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RESEARCH ARTICLE

Sugar-sweetened beverage intake and anthropometric profile of grade 6 learners in the Nelson Mandela Bay area, South Africa: a mixed-methods study

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Background: A paucity of data exists regarding the intake of sugar-sweetened beverages (SSBs) among children and the prevalence of childhood overweight and obesity in the Nelson Mandela Bay area in South Africa (SA).
Objective: To obtain anthropometric data (weight and height), describe the SSB intake, and explore perceptions regarding SSBs of Grade 6 learners attending quintile four and five public schools in the Nelson Mandela Bay (NMB) area.
Design: A mixed-method study with a convergent design was employed. The quantitative phase was a cross-sectional descriptive study with an analytical component. The qualitative phase followed a phenomenological approach.
Setting: Quintile 4 and 5 public schools in the NMB area.
Subjects: Grade 6 learners.
Outcomes measured: A self-administered questionnaire and focus-group discussions (FGDs) provided information on SSB intake and perceptions regarding SSBs. The anthropometric profile of learners was described.
Results: A total of 183 learners completed the questionnaire, of which 24.6% and 16.4% were classified as overweight and obese respectively. Soft drinks were the most consumed SSB, with 77.6% of learners reporting a frequency of one to four times per week. There was no statically significant relationship between BMI and SSB intake. There was a statistically significant positive relationship between sugar-free drinks ($p = 0.019$) and BMI. Learners had a high awareness of the negative health effects of SSBs, but this did not deter them from consuming SSBs.
Conclusion: A multi-sectoral approach including advocating for policy reform and the Health Promotion Levy, coupled with parent education, is recommended to reduce SSB consumption in children to curb childhood overweight and obesity in SA.

Keywords: body mass index (BMI), sugar-sweetened beverages (SSBs), Nelson Mandela Bay area, perceptions, overweight

Introduction

The WHO (2017) reported that nearly 124 million children between the ages of 5 and 19 years are affected by obesity globally,[1] with an estimated prevalence of overweight and obesity in Africa of 12.7%.[2] According to the South African National Health and Nutrition Examination Survey, 20–25% of SA children aged 2–14 years are overweight or obese.[3] The prevalence of overweight and obesity in the Eastern Cape province for the same age group is slightly lower at 12.4% and 3.7% respectively.[3]

Childhood overweight and obesity stems from a complex collaboration of several lifestyle, genetic, and environmental factors that negatively influence energy balance in the long term.[4,5] The consequences of childhood overweight and obesity are far reaching, as they can cause physical and medical health challenges, psychological dysfunction, decreased school performance, low self-esteem, and may affect a child's emotional and social well-being.[2,6,7–9] Coupled with the increased risk of adult overweight and obesity is the increased risk of adult-onset non-communicable diseases of lifestyle such as hypertension, type 2 diabetes, coronary heart disease, stroke, and asthma.[8]

There have been several contributing factors linked to childhood overweight and obesity; however, a major factor is the consumption of sugar-sweetened beverages (SSBs). The Centers for Disease Control and Prevention (CDC) defines SSBs as drinks comprising: 'regular soda, fruit drinks (including sweetened bottled waters and fruit juices and nectars with added sugars), sport and energy drinks, sweetened coffees and teas, and other sugar-sweetened beverages'.[4] These are beverages that have a high energy content but a low nutrient value due to the high amounts of sugar used. On average, a serving of 225 ml of an SSB contains more than 25 kcal or 100 kJ and more than two teaspoons of sugar. Systematic reviews and meta-analyses have found strong positive correlations between SSB intake and BMI in both children and adults.[5,10] A systematic review by Luger et al. (2017) found that 26 out of 30 studies had a positive association between SSB intake and BMI/weight in children and adults,[5] while another systematic review done by Keller and Della Torre (2015) found the same positive correlation in nine out of the 13 meta-analyses.[10] These findings suggest that the intake of SSB is associated with a higher BMI, which can increase the risk of developing non-communicable disease.

