1).

Discussion

BMI classification of university students

More than half of the students were within a normal BMI classification (64.9%), approximately one-third were overweight or obese (19.1% and 8.5%, respectively) and 7.5% were underweight. These findings correspond with other cross-sectional studies that were conducted among students attending national[3,4,6] and international[7–9] universities.

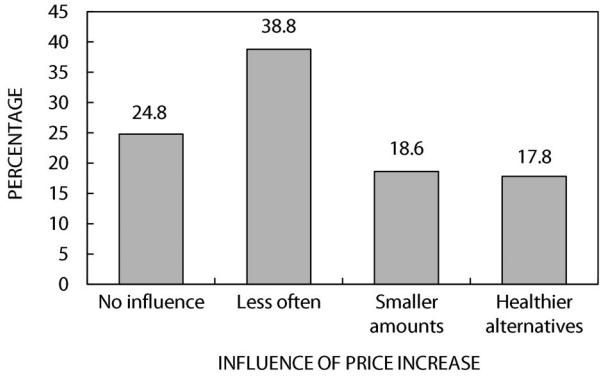

Figure 1: Influence of a price increase on the subjects' intention to consume/purchase SSBs.

A significantly higher percentage of the male (77.3%) than female students were within the normal BMI classification, whereas female students were significantly more overweight and obese than their male counterparts (22.0%, $n = 57$; 11.6%, $n = 30$ and 13.3%, $n = 17$; 2.3%, $n = 3$, respectively). Studies conducted at other South African universities (with a similar gender distribution to that of the UKZN study) have also indicated a higher prevalence of overweight and obesity among female than male students (Eastern Cape 58.2% vs. 31.4%[3], Free State 22.1% vs. 12.8%[4], and Limpopo[6] 30.5% vs. 8.7%, respectively), and that more male than female students were classified as having a normal BMI (Eastern Cape 58.8% vs. 40%[3], Free State 87.2% vs. 67.2%[4], and Limpopo 76.1% vs. 56.5%[6], respectively). Factors such as culture, socioeconomic status and nutrition transition could be responsible for the gender differences in being overweight and obese.[25,26]

Added sugar intake of university students

The mean percentage contribution of added sugars to the total dietary energy intake exceeded the WHO recommendations.[27] However, these results should be interpreted with caution because a single 24-hour dietary recall cannot be regarded as a valid method to estimate total energy intake.[28]

Carbonated soft drinks, 100% fruit juices and juice concentrates were the most frequently consumed beverages. Students mostly consumed carbonated soft drinks and 100% fruit juices on a weekly basis and juice concentrates on a daily basis; however, this accounted for only approximately one-third of the students. Similarly, a study conducted at the University of the Free State[4] found a higher weekly consumption of carbonated soft drinks and 100% fruit juices (77% and 75.2%, respectively), whereas a study conducted at a university in the Eastern Cape[3] indicated a higher monthly consumption of these beverages (72.1% and 68.9%, respectively).

Table sugar was consumed by a large percentage of the students (78.8%, $n = 305$), and most reported consuming it on a daily basis (46.0%). Similarly, the studies conducted in the Free State[4] and Eastern Cape[3] also indicated a high daily consumption of table sugar (Eastern Cape 59.0%, Free State 57.1%).

With regard to the breakfast cereal category, more than two-thirds of the students did not consume powdered breakfast cereals (71.3%, $n = 276$); instead the majority consumed cornflakes. Contrary to these findings, the studies conducted in the Free State[4] and Eastern Cape[3] reported that more than

two-thirds of the students consumed powdered breakfast cereals on a weekly and monthly basis, respectively.

A low frequency of consumption was observed for the items listed under the spreads, desserts, cakes and biscuits, chocolates and sweets categories as more than 50% of the students reported that they did not consume these items. Contrary to these findings, the study conducted in the Eastern Cape[3] indicated a higher monthly consumption of sweets and chocolates (77.0%) and cakes and biscuits (85.7%), whereas the study conducted in the Free State[4] indicated a higher weekly consumption of these items (sweets and chocolates 92.5% and cakes and biscuits 87.6%).

