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Knowledge, Behaviour, Perceptions, Attitudes and Consumption Patterns of Sugar-sweetened and Artificially Sweetened Beverages Among University Residence Students

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Abstract

This study aimed to determine university students' nutritional knowledge, behaviour, perceptions, attitudes, and consumption patterns of sugar-sweetened beverages (SSBs) and artificially sweetened beverages (ASBs). This study was a cross-sectional study that made use of an online questionnaire. One hundred university students (n=100) living at a selected on-campus residence were recruited through convenience sampling to participate in this study. Overall, the university students had limited knowledge regarding SSBs and ASBs, whilst their behaviour, perceptions and attitudes towards SSBs and ASBs were not significantly different. Although the price and taste of beverages were the major determinants of whether the students purchased the beverages for both SSBs and ASBs. The sugar tax, which was imposed on the SSBs by the South African Government, made them more expensive than the ASBs, deterring the students from purchasing and consuming larger quantities of the SSBs compared to the ASBs. There seems to be a need for the provision of nutrition education to university students and behaviour and lifestyle interventions to reduce the high consumption of SSBs and thereby decrease the risk of health conditions associated with a high intake of sugar.

Keywords: Artificially sweetened beverage; obesity; overweight; sugar-sweetened beverage; sugar tax

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Introduction

Worldwide, there has been a rapid increase in overweight and obesity in developed and developing countries (Development and Initiatives, 2020). The World Health Organization (WHO) reported that in 2016, 39% of all adults were overweight and 13% of all adults were obese (WHO, 2021). Globally, between 2000 and 2016, there has been an increase in overweight (7.5%) and obesity (4.5%) in women. A similar trend is seen in men, with an increase in overweight (8.8%) and obesity (4.4%) (Development Initiatives, 2020). Similarly, in South Africa (SA), the prevalence of overweight and obesity has increased between 2012 and 2016. In and amongst South African men, the prevalence of overweight and obesity has increased from 20.1% to 20.3% and from 10.6% to 11%, respectively. On the contrary, the prevalence of overweight and obesity in South African women has increased from 24.8% in 2012 to 26.6% in 2016 and 39.2% in 2012 to 41% in 2016, respectively (National Department of Health and ICF, 2019, Shisana et al., 2013). Overweight and obesity are also prevalent among university students. A study conducted in 2012 among university students (n=289) in SA found that 30.5% of female students and 8.7% of male students were overweight and obese (Peltzer & Pengpid, 2012). Additionally, a cross-sectional study conducted at a South African university using 110 female undergraduate students found that the prevalence of obesity was 17.3% (Cohen & Gradidge, 2018). Likewise, another study conducted in 2016 at another South African university (n=387) found that 19.1% and 8.5% of all students (male and female) were overweight and obese, respectively (Nakhooda & Wiles, 2020). Similarly, a study conducted to determine the prevalence of obesity in a sample of 338 students aged 17-35 years at the University of Venda, found that 20% and 9.5% of the students (males and females) were overweight and obese, respectively (Chukwudi, 2016). These studies show that the prevalence of overweight and obesity is a health problem among university students and seems more prevalent in female than male students (Chukwudi, 2016; Peltzer & Pengpid, 2012; Nakhooda & Wiles, 2020). The high rates of overweight and obesity seen in university students are of concern as it increases their risk of non-communicable diseases (NCDs), such as cardiovascular disease, hypertension and diabetes mellitus (Escott-Stump, 2015). There are several factors contributing to the high rates of overweight and obesity seen in university students. However, the leading factor is the consumption of diets high in sugar and fat. Unhealthy energy-dense diets and a lack of physical activity can create an energy imbalance, resulting in overweight and obesity (Blüher, 2019).

The transition to university life often involves significant lifestyle changes, including living away from home and taking responsibility for one's dietary choices. This period is frequently marked by the nutrition transition, where students shift from traditional, generally healthier diets to more Westernised diets that are high in fat, processed foods, and sugary beverages, leading to unhealthy eating practices (Vadeboncoeur et al., 2015; Shankar et al., 2013). Additionally, university students tend to adopt more sedentary lifestyles, which, combined with poor dietary habits, contribute to weight gain and increased risk of obesity (Van den Berg et al., 2012; Van den Berg et al., 2013). Weight gain among university students is also linked to the

increased consumption of SSBs. A study by Madiba et al. (2017) on undergraduate oral health students in South Africa found that SSB consumption was high, particularly among students with poor knowledge and attitudes toward SSBs (Madiba et al., 2017). Similarly, a study in Bangladesh revealed that 95.4% of undergraduate students consumed SSBs, with more than half consuming them two or more times per week (Bipasha et al., 2017). While some studies, such as Warner & Ha (2017), found no significant relationship between knowledge and SSB consumption, they highlighted that taste was a primary factor influencing students' beverage choices. This finding aligns with research by Nakhooda & Wiles (2020), who also identified taste as a key driver of SSB consumption among South African university students. Despite recognising SSBs as a health risk rather than a benefit (Warner and Ha, 2017), students continue to consume them, contributing significantly to their daily calorie intake. These "empty calories" are a major factor in weight gain and obesity (Temple & Steyn, 2013; Te Morenga et al., 2013). A study from Jordan further confirmed a significant relationship between calories consumed and body mass index (BMI) among university students (Bawadi et al., 2019). To address the rising rates of overweight and obesity linked to SSB consumption, the South African government implemented a sugar tax in 2016. This tax is referred to as the Health Promotion Levy and imposes a charge of 2.1 cents tax per gram of sugar on beverages with added sugar exceeding 4 grams per 100 ml (National Treasury, 2016). Artificial sweeteners, used to replace added sugars and reduce calorie content, have been associated with health benefits, including a reduced risk of obesity, lower fasting blood glucose levels, and improved BMI (Peters et al., 2014; Blackburn et al., 1997; Imamura et al., 2015; Raben et al., 2002; Nichol et al., 2018). However, ASBs are not widely consumed by the general population and are primarily favoured by health-conscious individuals (Ndofirepi et al., 2020). The strong preference for sweet-tasting SSBs over ASBs continues to contribute to the development of NCDs (Ndofirepi et al., 2020). It is well accepted that consumers who have knowledge of the nutritional composition of foods will generally have better food choices, thus improving their diet quality and overall health (Wardle et al., 2000; Spronk et al., 2014). Research findings demonstrate that nutrition education can positively change food choices (Perez-Cueto, 2019). Lifestyle modification by incorporating healthier diet options would result in a decreased risk for NCDs (Perez-Cueto, 2019). This emphasises the important role that nutrition education has on healthy food choices and overall health status. Currently, there is a paucity of publications reporting on knowledge, behaviour, perceptions and consumption patterns of SSBs and ASBs among university students in SA and whether or not the SSB tax affects beverage choice, hence the aim of the current study.