Momin and Wood (2018) reported an increase in SSB intake over recent years, specifically in children. This has now resulted in SSBs being a major contributor of added sugar and one of the main sources of calories in a child's diet globally.[4,11] According to the Healthy Active Kids South Africa Report Card of 2018, South African children consume more than four SSB portions a week, which was the highest of all the countries in the study.[12] With this increase in intake, research studies have been done to determine the factors that contribute to SSB consumption. Results revealed that the consumption of SSBs is complex and can be influenced by many factors, including family-related factors such as parenting practices and attitudes, accessibility and availability, school tuckshops, increased screen time, pocket money, and decreased physical activity, among others.[13–16]

Even though compelling evidence exists showing the effect SSB intake can have on BMI, some argue otherwise. Katzmarzyk et al. (2016) found no correlation between SSB intake and BMI in children between 9 and 11 years of age.[17] Therefore, the relationship between BMI and SSB intake remains unclear.[17] Another study conducted by Smith et al. (2020) in disadvantaged communities revealed that 18.7% of Grade 4 learners attending quintile 3 schools were overweight.[18] Due to paucity of data in more affluent communities in the NMB area, quintile four and five schools were included for this study. The objectives of the study were to obtain anthropometric data (weight and height), describe the SSB intake, and explore perceptions regarding SSBs of Grade 6 learners. attending quintile four and five public schools in the Nelson Mandela Bay (NMB) area. The study is reported in accordance with STROBE guidelines.

Methods

Study design, participants and setting

A mixed-method study with a convergent design was conducted in two phases. The quantitative part (Phase 1) was a cross-sectional descriptive study with an analytical component, and the qualitative part (Phase 2) followed a phenomenological approach.

The study population consisted of Grade 6 learners attending national quintile (NQ) 4 and 5 schools within the NMB area. The area and quintiles were chosen due to a paucity of data for children attending quintile 4 and 5 schools in the selected area. In addition, data on the SSB consumption of learners attending quintile 1 to 3 schools is available as reported in the International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE) (2013), but not for NQ 4 and 5 schools.[19] The quintile system is an education system in SA that classes schools and children into socioeconomic groups, with quintile 1 schools being the poorest quintile, and quintile 5 schools being the least poor.[20]

The inclusion criteria for schools were: (i) the school needed to be an NQ 4 or 5 school in the NMB area, and (ii) the school principal needed to grant consent to participate in the study. For learners participating in the study, the inclusion criteria were: (i) the learner should be in Grade 6 at an NQ 4 or 5 school in the NMB area; (ii) the learner needed to provide assent along with written consent from a parent/guardian, and (iii) the learner needed to be present on the day of data collection. Outcomes measured included anthropometric measures and the frequency of SSB intake.

Sampling of schools for phase 1

A list was received from the ECDoBE indicating that there were 47 NQ 4 and 5 schools in the NMB area. A sample size of 255 was needed to ensure an effect size of 0.05 and a level of confidence of 1.96. Assuming each school would have 70 Grade 4 pupils, four schools were sampled.

For Phase 1 a combination of random sampling and purposive sampling for schools was completed. Microsoft Excel's random generation function (Microsoft Corp, Redmond, WA, USA) was used for random sampling from the list provided by the Eastern Cape Department of Basic Education (ECDoBE). Owing to the COVID-19 national lockdown being in effect during data collection, many schools declined participation. Only one school provided permission through the random selection process and therefore purposive sampling was then employed to select the other three schools. Schools were approached one by one from the list provided by the ECDoBE. A total of four schools were included in the study.

Sampling of the learners for phase 1 and phase 2

All learners in the Grade 6 classes of selected schools were given the opportunity to participate in the study. Only those learners from the selected schools who handed in both the assent and consent forms were included in the quantitative part of the study. In total, 183 learners from the 4 selected schools met the above requirements.

The second phase (qualitative phase) of sampling commenced after completion of Phase 1. On the consent forms given to the parents/guardians of the children to complete, there was a separate section where they could consent to their child's participation in a focus group. Only those learners who had this section completed were considered potential focus-group participants. Only one school provided consent for focus groups to take place. At this school few parents provided consent for their child to participate in a focus-group discussion (FGD). Therefore, two focus groups with seven and five learners, respectively, were conducted from the one consenting school. After two focus groups all volunteers participated, and it was not possible to conduct more focus groups.

Data collection

Data collection was conducted between June and November 2022. Data collection included the completion of a self-administered questionnaire to obtain data on SSB intake and measuring of height and weight. A focus-group discussion guide was developed to explore perceptions regarding SSBs. The self-administered questionnaire used was adapted from a validated questionnaire used by Krukowski et al. to investigate SSB intake in children of a similar age group of 11–13 years.[19,21] Two registered dietitians assessed content validity of the questionnaire. The questionnaire was divided into three sections. The first section was a demographic section (age, gender, etc.), the second section was for the anthropometric measurements to be recorded, and the third section comprised questions regarding SSB intake.

Data were collected at the four different schools on the days and times agreed upon with each principal prior to the data-collection process. Data were collected during one half-day visit at each school. Prior to data collection, each of the principals was contacted to make an appointment. The data-collection procedure was explained to the principals as well as how privacy, confidentiality, and ethical standards would be upheld. This information was then shared by the principals with the teachers involved.