Association between added sugar intake and BMI

The added sugar intake did not differ significantly across the students' BMI. A significant relationship was found between the BMI categories and the frequency of consuming some food items that contained added sugars. A significant proportion of the students who consumed flavoured milks on a daily basis had a normal BMI. In addition a significant proportion of students who consumed hot chocolate drinks weekly were underweight, while a significant proportion that consumed this item at most once a month were overweight/obese. Students who consumed jam on a daily basis were significantly more likely to be underweight or overweight/obese. A significant proportion of the students who consumed chocolate bars weekly were overweight/obese, while a significant proportion who consumed these at most once a month were underweight.

Other cross-sectional studies that were conducted among university students have also indicated differences in the frequency of consumption of added sugars across the BMI categories.[3,29] The study that was conducted in the Eastern Cape revealed that a significantly smaller proportion of underweight than normal, overweight or obese students consumed sweets, chocolates and chips (crisps) on a daily basis.[3] Furthermore, a study that was conducted on 2 259 students attending a university in Turkey[29] found that students with a higher BMI (overweight or obese) consumed these foods and beverages more frequently than students who were classified as being underweight or normal.

From the results it can be deduced that an increase or decrease in the consumption of any food and beverage item will alter the total energy intake; however, the extent to which it impacts on an individual's weight will depend on the quantity and quality of the food or beverage consumed. Thus, it is important to take into account the total energy intake when assessing the weight status of an individual as alteration in the total energy intake can also impact on body weight.[30]

Differences in the consumption of added sugars across the categories of each demographic variable

Added sugar intake did not differ significantly across the categories of each demographic variable. The consumption frequency of certain food groups was significantly higher among the female than the male students, and the frequency of consumption of these food groups was significantly higher among students who lived at home in comparison with those who lived away from home. Several studies from European[31,32] and Malaysian[33] universities found a higher consumption frequency of sweets and cakes among female than male students, while male students had a higher frequency of consumption of carbonated soft drinks than females. Although the literature has suggested that university students who live away from home might develop more unhealthy eating habits in comparison with those who lived at home,[10] the findings from previous studies have been inconsistent.[31,32]

Determinants of added sugar intake

According to the literature, different taste preferences influence the type of foods/beverages consumed by individuals of different ages, genders and races.[34] The findings from the current study indicated that taste had the greatest influence on the consumption/purchases of SSBs, possibly due to the fact that students have a strong preference for sweetness.

Price was the second most influential factor affecting the purchases/consumption of SSBs. A possible reason for this is that the majority of students who participated in this study lived away from home and studies have shown that students living away from home become more independent, are often on a budget and therefore take price into consideration when doing grocery shopping.[13] Since the cost of healthy foods and beverages is higher than the cost of energy-dense foods and beverages,[35] students generally resort to purchasing energy-dense foods. In South Africa, it has been found that a healthy diet costs about 69% more than an unhealthy diet, and if South Africans adopted healthy eating habits approximately 10–15% of their income would be spent on food.[36]

A significant proportion of students reported that they would purchase/consume SSBs less often if the price of the beverages increased and 17.8% reported that they would purchase/consume healthier alternatives. Other studies that have investigated the influence of fiscal policies on the consumption of SSBs have also found a positive relationship between price increases and consumption patterns.[37] Subsidising healthy food products while imposing taxes on unhealthy food products could be one of the many strategies that could steer consumers' dietary habits in a more positive direction.[37]

Limitations and recommendations

This study was of cross-sectional design; hence a longitudinal study should be conducted in order to gain a better understanding of the association between added sugar intake and BMI. Only undergraduate students attending one university were included in this study, thus more studies should be conducted among students from different universities in order to have a countrywide perspective of the added sugar intake of university students, and its influence on their BMI. Only a single 24-hour dietary recall was used to measure the total dietary energy intake. Single 24-hour dietary recalls are more appropriate to compare group intakes, and further research should make use of additional 24-hour dietary recalls in order to establish trends in the daily consumption of added sugars. In conjunction with analysing the frequency of consumption of added sugars, studies should also examine the amounts consumed. This study did not assess the physical activity levels of the students, thus future studies should focus on assessing the other determinants of BMI.

Conclusion

This study supports current knowledge and extends the latter in that university students are at risk for developing poor dietary and lifestyle behaviours that could negatively impact on their bodyweight and predispose them to the development of various non-communicable diseases. Various factors tend to influence such behaviours, therefore providing students with

health education prior to their admission, as well as during their tertiary education, could equip them with the necessary skills to enable them to make wise dietary choices throughout adulthood.

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