Methodology

A cross-sectional descriptive study was conducted. University students' knowledge, behaviour, perception and consumption patterns of sugar-sweetened and artificially sweetened beverages were evaluated using a standardised online questionnaire. The online survey was carried out through Google Forms from June to August 2020. The survey invite was posted on the University of KwaZulu-Natal (UKZN) Notice System and emailed to students attending the Howard College campus (in Durban) only. Thus, all students residing at the UKZN Howard College campus on-campus residence at the time of the study who met the inclusion criteria had an equal opportunity to participate. The Howard on-campus residence was selected as a study site as it is the one campus residence that consists of students from different disciplines. The study design is presented in Figure 1. The Howard College on-campus residence of UKZN has a capacity (population) of 1798 students (both undergraduate and postgraduate). Ideally, a sample size of 315 students would represent a 95% confidence interval. However, during the time of data collection, there was a global pandemic (COVID-19); thus, not all students were staying at the Howard College on-campus residence at the time of the study. A total of 100 students were recruited by convenience sampling to participate in the study. The study participants were recruited from students who were allowed back onto campus residence and were residing at the Howard Campus on-campus residence at the time of the study. The university had reduced the number of students allowed to stay in the on-campus residences in accordance with the COVID-19 Lockdown Restrictions Regulations imposed by the South African Government. Approximately 5-10% of the usual campus residence students were invited back onto on-campus residence. This was the reason for a lower number of students recruited than initially calculated. Furthermore, the study sample represented the proportion of students who were allowed back on residence during Level Three Lockdown Restrictions in SA (the Lockdown Restrictions range from Level One (the least strict) to Level 5 (the strictest). The student population allowed back to on-campus residences was 90-180 students. Using a population of 135 (halfway between 90 and 180), the required sample size was 100 students (Kotrlik & Higgins, 2001).

The inclusion criteria were students between the ages of 18-40 years who studied at UKZN and were either undergraduate or postgraduate (Diploma, honours, masters and doctoral) students and resided at Howard College on-campus residence from all race groups and gender. The exclusion criteria were students allocated university residences by the Howard College on-campus of UKZN, but the allocated residences were off-campus, and students staying at university residences (both on-campus and off-campus) were allocated by the other campuses of UKZN. Students over 40 years of age, post-doctoral fellows, from other tertiary institutions, and those residing in private accommodation that the university did not provide (non-university residence) were not allowed to participate in the study. The rationale behind the exclusion criteria was that students staying at the off-campus residence or private accommodation were exposed to a different environment in terms of their living conditions and external influences, such as accessibility to shops due to the COVID-19 restrictions. As mentioned earlier, the Howard on-campus residence was selected as it is the one campus residence with students from several disciplines. There is a mixture of students with a health science background and those without a health science background. Post-doctoral fellows were excluded from this study as they do not represent the student population affected by changes in leaving home for the first time to live in a university residence. Postgraduate students are more mature and are likely to already have significant nutrition and health knowledge, which would not truly reflect the university student population affected by a nutrition transition.