After conducting a pilot study, it was suggested by the school principal it would be more suitable to give the questionnaires to the teachers ahead of time to distribute to the learners to complete at a time most suited to them. This minimised

Table 1: Classification of SSBs into low, moderate, or high intake[21]

Intake category	Number of SSBs per week
Low intake	0 cups per week
Moderate intake	1–4 cups per week
High intake	≥ 5 cups per week

contact time with learners taking into consideration the COVID-19 restrictions that were still applicable during the time of data collection. It was not allowed to take home the questionnaires, which had to be completed in class during the week of data collection.

The self-administered questionnaires (SAQs), consent, and assent forms were distributed to the classes prior to data collection. The consent forms were given to the children by the class teachers to take to their parents to complete. Children had to return the consent forms within one week. The teacher kept the assent and consent forms in an envelope provided by the researcher. All questionnaires were completed in class under supervision of the class teacher. The PI collected the SAQs and consent forms and checked them for completeness. The PI was available in person at the school to answer any uncertainties during the completion of the SAQs.

On the day of data collection, the PI went to each class to determine how many of the consenting learners were present and to note any absentees. After the children completed the questionnaires, they were accompanied, one learner at a time, by the teacher to a separate area where each child's height and weight was recorded by the PI. Stature (referred to as height in the study) was taken with a Seca 213 portable stadiometer (Seca GmbH, Hamburg, Germany) and measured in cm, and mass was taken on a Seca 874 flat scale measured in kg. Stature was measured according to the following procedures: learners had to remove all shoes, socks, and headgear and the measurement was taken at eye level with the PI. This was repeated twice for accuracy.[22] Weight was taken on a Seca 874 flat scale that was calibrated prior to data collection. The measurement was taken according to the following procedures: learners had to remove all shoes, socks, items in their pockets, and any heavy clothing such as jackets. The weight for each child was taken twice; however, if there was more than a 0.5 kg difference, a third measurement was taken for accuracy with the average of the two closest weights being used as the learner's weight.[4] BMI was then calculated according to the following equation: $BMI = \frac{Weight}{Height^2}$. All anthropometric data were taken by the PI in a separate, private area on the school premises near the Grade 6 classrooms and away from the rest of the learners, to ensure privacy.

For the focus groups, the PI messaged each parent prior to the day concerned to inform them of the details of the focus group. The learners who agreed to be a part of the focus groups were given separate focus-group assent forms a week prior to the focus groups. Two focus groups were conducted at the one school that provided consent to conduct FGDs. The focus groups were conducted during class times on the school premises and were facilitated by the PI. A teacher was not present for the FGDs, but the children had met the PI when anthropometric measurements were taken. This helped to set the children at ease.

A discussion guide, reviewed by two registered dietitians, was used to guide the questions. The discussion guide used a semi-structured approach, with most questions being open ended, covering topics such as their thoughts on SSBs, their reasons why a learner should/should not drink SSBs, and their thoughts and ideas on SSB reduction strategies. Assent and consent forms for the focus groups were collected. The FGDs lasted 30–45 minutes and were voice recorded. A token of appreciation in the form of health snacks was given to each child who participated in the focus groups.

Table 2: Demographics and anthropometric profile of learners who completed the self-administered questionnaire ($n = 183$)

Characteristic	*n*	%	WHO normal ranges (BMI for age z-scores)
Gender			
Male	69	37.7	
Female	114	62.3	
Weight classification			
Thin	2	1.1	≥ −3 but < −2 z score
Normal	106	57.9	≥ −2 but < + 1 z score
Overweight	45	24.5	≥ + 1 but < + 2 z score
Obese	30	16.4	≥ + 2 z –score

Data analysis

Anthropometric data from the questionnaires were entered and analysed by the WHO AnthroPlus program (https://www.who.int/tools/growth-reference-data-for-5to19-years/application-tools). The data were then analysed to determine the percentage of learners who were thin, had a normal weight, were overweight, or obese, according to the WHO classification.[23]

The data from the questionnaires were cleaned and entered into Microsoft Excel and exported to STATISTICA® version 14 (TIBCO software, USA; https://www.statsoft.de/en/data-science-applications/tibco-statistica/) for analysis. Questionnaire data were analysed and presented as means ± standard deviation (if normally distributed), medians with interquartile ranges (IQR) (if not normally distributed), or as frequencies and counts, as appropriate. Summary statistics were used to define the characteristics of the study population. The relationship between BMI and frequency of sugar intake was analysed using appropriate analysis of variance (ANOVA). A *p*-value of less than 0.05 represented statistical significance in hypothesis testing and 95% confidence intervals were used to describe the estimation of unknown parameters. Table 1 provides the frequency of SSB consumption categories used for data analysis.