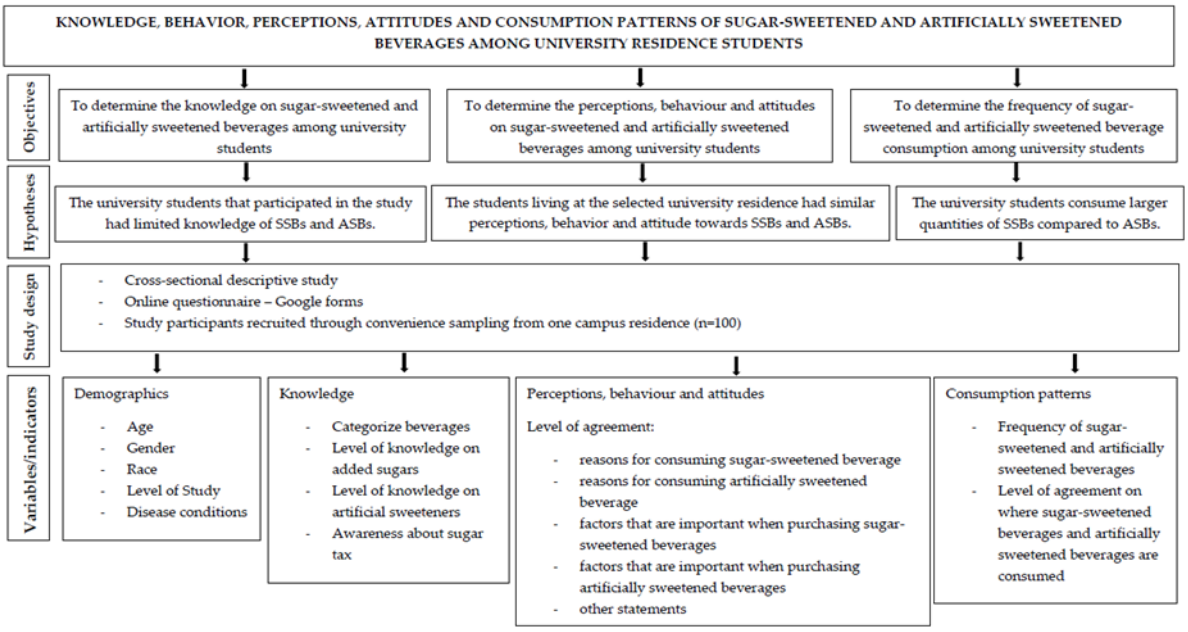

Figure 1. Study design

The lead researcher designed the questionnaire in English, and it was first validated by three experts in the field of nutrition and, thereafter, finally validated by the statistician. Subject-matter experts assessed the relevance of the questions to the study, while the statistician evaluated their alignment with the research objectives. Additionally, the statistician provided guidance on the design and application of the rating scales. The questionnaire was further tested during a pilot study to determine if the questions asked were appropriate and to identify if there were any glitches when answering the questionnaire online. The questionnaire was only available in English as that is the medium of communication at UKZN. The questionnaire was initially designed for face-to-face interviews and thereafter adapted to be answered online due to COVID-19 restrictions. Google Forms was the platform used to conduct the online survey. The questionnaire had four sections. The first section was to collect demographics (age, gender, race, level of study and if they suffered from any disease conditions) on the study population. The second section aimed to collect information on the students' knowledge of SSBs and ASBs. Before students answered the questions on their knowledge of SSBs and ASBs, they were provided with a definition for SSBs and ASBs. Students were required to first categorise different beverage types into "sugar-sweetened", "artificially sweetened", or "neither sugar-sweetened, or artificially sweetened", thereafter they indicated their knowledge of sugar additives and their awareness of sugar tax in SA. The third section determined the students' perceptions, behaviour and attitudes toward SSBs and ASBs. For this component of the questionnaire, students were required to indicate their level of agreement with several factors related to why they consumed SSBs and ASBs, which factors were important when purchasing SSBs and ASBs and some general statements. The last section was to determine the consumption patterns of SSBs and ASBs. Students first indicated how often they consumed SSBs and/or ASBs. Thereafter, they indicated how much was consumed by SSBs and ASBs, respectively. Lastly, they indicated their level of agreement on when they consumed SSBs and/or ASBs. The questionnaire consisted of 19 questions and largely made use of the Likert scale (Scale ranged from strongly agree to strongly disagree, i.e. 6-point scale). All but one question required students to select from alternative answers. This made the questionnaire more user friendly and prevented students from leaving the survey mid-way due to the questions being too long or taking too much time to answer. The online nature of the questionnaire allowed the students to only see certain questions based on their responses. For example, if students answered that they did not consume ASBs, all questions related to ASBs were not shown to the participant.

Before the main study, a pilot study was conducted to test the survey questions and the online process. Five university students studying at the UKZN from the Pietermaritzburg campus and residing in an on-campus residence were recruited by researchers to participate in the pilot study. This ensured that the students who participated in the pilot study did not participate in the main study, as only students who were residing at Howard College campus on-campus residence were allowed to participate in the main study. All participants clearly understood the questions, and answering the online questionnaire was user friendly. Thus, no changes were made to the questionnaire. It was established that the average time it took students to complete the survey during the pilot study was between 15 and 20 minutes. In terms of the main study, as stated earlier, students were recruited to participate in the study through an invitation that was posted on the UKZN Notice System. Students who met the study's inclusion criteria had to (according to instructions) click on the link to answer the online questionnaire. The study participants were required to read and give consent online before they could start completing the questionnaire. If a student gave consent, they were redirected to the questionnaire. Students were aware that they could leave the study at any time if they wished, with no negative implications for them. It was assumed that all students answered the questionnaire honestly and

without using the Internet. Before the questions on consumption patterns were asked, the students were first asked if they consumed SSBs. If students selected that they did not consume SSBs, the questions on SSBs did not appear when they were answering the survey, and they were redirected to the question that asked if they consumed ASBs and vice versa. If students consumed SSBs, only once all questions related to SSBs were answered, they were asked if they consumed ASBs. Relevant questions from Section 4 were asked together with questions from Section 3, depending on whether they consumed SSBs or ASBs. This ensured that students did not have to answer irrelevant questions and resulted in a higher response rate. Having an online survey also reduced bias as the research assistants did not influence students in any way. If students had any questions, they could contact the researchers via email. A researcher was always available on standby. For the current study, no queries were received. On completing the online survey, students submitted their completed questionnaire, which was collated on Google Forms. Participant responses were available to the researchers immediately after submission. Data was exported from Google Forms onto a Microsoft Excel spreadsheet and cross-checked for accuracy. The participant responses were coded and cross-checked by a second researcher to ensure there were no errors during the coding process. Thereafter data were analysed using the Statistical Package for Social Science® (SPSS) version 26. Appropriate statistical techniques, including the Binomial test, Wilcoxon signed-rank test and Chi-square test. A p-value of < 0.05 was considered to be statistically significant. Ethical approval was obtained from the UKZN, Humanities and Social Science Ethics Committee (HSSREC/00001254/2020). The UKZN Registrar issued a supporting letter to conduct the study online using Howard College on-campus residence students. The UKZN Notice System administrators granted clearance to place the invite on the university notice system. As stated previously, all participants gave consent online before beginning the survey.

Results

Demographic characteristics

Table 1 presents the demographic characteristics of the university students and indicates that the majority of the students were aged 18-25 years (n=80; 80.0%), were female (n=63; 63.0%), were of black ethnicity (n=89; 89.0%) and were studying toward an undergraduate degree (n=56; 56%). Approximately 76% of students answered "no" to having a pre-existing health condition. Only 24% of students indicated that they had one or more health conditions. Most of the students with health conditions suffered from overweight or obesity (n=18; 18%).

Table 1. Demographic characteristics of the study sample (university student study participants)

Characteristics	Category	n	%*
Age (n=100)	18-25 years	80	80.0
	26-34 years	15	15.0
	35-40 years	5	5.0
Gender (n=100)	Male	37	37.0
	Female	63	63.0
Race (n=100)	Black	89	89.0
	Coloured	2	2.0
	Indian	8	8.0
	White	1	1.0
Level of study (n=100)	Undergraduate degree	56	56.0
	Postgraduate diploma	19	19.0
	Honours degree	12	12.0
	Masters degree	13	13.0
Diagnosed with a disease condition**	Overweight or obesity	18	18.0
	Diabetes mellitus	0	0
	Hypertension	2	2.0
	High cholesterol	4	4.0

*Percentage of the sample (n=100)
**Diagnosed with disease condition did not sum up to 100% as some students were not diagnosed with any disease condition/s, and some had more than one disease condition. Only 24% of the study sample size reported being diagnosed with a health condition. The n only represents the number that answered yes to having that health condition. The remainder of the students answered no.

Knowledge of sugar-sweetened and artificially sweetened beverages

Table 2 presents the number of students who correctly and incorrectly classified different beverage types. Students were asked to categorise 11 different beverage types into 'sugar-sweetened', 'artificially sweetened' or 'Neither sugar-sweetened or artificially sweetened' (supplementary information S1). Statistical analysis was conducted on the data and was presented as correctly or incorrectly classified (Table 2). The binomial test was applied to each beverage type classification and results indicated that a large number of students correctly classified the following beverage types; diet soft drinks (n=64; 64%), water (n=84; 84%), regular soft drinks (n=61; 61%) and sugar-free energy drinks (n=62; 62%) ($p<0.05$). However, a large number of students incorrectly classified 100% fruit juice (n=72; 72%) and vitamin water drinks (n=75; 75%) ($p<0.05$). The study participants were asked to classify a total of 11 beverage types, which comprised of six SSBs, three ASBs and two beverage types that were neither SSBs nor ASBs. Of the total of six SSB types, three (50%) were classified correctly by more than 50% of the study participants. On the other hand, all three ASB types (100%) were classified correctly by more than 50% of the study participants.

Table 2. Students' knowledge of sugar-sweetened and artificial sweetened beverages (n=100)

Beverage types (n=11)	Correctly classified	Incorrectly classified	p value*
Squashes e.g. Jungle yum, Oros, Fusion	54[a] (54)[b]	46 (46)	0.484
100% fruit juice e.g. Liquifruit, Spar brand	28 (28)	72 (72)	**<0.0005**
Vitamin water drinks e.g. Glaceau	25 (25)	75 (75)	**<0.0005**
Diet soft drink e.g. Coke Zero, Coke Light	64 (64)	36 (36)	**0.007**
Milk drinks e.g. Yogi sip	58 (58)	42 (42)	0.133
Water e.g. Valpre	84 (84)	16 (16)	**<0.0005**
Regular soft drinks e.g. Coke, Fanta, Pepsi	61 (61)	39 (39)	**0.035**
Regular sports and energy drinks e.g. Powerade, Energade	43 (43)	57 (57)	0.193
Iced tea e.g, Lipton, Fuze	49 (49)	51 (51)	0.920
Vitamin water zero e.g Glaceau	53 (53)	47 (47)	0.617
Sugar free energy drinks e.g. Red Bull Sugar Free	62 (62)	38 (38)	**0.021**

[a] percentage of students, [b] number of students,*p-values < 0.05 is significant according to the Binomial test, which compared correctly classified to incorrectly classified.

Students' level of knowledge of added sugars and artificial sweeteners was investigated, and the results are presented in Table 3. The binomial test was applied to test if a significant proportion had or had not heard of each additive. The data from the categories for level of knowledge in Table 3 were used for the analysis. The category groups were Group 1 which means they have never heard of it [(a) I have never heard of it as an additive to beverages] and Group 2 which means they have heard of it but don't necessarily have any knowledge about it [(b) I have heard of it as an additive to beverages but don't know anything about it, (c) I have heard of it as an additive to beverages and know little about it and (d) I have heard of it as an additive to beverages and know a lot about it]. The results indicate that a large number of the students had heard of corn syrup (n=65; 65%) (p=0.004); fructose (n=80; 80%) (p<0.0005), nectar (n=75; 75%) (p<0.0005) and sucrose (n=81; 81%) (p<0.0005) but don't necessarily have knowledge on it. Thereafter the results of the study were grouped differently so that Group 1 means that they do not know anything about the additive [(a) I have never heard of it as an additive to beverages and (b) I have heard of it as an additive to beverages but don't know anything about it] and Group 2 means that they know something about the additive [(c) I have heard of it as an additive to beverages and know little about it and (d) I have heard of it as an additive to beverages and know a lot about it]. It was found that a significant number of students did not know anything about corn syrup (n=66; 66%, p= 0.002), dextrose (n=68; 68%, p<0.0005), evaporated cane (n=77; 77%, p<0.0005) and nectar (n=63; 63%, p=0.12). The binomial test was applied to test if a significant proportion had or had not heard of each artificial additive. The category groups were the same as for the sugar additive, Group 1 which means they have never heard of it [(a) I have never heard of it as an additive to beverages] and Group 2 which means they have heard of it but don't necessarily have any knowledge about it [(b) I have heard of it as an additive to beverages but don't know anything about it, (c) I have heard of it as an additive to beverages and know little about it and (d) I have heard of it as an additive to beverages and know a lot about it]. Results show that most of the students had never heard of aspartame (n=63; 63%, p=0.012), acesulfame k (n=67; 67%, p=0.001), sucralose (n=61; 61%, p=0.035), neotame (n=69; 69%, p<0.0005) and advantame (n=71; 71%, p<0.0005) which is concerning. When comparing the categories, Group 1 which means that they do not know anything about the additive [(a) I have never heard of it as an additive to beverages and (b) I have heard of it as an additive to beverages but don't know anything about it] to Group 2 which means that they know something about the additive [(c) I have heard of it as an additive to beverages and know little about it and (d) I have heard of it as an additive to beverages and know a lot about it], it was found that most students did not know about aspartame (n=79; 79%), acesulfame k (n=86; 86%), saccharin (n=84; 84%), sucralose (n=80; 80%), neotame (n=87; 87%), advantame (n=91; 91%), stevia (n=81; 81%) and xylitol (n=68; 68%) (p<0.0005).

Table 3. Percentage of students with a specified level of knowledge of added sugar and artificial sweeteners

Additives	Level of knowledge			
	a) I have never heard of it as an additive to beverages	b) I have heard of it as an additive to beverages but don't know anything about it	c) I have heard of it as an additive to beverages and know little about it	d) I have heard of it as an additive to beverages and know a lot about it
Added sugar				
Corn syrup	35[a] (35)[b]	31 (31)	27 (27)	7 (7)
Dextrose	41 (41)	27 (27)	20 (20)	12 (12)
Evaporated cane	45 (45)	32 (32)	16 (16)	7 (7)
Fructose	20 (20)	29 (29)	33 (33)	18 (18)
Nectar	25 (25)	38 (38)	25 (25)	12 (12)
Sucrose	19 (19)	20 (20)	27 (27)	25 (25)
Artificial sweeteners				
Aspartame	63 (63)	16 (16)	12 (12)	9 (9)
Acesulfame K	67 (67)	19 (19)	11 (11)	3 (3)
Saccharin	60 (60)	24 (24)	10 (10)	6 (6)
Sucralose	61 (61)	19 (19)	15 (15)	5 (5)
Neotame	69 (69)	18 (18)	9 (9)	4 (4)
Advantame	71 (71)	20 (20)	8 (8)	1 (1)
Stevia	58 (58)	23 (23)	13 (13)	6 (6)
Xylitol	49 (49)	19 (19)	15 (15)	17 (17)

[a] number of students, [b] Percentage of students

Perceptions, behaviour and attitudes of students towards sugar-sweetened and artificially sweetened beverages

A significant number of students consumed SSBs (n=97, 97%) and ASBs (n=89, 89%) (p<0.0005). Tables 4 and 5 indicate the perceptions, behaviour and attitudes of the students towards SSBs and ASBs. There is a significant agreement that taste is a reason that students drink SSBs and ASBs. However, there are students who significantly disagreed that they drink sugar-sweetened beverages because they are affordable, influenced by social media, peers, friends, colleagues, parents or the fact that they are healthy to drink. For ASBs, students strongly disagreed with statements such as:

- "I am influenced by my peers, friends, colleagues or parents"

- "I am influenced by what is written on social media (Facebook, Instagram, TV)"
- "I am brand loyal"
- "it is part of my lifestyle, and they are healthy to drink"

When it comes to SSBs students identified taste and cost as important factors in purchasing decisions. However strongly disagreed that peer pressure played a significant role in their choice of SSBs.