Focus groups were recorded and transcribed verbatim using thematic content analysis. The researcher listened to the recordings and transcribed each focus group verbatim in Microsoft Word. Once the transcription was completed, verification took place through the PI re-reading the transcripts twice to ensure accuracy and to allow the identification of content areas or 'codes'. Thereafter, coding and thematic content analysis were done manually by the PI using an inductive approach, grouping related content under the various 'codes'.[24] The research team discussed the codes until consensus was reached and the code list was finalised. Coded content was then used to identify themes and subthemes.

Results

From the 4 schools, 183 learners participated in Phase one and 12 learners participated in Phase 2 of the study. The average age of the study population was 11.08 years (SD ± 0.57). The mean BMI for the group was 20.8 kg/m^2. Most learners ($n = 106$; 57.9%) were classified as normal weight. Table 2 presents the demographic characteristics and anthropometric profile of the study population.

The most frequently consumed SSBs were fizzy soft drinks, with 77.6% ($n = 142$) of learners consuming fizzy soft drinks between one to four times per week and 13% ($n = 24$) consuming fizzy soft drinks five or more times per week. The SSBs with the lowest frequency of intake were energy drinks, with 57.4% ($n = 105$) of learners reporting they never drank energy drinks. Table 3 provides a summary of the frequency of weekly SSB intake. A statistically significant relationship ($p = 0.003$) between frequency of sports drinks and BMI was found. The highest BMIs were seen in the 0 times a week category, i.e. having sports drinks 0 times a week was associated with having a higher BMI. Although there were associations observed for some of the other beverages (i.e. diet soft drinks and sweetened coffee drinks) with BMI, these associations failed to achieve statistical significance.

The majority of learners ($n = 129$; 70.5%) indicated that they consumed one can or fewer of fizzy soft drinks a week and 16.9% of learners ($n = 31$) indicated that they drank more than one can of fizzy soft drinks a week (Table 4). The lowest quantity of SSB intake came from energy drinks. More than half (57.9%; $n = 106$) of learners indicated that they did not drink energy drinks at all.

The results from comparing the quantity of SSB intake and BMI showed two statistically significant findings regarding diet/sugar-free soft drink ($p = 0.019$) and sports drinks ($p = 0.003$). The results indicated that having more than one can of diet/sugar-free soft drink per week is associated with having a higher BMI while drinking 0 cups of sports drinks a week is associated with having a higher BMI.

Table 3: Frequency of SSB intake per week ($n = 183$)

Type of SSB	0 times	1–4 times	5 or more times	*p*-value*
		n (%)		
Fizzy soft drinks	17 (9.3)	142 (77.6)	24 (13.1)	0.564
Diet/sugar-free fizzy soft drinks	40 (21.9)	134 (73.2)	9 (4.9)	0.082
Sweetened coffee drinks	59 (32.2)	102 (55.7)	22 (12.1)	0.054
Energy drinks	105 (57.4)	72 (39.3)	6 (3.3)	0.954
Sports drinks	58 (31.7)	115 (62.8)	10 (5.5)	**0.003**
Milk (not in cereal)	29 (15.8)	116 (63.4)	38 (20.8)	0.912
Other sweetened beverages (iced tea, cordial drinks)	28 (15.3)	33 (72.7)	22 (12)	0.437
Water	6 (3.3)	48 (26.2)	129 (70.5)	0.991

*ANOVA test done with $p < 0.05$ indicating statistical significance between frequency of SSB intake and BMI.
The significance seen in sports drinks was found in the 0 times a week category; meaning the higher the BMI the less sports drinks were consumed.

Perceptions

Two focus groups were conducted with five and seven students respectively. Of the 12 learners who participated, 25% were male ($n = 4$) and 75% were female ($n = 8$). The main themes identified were perceptions of SSBs, factors influencing SSB intake, consequences of SSB intake, and suggestions for reducing SSB intake in children. Themes were identified through content analysis, then discussed with co-authors until consensus was reached. The focus groups were led by questions found in the FGD guide that was developed by the PI and co-authors. Each theme is discussed in greater detail in the sections that follow. Table 5 provides participant quotations supporting each of the primary themes and subsequent sub-themes.