On the other hand, students significantly agreed that the taste and beverage cost were important factors when purchasing ASBs and significantly disagreed that peer pressure affected purchasing.

Table 4. Students perceptions, behaviour and attitudes towards sugar-sweetened and artificially sweetened beverages

Factors	Level of agreement or disagreement					
	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
Reason to drink sugar-sweetened beverages (n=97)						
I am influenced by my peers/friends/colleagues/parents	32[a] (32.0)[b]	35 (36.1)	6 (6.2)	11 (11.3)	6 (6.2)	7 (7.2)
I am influenced by what is written on social media (Facebook, Instagram, TV)	30 (30.9)	36 (37.1)	5 (5.2)	9 (9.3)	13 (13.4)	4 (4.1)
I like the taste	19 (19.6)	6 (6.2)	3 (3.1)	9 (9.3)	25 (25.8)	35 (36.1)
I am brand loyal	17 (17.5)	26 (26.8)	11 (11.3)	14 (14.4)	18 (18.6)	11 (11.3)
Sugar-sweetened beverages are affordable	18 (18.6)	25 (25.8)	16 (16.5)	14 (14.4)	16 (16.5)	8 (8.2)
It is part of my lifestyle	16 (16.5)	24 (24.7)	11 (11.3)	20 (20.6)	19 (19.6)	7 (7.2)
These beverages quench my thirst	19 (19.6)	14 (14.4)	12 (12.4)	20 (20.6)	18 (18.6)	14 (14.4)
They are healthy to drink	41 (42.3)	33 (34)	14 (14.4)	7 (7.2)	0 (0)	2 (2.1)
Important factors when purchasing sugar-sweetened beverages (n=97)						
Cost of beverage	7 (7.2)	15 (15.5)	16 (16.5)	12 (12.4)	21 (21.6)	26 (26.8)
Type of packaging	10 (10.3)	19 (19.6)	15 (15.5)	20 (20.6)	22 (22.7)	11 (11.3)
The taste of the beverage	4 (4.1)	5 (5.2)	12 (12.4)	8 (8.2)	26 (26.8)	42 (43.3)
Peer pressure	37 (38.1)	16 (16.5)	20 (20.6)	15 (15.5)	5 (5.2)	4 (4.1)
Reason to drink artificially sweetened beverages (n=89)						
I am influenced by my peers/friends/colleagues/parents	25 (28.1)	29 (32.6)	11 (12.4)	9 (10.1)	6 (6.7)	9 (10.1)
I am influenced by what is written on social media (Facebook, Instagram, TV)	33 (37.1)	20 (22.5)	7 (7.9)	12 (13.5)	10 (11.2)	7 (7.9)
I like the taste	6 (6.7)	9 (10.1)	6 (6.7)	17 (19.1)	33 (37.1)	18 (20.2)
I am brand loyal	23 (25.8)	19 (21.3)	8 (9)	14 (15.7)	16 (18)	9 (10.1)
Sugar-sweetened beverages are affordable	13 (14.6)	12 (13.5)	15 (16.9)	18 (20.2)	18 (20.2)	13 (14.6)
It is part of my lifestyle	20 (22.5)	21 (23.6)	8 (9)	20 (22.5)	13 (14.6)	7 (7.9)
These beverages quench my thirst	14 (15.7)	11 (12.4)	10 (11.2)	29 (32.6)	15 (16.9)	10 (11.2)
They are healthy to drink	30 (33.7)	16 (18)	12 (13.5)	16 (18)	4 (4.5)	11 (12.4)
Important factors when purchasing artificially sweetened beverages (n=89)						
Cost of beverage	7 (7.9)	6 (6.7)	13.5 (12)	17 (19.1)	23 (25.8)	24 (27)
Type of packaging	11 (12.4)	13 (14.6)	12.4 (11)	24.7 (22)	23 (25.8)	9 (10.1)
The taste of the beverage	8 (9)	3 (3.4)	9 (10.1)	15 (16.9)	27 (30.3)	27 (30.3)
Peer pressure	36 (40.4)	10 (11.2)	20 (22.5)	13 (14.6)	6 (6.7)	4 (4.5)

[a] number of students, [b] Percentage of students

Table 5. Mean and SD values for perceptions, behaviour and attitudes on sugar-sweetened and artificially sweetened beverages

Factors	Sugar-sweetened beverages (n=97)		Artificially sweetened beverages (n=89)	
	Mean ± SD	p value[a]	Mean ± SD	p value[a]
Reason to drink beverages				
I am influenced by my peers/friends/colleagues/parents	2.43 ± 1.547	**<0.0005**[b]	2.60 ± 1.624	**<0.0005**[b]
I am influenced by what is written on social media (Facebook, Instagram, TV)	2.49 ± 1.542	**<0.0005**[b]	2.63 ± 1.701	**<0.0005**[b]
I like the taste	4.24 ± 1.930	**0.005**[c]	4.30 ± 1.480	**<0.0005**[c]
I am brand loyal	3.24 ± 1.688	0.057	3.09 ± 1.749	**0.034**[b]
Sugar-sweetened beverages are affordable	3.09 ± 1.601	**0.015**[b]	3.62 ± 1.641	0.420
It is part of my lifestyle	3.24 ± 1.586	0.092	3.07 ± 1.636	**0.017**[b]
These beverages quench my thirst	3.47 ± 1.727	0.868	3.56 ± 1.574	0.577
They are healthy to drink	1.95 ± 1.093	**<0.0005**[b]	2.70 ± 1.729	**0.001**[b]
Important factors when purchasing beverages				
Cost of beverage	4.06 ± 1.657	**0.001**[c]	4.29 ± 1.546	**<0.0005**[c]
Type of packaging	3.60 ± 1.552	0.636	3.67 ± 1.550	0.302
The taste of the beverage	4.78 ± 1.452	**<0.0005**[c]	4.47 ± 1.538	**<0.0005**[c]
Peer pressure	2.45 ± 1.465	**<0.0005**[b]	2.49 ± 1.523	**<0.0005**[b]

[a] p-values < 0.05 is significant according to the Wilcoxon Signed Ranks Test which compared the level of agreement and disagreement for SSBs and ASB, respectively; [b] Significant disagreement; [c] Significant agreement

Table 6 presents the students' general perceptions about SSBs and ASBs.