In general, learners' perceptions of SSBs being unhealthy were high, with all learners in agreement that sugar and SSBs are unhealthy. The most mentioned examples of SSBs were soft drinks/fizzy soft drinks, with fewer participants mentioning mix-on juices, fruit juice, dairy-based drinks, energy drinks, and sports drinks. Learners' most perceived negative health effect of SSBs was the sugar content found in SSBs. Among the negative health effects associated with sugar, links with illness, weight gain, and poor concentration were the most frequently mentioned perceptions throughout the discussion.

Although learners were aware that SSBs are unhealthy, they agreed that they enjoyed the taste. Others felt it was the 'fizz' aspect that made them so attractive. Another important aspect mentioned was the 'functional' aspect of SSBs. Further discussions revealed that children had the perception that consuming SSBs had a 'functional' aspect in that they provide energy before participating in sport and physical activities. Overall, there was consensus among the learners regarding both the health aspects of SSBs and the enjoyment found in

Table 4: Quantity of SSB intake per week ($n = 183$)

Type of SSB (serving size)	I don't drink this	One serving or less	More than one serving	*p*-value*
		n (%)		
Fizzy soft drinks (can)	23 (12.6)	129 (70.5)	31 (16.9)	0.628
Diet/sugar-free fizzy soft drinks (can)	43 (23.5)	127 (69.4)	13 (7.1)	**0.019**
Sweetened coffee drinks (cup)	64 (35)	88 (48.1)	31 (16.9)	0.323
Energy drinks (can)	106 (57.9)	53 (29)	24 (13.1)	0.822
Sports drinks (bottle)	60 (32.8)	100 (54.6)	23 (12.6)	**0.003**
Milk (not in cereal) (cup)	34 (18.6)	96 (52.5)	53 (28.9)	0.408
Other sweetened beverages (iced tea, cordial drinks) (cup)	39 (21.3)	104 (56.8)	40 (21.9)	0.868
Water (cup)	6 (3.3)	24 (13.1)	153 (83.6)	0.962

*ANOVA test done with $p < 0.05$ indicating statistical significance between quantity of SSBs and BMI.
The significance seen in diet/ sugar free soft drinks was found in the "more than one serving" category; meaning the the more servings consumed weekly the higher the BMI.

Table 5: Representative quotations for each focus group question according to theme/subtheme

Theme	Subtheme	Quotation
Perceptions of SSBs	Risk of illness/health concerns	'Not good for your teeth … because of all the sugar in it' 'The more you drink it the more your body is not going to be happy, because it's too much sugar ma'am, and it is causing damage'
	Focus and concentration	'It has too much sugar in which can make us [children] hyperactive'
	Taste	'Ma'am I think I like it because it's sweet and it tastes nice' 'because it tastes, umm, better than water'
	Fizz	'[I like it because] it also has acid and it has a fizzy feeling'
	Attractive packaging	'I like it because it is colourful and looks nice'
	Price	'Joh, it is expensive ma'am'
	Provides energy	'Sometimes they drink it before they do sport so that they can be energetic' 'Because they know they are going to get energy from it and they like energy and they like the taste of it'
Factors that influence SSB consumption and choice	Price	'It can be too expensive for us to buy'
	Parents' purchasing decisions	'[The reason children might not drink SSBs] because their parents don't buy it' 'Their parents don't allow them and there are consequences if they do drink them [SSB]'
	Taste	'Some learners don't like it because it is too sweet' 'They like the taste – it is the main reason children buy it!'
	Gut concerns	'They could have a sensitive tummy … sensitive to too much sugar' 'They have a weak tummy'
	Disease conditions	'They might have an illness, ma'am, like diabetes'
	Healthy lifestyle	'They don't want to live an unhealthy life' 'Because they know it is unhealthy'
	Dieting	'Some people are dieting; they want to get their body nice'
	Poor concentration in class due to hyperactivity	'They can't have a lot of sugar … because it's going to make them hyperactive' 'The parents and teachers are going to have a hard time dealing with the children [because they are hyperactive]' 'Because it's [sugar] … . It can like, it doesn't make you concentrate in class'
Consequences of high intake level of SSBs	Weight gain	'It's [SSB] going to make you fat' 'Because it's [sugar] … . It can like, it makes you fat' 'Because ma'am if your body has too much sugar in it changes into fat and cause you to gain weight'
	Unhealthy for you	'It's unhealthy for you … because it has too much sugar' It has too much sugar and it gives you a lot of energy and then burns out quickly' 'It can cause tooth decay because of the sugar'
	Poor concentration	'It gives you too much energy ma'am … you aren't able to concentrate' 'Because it's [sugar] … . It can like, it doesn't make you concentrate in class'
	Cause illness	'It's going to make you sick like diabetes'
Suggestions for reducing SSB intake in children	Reduce cost of water	'Make water a cheaper price'
	Make water accessible and exciting	'Make a water tank that has like a face and the mouth is the water that all learners can use that is free'
	Educate on importance of water	'Illustrate [picture] something that you are showing the importance of water'
	Educate on why SSBs are unhealthy	'We tell them more facts about what sugary cooldrinks do to you' 'We would tell them that it is unhealthy, and it makes your immune system weaker and it can cause some diseases'
	Reduce sugar in SSBs	'Dilute fizzy cooldrinks like Sprite with water to reduce the sugar'
	Limit access to SSBs	'Reduce amount of cooldrinks the tuckshop sells'

drinking SSBs due to the taste, fizziness, and energy they provide.

When learners were asked the following questions: 'Why do you think children drink sugary drinks?' and 'Why do you think some children do not drink sugary drinks?' their answers related to factors that influenced their/other learners' consumption of SSBs. The main subthemes emerging from the discussions that could influence SSB consumption were led by taste, followed by health, access to SSBs, weight, and the type of function/purpose SSBs provide. Most learners mentioned that taste, mainly contributed by sugar, plays a huge role in the decision to consume or not to consume SSBs. 'They like the taste – it is the main reason children buy it!' One participant mentioned: 'I think I like it because it's sweet and it tastes nice'. Another noted: 'Some learners don't like it because it is too sweet'.

Another theme that emerged from the discussion was health-related factors. Learners noted that health conditions such as diabetes or sensitivity to sugar or simply wanting to lead a healthy lifestyle might influence the number of SSBs children consume. Access, relating to parental control practices, was also mentioned as a factor that would influence consumption. Learners mentioned that if parents were strict and did not allow SSBs or did not buy SSBs to keep in the home, it would limit the number of SSBs a child could consume. Weight and dieting were also factors. According to the learners, if a child were dieting to lose weight, he or she might decide to drink fewer SSBs because of the amount of sugar in these beverages. Many learners also mentioned the potential negative impact of SSBs on concentration in class. The sugar content could decrease concentration and cause them to become hyperactive in class.

When learners were asked, 'How do you think we can help children to drink fewer sugary soft drinks?' they made a few suggestions. The main suggestion revolved around promoting water intake. The learners believed that by promoting water, it would encourage children to increase their water intake. This would then hopefully decrease their SSB intake in the process. A suggestion was made that learners' awareness of the importance of water intake should be strengthened.

However, a key point that was made was that whatever strategies are used, they need to be fun, creative, and visual versus using words or lectures. They believe that learners will respond better to this type of format. A further suggestion was that water should be freely available or at a reduced cost.

Another suggestion was to try reducing the access children have to SSBs by limiting the number of SSBs tuckshops sell or by creating fun ways to reduce the amount of sugar found in SSBs. One learner mentioned: 'Reduce the amount of soft drinks the tuckshop sells'. It seemed that increasing learners' awareness and knowledge of the unhealthy aspects and health consequences of consuming SSBs was also one way of reducing SSB intake. Other learners felt it might not be possible to reduce access to or reduce intake of SSBs, and therefore focus should be placed on reducing the sugar content of SSBs.

Discussion

The objectives of the study were to obtain anthropometric data (weight and height), and describe the SSB intake, of Grade 6 learners attending quintile 4 and 5 public schools in the Nelson Mandela Bay (NMB) area. Qualitative methods explored learners' perceptions related to SSBs.

Anthropometric measurements showed that the majority of learners in this study were found to have a normal BMI, while 24.5% were classified as being overweight ($n = 45$) and 16% as obese ($n = 30$). These statistics correlate with a local study done by McKersie and Baard that found 20.9% and 9.8% of children between the ages of 7 and 10 years in the NMB area were classified as being overweight and obese respectively.[25] Similar to the study done by McKersie and Baard (2014), our study's statistics are also nearly double those of the provincial statistics for prevalence of overweight. The Eastern Cape's statistics for overweight and obesity in children aged 2–14 years are 12.4% and 3.7% respectively. South African statistics report a slightly higher prevalence of 20–25% for overweight and obesity in South African children.[3]

Overall, this study showed a moderate intake of SSBs according to the criteria of Hebden et al (2013).[13] Compared with the average intake of four portions of SSBs per week found in the Healthy Active Kids South Africa Report Card,[12] the participants in this study had a similar intake of SSBs on a weekly basis. It was encouraging, however, to see that 70.5% of students consume water more than five times week.