Table 6. General perceptions about sugar-sweetened and artificially sweetened beverages

Factors	Level of agreement or disagreement								
	N/A	Strongly disagree	disagree	Slightly disagree	Slightly agree	Agree	Strongly agree	Mean ± SD	p value[a]
I check the content before purchasing sugar-sweetened beverages	3[b] (3)[c]	27 (27)	37 (37)	9 (9)	2 (2)	21 (21)	1 (1)	2.55 ± 1.514	**<0.0005**[d]
The sugar tax has not affected my choice of beverage that I purchase and consume	0 (0)	9 (9)	7 (7)	3 (3)	7 (7)	56 (56)	18 (18)	4.48 ± 1.480	**<0.0005**[e]
I check the type of artificial sweetener in artificially sweetened beverages before purchasing them	11 (11)	48 (48)	11 (11)	6 (6)	1 (1)	22 (22)	1 (1)	2.34 ± 1.725	**<0.0005**[d]
Consuming sugar-sweetened beverages has a negative impact on one's health	0 (0)	1 (1)	5 (5)	8 (8)	10 (10)	30 (30)	46 (46)	5.01 ± 1.227	**<0.0005**[e]
Increased consumption of sugar-sweetened beverages causes diabetes	0 (0)	0 (0)	10 (10)	0 (0)	7 (7)	53 (53)	30 (30)	4.93 ± 1.130	**<0.0005**[e]
Increased consumption of sugar-sweetened beverages causes weight gain that can lead to overweight and obesity	0 (0)	7 (7)	1 (1)	0 (0)	5 (5)	30 (30)	51 (51)	5.15 ± 1.329	**<0.0005**[e]
Artificially sweetened beverages are healthier than sugar-sweetened beverages	0 (0)	1 (1)	13 (13)	2 (2)	12 (12)	46 (46)	26 (26)	4.67 ± 1.303	**<0.0005**[e]

[a] p-values < 0.05 is significant according to the Wilcoxon Signed Ranks Test, which compared the level of agreement and disagreement for SSBs and ASB, [b] number of students, [c] Percentage of students, [d] Significant disagreement; [e] Significant agreement

The results indicate that students significantly disagreed with "I checked the content before purchasing sugar-sweetened beverages" and "I check the type of artificial sweetener in artificially sweetened beverages before purchasing them". A significant number of students agreed that "the sugar tax has not affected my choice of beverage that I purchase and consume", "consuming sugar-sweetened beverages has a negative impact on one's health", "increased consumption of sugar-sweetened beverages causes diabetes", "increased consumption of sugar-sweetened beverages causes weight gain that can lead to overweight and obesity" and "artificially sweetened beverages are healthier than sugar-sweetened beverages".

Consumption patterns of sugar-sweetened and artificially sweetened beverages

According to the Chi-square test, a significant number of students indicated that they consumed SSBs 1-2 times a week (n=45; 46.5%) and 3-4 times a week (n=31; 32%), p <0.0005, whilst a significant number indicated that they drank between 250 and 500 ml (n=49; 50.5%) of these beverages each time (p < 0.0005). On the other hand, a significant number of students indicated they consumed ASBs 1-2 times a week (n=58). Furthermore, most students consumed 125 to < 250 ml (n=32) and 250 to < 500 ml (n=23) (p<0.0005). Table 7 presents the time, occasions and location of consumption. The Wilcoxon ranks test was applied to determine a significant agreement and disagreement on the different times, occasions or locations of consumption of SSBs and ASBs, respectively. With regards to SSB consumption, students significantly agreed that they consumed SSBs "at home", "at university", "at residence", "with friends", "family functions, lunches or celebrations", "at a restaurant or with takeout", "on holiday", "on hot days" and "during excursions or outings". However, students disagreed to the consumption of SSBs and ASBs "on cold days" and "after gym or exercise". Additionally, students significantly agreed that they consumed ASBs "at home", "at university", "at residence", "with friends", "family functions, lunches or celebrations", "at a restaurant or with takeout", "on holiday" and "on hot days"

Table 7. Time, occasions and location of students' consumption of beverage

Time/occasions/locations of consumption	Level of agreement or disagreement							
	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree	Mean ± SD	p value[a]
Sugar-sweetened beverages (n=97)								
At home	7[b] (7.2)[c]	7 (7.2)	9 (9.3)	15 (15.5)	30 (30.9)	29 (29.9)	4.45 ± 1.534	**<0.0005[d]**
At university	7 (7.2)	19 (19.6)	4 (4.1)	6 (6.2)	35 (36.1)	26 (26.8)	4.25 ± 1.696	**<0.0005[d]**
At residence	7 (7.2)	15 (15.5)	9 (9.3)	4 (4.1)	30 (30.9)	32 (33)	4.35 ± 1.702	**<0.0005[d]**
With friends	3 (3.1)	9 (9.3)	7 (7.2)	16 (16.5)	35 (36.1)	27 (27.8)	4.57 ± 1.376	**<0.0005[d]**
Family functions/lunches/celebrations e.g. Christmas, braais, parties	6 (6.2)	4 (4.1)	9 (9.3)	11 (11.3)	35 (36.1)	32 (33)	4.66 ± 1.443	**<0.0005[d]**
At a restaurant or with takeout	4 (4.1)	8 (8.2)	5 (5.2)	15 (15.5)	35 (36.1)	30 (30.9)	4.64 ± 1.401	**<0.0005[d]**
On holiday	7 (7.2)	6 (6.2)	8 (8.2)	9 (9.3)	40 (41.2)	27 (27.8)	4.55 ± 1.493	**<0.0005[d]**
When I am stressed	13 (13.4)	18 (18.6)	8 (8.2)	16 (16.5)	16 (16.5)	24 (24.7)	3.84 ± 1.801	0.087
During test/exam time	20 (20.6)	13 (13.4)	8 (8.2)	16 (16.5)	16 (16.5)	24 (24.7)	3.69 ± 1.889	0.329
On hot days	10 (10.3)	11 (11.3)	7 (7.2)	13 (13.4)	29 (29.9)	27 (27.8)	4.25 ± 1.683	**<0.0005[d]**
On cold days	30 (30.9)	14 (14.4)	19 (19.6)	12 (12.4)	13 (13.4)	9 (9.3)	2.91 ± 1.702	**0.002[e]**
After gym/exercise	35 (36.1)	28 (28.9)	15 (15.5)	4 (4.1)	8 (8.2)	7 (7.2)	2.41 ± 1.560	**<0.0005[e]**
During excursions/outings	11 (11.3)	7 (7.2)	14 (14.4)	13 (13.4)	30 (30.9)	22 (22.7)	4.13 ± 1.637	**0.001[d]**
Artificially sweetened beverages (n=89)								
At home	12 (13.5)	11 (12.4)	4 (4.5)	10 (11.2)	31 (34.8)	21 (23.6)	4.12 ± 1.750	**0.001[d]**
At university	8 (9)	12 (13.5)	7 (7.9)	13 (14.6)	29 (32.6)	20 (22.5)	4.16 ± 1.630	**0.001[d]**
At residence	16 (18)	6 (6.7)	8 (9)	12 (13.5)	26 (29.2)	21 (23.6)	4.00 ± 1.803	**0.038[d]**
With friends	5 (5.6)	5 (5.6)	10 (11.2)	15 (16.9)	30 (33.7)	24 (27)	4.48 ± 1.431	**<0.0005[d]**
Family functions/lunches/celebrations e.g. Christmas, braais, parties	9 (10.1)	6 (6.7)	12 (13.5)	8 (9)	31 (34.8)	23 (25.8)	4.29 ± 1.625	**<0.0005[d]**
At a restaurant or with takeout	11 (12.4)	5 (5.6)	8 (9)	13 (14.6)	29 (32.6)	23 (25.8)	4.27 ± 1.657	**<0.0005[d]**
On holiday	11 (12.4)	7 (7.9)	11 (12.4)	9 (10.1)	29 (32.6)	22 (24.7)	4.17 ± 1.694	**<0.0005[d]**
When I am stressed	16 (18)	13 (14.6)	17 (19.1)	10 (11.2)	20 (22.5)	13 (14.6)	3.49 ± 1.726	0.748
During test/exam time	20 (22.5)	11 (12.4)	9 (10.1)	16 (18)	19 (21.3)	14 (15.7)	3.51 ± 1.804	0.910
On hot days	11 (12.4)	10 (11.2)	7 (7.9)	15 (16.9)	28 (31.5)	18 (20.2)	4.04 ± 1.671	**0.008[d]**
On cold days	30 (33.7)	11 (12.4)	17 (19.1)	12 (13.5)	15 (16.9)	4 (4.5)	2.81 ± 1.637	**0.001[e]**
After gym/exercise	29 (32.6)	19 (21.3)	10 (11.2)	11 (12.4)	9 (10.1)	11 (12.4)	2.83 ± 1.779	**0.001[e]**
During excursions/outings	17 (19.1)	12 (13.5)	9 (10.1)	11 (12.4)	26 (29.2)	14 (15.7)	3.66 ± 1.790	0.404