There have been mixed results from other studies in children globally with respect to the relationship between sugar-sweetened beverages and BMI. Our results are similar to those reported in a study done by Katzmarzyk et al. (2016) that found no association between SSB intake and children living with obesity between 9 and 11 years of age.[17] Eney et al. (2017) compared BMI and SSB intake within sets of twins and compared this between sets of twins.[26] The study found a strong statistically significant relationship between BMI and SSB intake between sets of twins but that the relationship was greatly reduced to no statistical relationship when comparing within sets of twins.[26]

The present study found that there were two statistically significant relationships between BMI and SSB intake. Contrary to what would be expected, higher BMIs were seen in learners who consumed sports drinks 0 times a week and those who had more than one can of diet/sugar-free soft drink per week. No cause-and-effect relationship can be determined at this time to explain why this occurred. A positive correlation was found between sugar-free (diet) soft drink consumption and BMI. Since sugar-free (diet) soft drinks contain no sugar or calories, it was surprising to see this result. Other studies, however, have also reported similar results. Artificial sweeteners are used widely to replace caloric sugar as one of the strategies to lessen caloric intake.[27] However, the association between the risk of obesity and artificially sweetened soda consumption is controversial. A systematic review conducted by Azad et al. (2017) found a positive correlation between non-nutritive sweetener intake (commonly found in SSBs), long-term weight gain, and an increase in BMI.[27] Similarly Katzmarzyk et al. (2016) reported a statistically significant relationship between sugar-free (diet) soft drink intake and BMI in children between 9 and 11 years of age.[17]

It may be that because some learners are overweight or obese, they drink sugar-free beverages to try to control their weight gain or to assist with weight loss. This could be their own choice or that of their parents. There is also a possibility that these learners had a high consumption of other energy-dense food items or had low physical activity levels in conjunction with having a high intake of diet soft drinks. These factors were not assessed in this study and therefore cannot be excluded as a possible reason. Another possible explanation for the association could be a link between non-nutritive sweeteners and weight gain.[28] A systematic review and meta-analysis by Ruanpeng et al. (2017) demonstrated a significant association between sugar and artificially sweetened soda consumption and obesity.[29] Similarly, studies have shown that a high intake of non-nutritive sweeteners could lead to a hyperinsulinemia response, microbiota dysbiosis, and an increased calorie intake, which ultimately can lead to weight gain and insulin resistance.[29,30] Further research is required to fully explain this association.

The main findings from the qualitative study found that learners had a high level of awareness of the unhealthy aspects of SSBs, specifically of sugar. This could possibly be due to social media, family and peer influence, or education at school. Similar results were seen in a study conducted by Battram et al (2020).[31] and Roesler et al (2021).[32] What was found in the present study was that though there was a high level of awareness, it did not often deter learners from consuming SSBs. This could be due to many learners enjoying the taste and sensation of SSBs. It appeared that taste outweighed the known negative health aspects. Similarly, in a study done by Teng et al. (2020), results showed that a high level of awareness of the negative health effects of SSBs did not act as a preventative tool to reduce SSB intake.[33]

There are also other factors that can affect a learner's consumption of SSBs, such as price, accessibility, health, and even dieting. This is in line with many other studies of factors that contribute to SSB consumption.[13–15] In respect of accessibility, learners felt that having a parent who bought SSBs or who allowed SSBs to be consumed would result in an increased intake of SSBs. Having parents who did not buy SSBs or disapproved of SSB consumption would result in lower consumption. This indicates that parents and their purchasing decisions play a significant role in the frequency and quantity of SSB intake of their children. This was also seen in a study conducted by Bogart et al (2020). The study showed that children whose parents purchased and consumed SSBs frequently were three times more likely to drink SSBs regularly compared with children whose parents did not drink SSBs frequently.[15]

Accessibility of SSBs in the school environment was also a factor influencing SSB consumption. This correlates with numerous studies indicating the harmful effects of SSBs sold in canteens (tuckshops) globally, with carbonated drinks being the number one sold drink in South African tuckshops.[13,34] Therefore, this information shows that by creating an environment whereby there is reduced accessibility and availability, it could help reduce the overall consumption of SSBs. Parents should be educated on the harmful effects of SSBs, and the importance of leading by example and reducing the accessibility of SSBs in the home. However, addressing parents alone is not the answer. A multi-sectoral approach would provide the best possible outcome by including the government, schools, and parents. Schools need to be taking action not only to reduce the number of SSBs sold in tuckshops, but to make heathy drinks such as water a more affordable option for learners.[13,15]

The presence of health risks/conditions that could prevent their drinking SSBs was explained. Many learners noted that having weak stomachs or diseases such as diabetes would deter some learners from consuming SSBs due to the sugar content. This factor was not frequently mentioned in similar studies. However, Battram et al. (2020) found that although it was not a common factor, learners in their study noted that health conditions did impact their SSB intake.[31] Learners believed that if a learner was dieting, he/she would not drink SSBs due to the possible effect on weight gain. With the average age of the children being 12 years, dieting was not an expected contributory factor to SSB consumption. Although commonly seen in links between adults and consumption of SSBs, it is concerning to see that learners are reporting dieting at such a young age.

Learners believed that through education on the consequences of consuming too much sugar (seen in SSBs), it would be possible to reduce SSB consumption. However, the execution of such education needs to be done in a way that is fun, relatable, and creative, and that includes visual aids and tools. This is exactly what has been found in other studies: that education is important, but how it is implemented is the key to its success.[31] Although the environment in which this should be done was not discussed, it can be gauged from other studies that the school environment has been shown to be most conducive.[31,32]

One of the strategies mentioned by the learners was to reduce the amount of sugar in SSBs. This is a strategy currently being implemented in South Africa with the Health Promotion Levy[35] in line with the WHO strategies to prevent obesity.[1] By increasing the percentage of tax charged on SSBs according to sugar content, it will increase the price of SSBs and hopefully cause a reduction in SSB consumption.[35] It can also be used to force SSB companies to reduce the amount of sugar added to SSBs or to decrease the volume to prevent a price increase.[35]

This study has several strengths. The first is that it is a mixed-method study design, including both qualitative and quantitative data. This is an uncommon methodology used in examining SSB intake of primary school learners. The perception of learners provides a novel contribution to a research area in which quantitative methods are mostly used. Very few studies have investigated the relationship between SSB intake and BMI in primary school learners in South Africa.

The study highlights the need for a multi-pronged approach including advocating for policy reform and healthy school food policies, fiscal measures such as the Health Promotion Levy, as well as parent education to curb the obesity pandemic among young children. Qualitative results provided insights into how children perceive the intake of SSBs. These results can inform the development of healthy school food policies to ensure a supportive environment for children at school.

The authors acknowledge that the study has some limitations. The main limitation of this study was the small sample size. The data collection took place during the peak of the COVID-19 pandemic and therefore there were many obstacles in acquiring the recommended sample size. Only two FGs could be conducted; however, this was sufficient to obtain saturation. With regard to the sample size, one other limitation was that it focused on only one socioeconomic group, thus the results cannot be generalisable. The study design, being cross-sectional, mitigates against any cause–effect interpretation. This can increase the risk of reverse causation seen in the study. The SAQ was also not formally validated for the South African context. The food frequency questionnaire (FFQ) used was self-administered, which could have allowed for respondent bias that could not be accounted for in the study. It could also have led to children misunderstanding questions and not answering the questions correctly. In addition, it did not include a diverse range of questions relating to total dietary intake, exercise, or other obesogenic factors.

Conclusion

This study showed that learners had a moderate intake of SSBs with the average intake being one to four times week. Despite the moderate intake a high prevalence of overweight and obesity was found. The results of the study did not find statistically significant associations between intake of SSBs and overweight and obesity in this study. However, there was a relationship between sugar-free soft drinks and BMI.

Further studies are needed to better understand the relationship between diet/sugar-free soft drinks and BMI in children. Studies with a larger sample size across various national quintile schools within SA are also needed to have a better understanding of the association between BMI and SSB intake. The perceptions of learners indicated that though there was a high level of awareness regarding the negative health effects of SSBs, it did not appear to deter them from consuming SSBs. Rather, behavioural changes need to be addressed through focusing on access and availability and by focusing on other strategies mentioned by the learners, to have a more significant outcome in reducing SSB intake in primary school children.

Even though this study focused mainly on the effects of SSBs on BMI, SSBs have many negative health effects, including dental cavities and increased risk of type 2 diabetes and heart disease. Therefore, the need for reduction of this high intake of SSBs cannot be based on their link with BMI only, but also with their effects on overall health.

Declaration – All authors are in agreement with the manuscript and declare that the content has not been published elsewhere.

Ethical approval and consent – The study was granted ethical clearance by Stellenbosch University's Health Research Ethics Committee (ref. no. S20/09/257) and the Eastern Cape Department of Basic Education, and consent was given by each of the school's principals that participated in the study. Every child who participated signed an assent form while every parent whose child participated in the study signed a consent form. Participants were under no obligation to participate in the study.

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