[a] p-values < 0.05 is significant according to the Wilcoxon Signed Ranks Test, which compared the level of agreement and disagreement for SSBs and ASB, respectively, [b] number of students, [c] Percentage of students, [d] Significant agreement; [e] Significant disagreement

Discussion

This study investigated the knowledge, behaviour, perceptions and consumption patterns of SSBs and ASBs among university students staying at an on-campus residence of a multi-campus university in SA. The results of the current study indicated that the students were able to classify several beverage types correctly. However, many students notably failed to classify 100% fruit juice and vitamin water drink. Although 100% of ASB types were classified correctly by more than 50% of participants, only 50% of SSB types were correctly classified by more than 50% of participants. Moreover, the students showed limited knowledge regarding added sugars, such as corn syrup, dextrose, sucrose, nectar, and fructose. They reported that they had heard about these added sugars, but they did not know anything about them. Additionally, the results showed that most students had no knowledge regarding artificial sweeteners. They reported that they had never heard anything, and they knew nothing about aspartame, acesulfame K, neotame, sucralose, saccharin, advantame, stevia and xylitol. On the contrary to the current study, a cross-sectional study conducted by Warner and Ha (2017) and another study conducted by Madiba et al. (2017) found that university students who participated in their respective studies had adequate knowledge regarding SSBs (Madiba et al., 2017). Additionally, a study conducted on Nigerian dental students found that they had a vast level of knowledge regarding SSBs (Fadupin et al., 2014). With regard to artificial sweeteners, the current study found similar results to a study that investigated university students' knowledge of artificial sweeteners, where participants had limited ability to identify artificial sweeteners (Wilson et al., 2019). The variation in the current study results, in terms of the students' knowledge of SSBs and sugar additives, compared to the other studies could be due to the difference in the academic background of students who

participated in the studies. The current study had participants from multiple disciplines, whereas the other studies focused on students of a Health Sciences background only. The fact that students had minimal knowledge of sugar additives and artificial sweeteners is of concern. It indicates that the students did not know what was in the beverages they consumed, which seems to have led to poor beverage choices. As alluded to earlier, being at university is a stage in the students' lives where they are given the opportunity to make their own food choices, and this may become overwhelming for them as they may be exposed to several environmental factors, which impact their food choice and could result in overconsumption of high sugar/artificially sweetened foods and thereby increase the risk of obesity and other related NCDs (Escott-Stump, 2015; Vadeboncoeur et al., 2015; Shankar et al., 2013; Blüher, 2019). It is also important to remember that other factors place individuals in a positive energy balance, resulting in obesity. These factors are lack of knowledge, socio-cultural, hunger, uncontrolled eating, peer pressure, snacking, no time for physical activity, studying environment or medication (Blüher, 2019) This emphasises that there is a need to provide nutritional education (including the general nutritional composition of a wide variety of foods and beverages) to university students, especially in the early years of study, to make healthier food choices. There is also a need for nutritional and behavioural interventions in addition to nutrition education, as education on its own is not enough to make a significant change in eating patterns.

The results of this study showed that the majority of the students consumed both ASBs and SSBs; however, SSBs were consumed by a higher percentage of the students sampled. This indicated that the sugar tax had no impact on their choice and purchasing of either beverage. It was stated earlier that a sugar tax had been imposed on SSBs by the South African Government and was in place during the time of the study. Surprisingly, there was no significant difference in the number of students who did not know anything about the sugar tax and those who were aware and knew something about it. This could be the reason for the observation that the students did not feel that the sugar tax had impacted their beverage choices and purchases. The current study results indicated that students regarded the taste and cost of beverages as important factors influencing their purchasing and consumption of SSBs and ASBs. Students perceived SSB consumption as the leading cause of overweight/obesity and type II diabetes. Despite students having the perception that consumption of SSB can lead to overweight/obesity and type II diabetes, they still consume them. Like with this study, several other studies indicated that taste was the main factor for the consumption and purchase of SSBs (Nakhooda & Wiles, 2020; Warner & Ha, 2017; Deliens et al., 2015; Bipasha et al., 2017). Sugar-sweetened beverages tend to be pleasurable to consume and usually contain sugar and caffeine, making them potentially addictive (Falbe et al., 2019; Anjum et al., 2018). Furthermore, frequent consumption of caffeinated SSBs can affect the typical physiological functioning of the brain and can cause psychomotor agitation, insomnia and headaches (Anjum et al., 2018). Caffeine generally decreases the production of nitric oxide, which is a vasodilator, thus reducing cerebral blood flow (CBF) (Bruce et al., 2002). While the effects of caffeine on endothelial function remain controversial, the diuretic effects of caffeine on CBF may be significant contributors to the development of headaches. Increased consumption of SSBs has been linked to an increased risk of overweight, obesity, type II diabetes mellitus and cardiovascular disease (Malik et al., 2006). Another factor that influences beverage choice is the cost, which was found in a number of other studies (Nakhooda & Wiles, 2020; Deliens et al., 2015; Bipasha et al., 2017). Regardless of the introduction of the sugar tax in SA, which increased the cost of SSBs, students of the current study still consumed more SSBs than ASBs. Here again, the lack of knowledge of the ingredients added to the beverages to impart the sweet taste could be the main reason for this choice. The goal for increasing the cost of SSBs was to reduce their purchase and consumption and ultimately reduce the prevalence of obesity in SA (National Treasury, 2016). Artificially sweetened beverages contain artificial sweeteners that are lower in calories and are used to replace added sugars in beverages and are seen as a preferred choice for individuals on a weight loss diet (Gardner, 2014). Reduced risk for obesity, body mass index and fasting blood glucose are some of the health benefits associated with the consumption of ASBs compared to SSBs. In addition to reducing the risk of NCDs it can also be cost effective in comparison to SSBs. The consumption of ASBs can aid in reducing the cravings for sugar as it helps one gradually decrease their sugar intake and their dependency on SSBs (Peters et al., 2014; Blackburn et al., 1997; Imamura et al., 2015; Raben et al., 2002; Nichol et al., 2018). However, increased consumption of ASBs also has health risks such as inability to manage weight, tumour development, glucose intolerance, which can affect the gut microbiome and an increased risk for type II diabetes and cardiovascular disease (Webb et al., 2020; Russell et al., 2020; Tayel et al., 2017). It is also interesting to note that ASBs have been linked with adiposity in Hispanic adolescents (Davis et al., 2018) and in children between ages 7 and 11 years (Laverty et al., 2015), which further indicates the health risks of ASBs consumption. While there is a health risk associated with artificial sweeteners, there is no clear evidence to demonstrate the role of ASBs on insulin secretion, indicating a need for long-term clinical trials in humans. Additionally, nutrition education on healthy beverage options and behaviour modification is needed to ensure students live healthy lives.

The current study results showed that the students consumed a larger amount of SSB (250ml-500ml) than ASB (125ml-250ml). Most of the students consumed SSB 3-4 times a week while they only consumed ASB between 1-2 times a week. The results also revealed that the majority of the students consumed SSBs while at home and at university residences, during holidays, during hot days, at family gatherings/celebrations and at restaurants. These findings are comparable with other SSB studies (Warner & Ha, 2017; Bipasha et al., 2017). There is a paucity of literature that compares the consumption of SBSs with the consumption of ASBs. Based on the results of the pattern of consumption of the SSBS and ASBS of the current study, a student takes in an equivalent of approximately 6 to 12 teaspoons of sugar from the consumption of 250 to 500 ml of an SSB/s. If the SSB/s were consumed four times a week, a student of the current study would take in an equivalent of approximately 24 to 48 teaspoons of sugar a week. The high sugar intake would contribute significantly to students having a positive energy balance, especially if they are leading a sedentary lifestyle which would result in overweight and obesity. This emphasises that

the high consumption of SSBs is likely detrimental to the health of the students, and there is a need for dietary modification and nutrition education regarding SSBs and ASBs to encourage healthier beverage choices. Students should be taught what healthier beverages and food choices are and how to modify their behaviour to incorporate them into their everyday lives. This would help to reduce overweight and obesity rates and encourage a healthy lifestyle.

Conclusions and recommendations

Overweight and obesity is currently a public health concern, especially in developing countries such as SA. The South African government has implemented strategies such as implementing a sugar tax to help reduce the consumption of sugar-containing beverages and reduce overweight and obesity. As part of this policy, every food with added sugar is taxed to minimise SSB consumption by the public, thus reducing the chances of excessive consumption, resulting in obesity. Although ASBs are relatively cheaper than SSBs, this study presented interesting findings. Students had limited knowledge regarding both SSBs and ASBs. There was high consumption of both SSBs and ASBs, with SSBs consumed in higher amounts. Despite the imposition of the sugar tax, the high consumption of SSBs by university students suggests that the sugar (SSBs) deterrence strategy did not work. The study was presented with some limitations. Due to the global COVID-19 pandemic and ethical restrictions, a limited number of students were on campus during data collection. Furthermore, no contact data collection was permitted. Only 100 students were recruited for the study due to these restrictions, and anthropometric data could not be collected. Anthropometric data would indicate a clearer picture of the perception and consumption patterns of SSBs and ASBs in relation to nutritional status. Additionally, to draw a more accurate conclusion on the behaviour, perceptions, attitudes and consumption patterns of university students in SA, this study could be conducted at different universities in the nine provinces in SA.

There is a need for an alternative, effective strategy, which is likely nutrition education and dietary and lifestyle modification, to tackle the risk for the development of overweight/obesity and other NCDs. Further, the results showed that students had limited knowledge of SSBs and ASBs, which further supports the need and recommendation for nutrition education for the student population studied and other student populations with similar dietary habits. The nutrition education being recommended should apply the principles of a food-based dietary guideline, "Use sugar and foods and drinks high in sugar sparingly", as well as reading food labels. Nutrition education should be presented on numerous platforms, including media, which has been proven to be a powerful tool in present times in persuading the public and changing their perception, attitude and behaviours. Social media platforms must be used to educate and provide individuals with accurate succinct information in a simple and understandable way. Nutrition education should be complemented by nutrition intervention strategies teaching individuals how to practically incorporate the information learnt into their daily lives. Future studies could be conducted to investigate if nutrition interventions, together with nutrition education, influence beverage choices among students. This type of nutrition education could also form part of curricula in the foundation phases of learning to help improve the health of young South Africans. Monitoring of the sugar tax policy and evaluating the impact on the South African population in terms of the consumption of SSBs and the obesity rate. Having more campus-based interventions where there is limited access to SSBs and ASBs and healthier alternatives at affordable prices, especially in vending machines.

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