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# Consumption patterns of sugar-sweetened beverages among tertiary institution students in Abeokuta, Nigeria and their association with the risk of developing type 2 diabetes using FINDRISC

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## ABSTRACT

**Background:** Increased consumption of Sugar-Sweetened Beverages (SSBs), with overweight and obesity have been associated with the risk of developing type-2 diabetes mellitus (T2DM). **Aims**: This study was aimed at assessing the pattern of consumption of SSBs and factors associated with the risk of developing T2DM within ten years among emerging adults in Abeokuta, (Nigeria). **Methods:** A cross-sectional survey of 350 students in public tertiary institutions in Abeokuta was undertaken using stratified random sampling. Data on SSBs consumption pattern and risk of developing T2DM was obtained using validated questionnaire. Height, weight and waist circumference (used to assess abdominal obesity (AO) were measured using standard procedures. Body mass index (BMI/BMI-for-age) was calculated. Fischer's exact test and binary logistic regression were employed to test for associations among variables. **Results**: Most (62.9%) of the respondents were female and within the age-range of 20-24 years. Carbonated drinks were the most commonly consumed SSB (99.7%). Participants consuming carbonated drinks more than twice weekly had higher rate of overweight (27.3%) and obesity (12.0%). Consuming fruit drinks (OR = 15.2, 95% CI = 1.971, 117.400), malt drinks (OR = 3.2, 95% CI = 1.862, 5.571), and other beverages (OR = 2.9, 95% CI = 1.293, 6.899) more than twice weekly increased the odds of developing diabetes. **Conclusion**: The high prevalence of SSB consumption among the study population highlights the need for interventions to reduce consumption and mitigate associated health risks, including overweight, obesity, and T2DM.

**Keywords:** Sugar-sweetened beverages, overweight, abdominal obesity, type 2 diabetes, risk factors.

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## 1 Introduction

Sugar-sweetened beverages (SSBs) refer to drinks with added sugar such as carbonated drinks, energy drinks, flavored juice drinks, non-diet soft drinks and beverages (Fadupin et al., 2014; Madiba et al., 2017; Ahmad et al., 2019; Scharf & DeBoer, 2016) and are the principal source of added sugars in the diet (Malik & Hu, 2019). The consumption of SSBs among various populations in both developing and developed countries is on the rise, especially among young individuals (15 - 24 years) and emerging adults (18-29 years) (Bleich & Vercammen, 2018; Fadupin et al., 2014; Lebel et al., 2016; Madiba et al., 2017; Nakhimovsky et al., 2016). This demographic often relies on SSBs to meet their nutritional needs rather than consuming regular meals. The reasons for SSB consumption and the patterns of intake vary across different population groups. However, this variation significantly contributes to increased body weight and elevated blood glucose levels among consumers (Huang et al., 2017; Luger et al., 2017). The rising consumption of SSBs among young people and emerging adults, coupled with unhealthy lifestyle practices, not only increase the risk

of overweight and obesity but also increases the likelihood of developing diabetes and other diet-related non-communicable diseases (NCDs) in adulthood. Diabetes, the fourth leading NCD globally, is responsible for 1.5 million deaths annually with a higher prevalence in low- and middle-income countries (Bhattacharya et al., 2023). Diabetes is identified as the leading cause of premature death and disability, increasing the risk of cardiovascular diseases, renal diseases, blindness among other conditions (Aynalem & Zeleke, 2018; Okur et al., 2017).

Diabetes mellitus is a significant global health burden, with direct mortality reaching 1.5 million individuals worldwide in 2019. Notably, 48% diabetes-related deaths occurred before the age of 70, underscoring the premature nature of this disease. Lower- and middle-income countries have witnessed a concerning rise in diabetes-induced mortality rates (Bhattacharya et al., 2023). In Nigeria, the prevalence of diabetes stands at 6.8 % and 7.5 % for females and males, respectively (Global Nutrition Report, 2022). Scharf and Deboer (2016) and Malik and Hu (2019) found that increase in the intakes of SSBs increase energy intakes, thereby contributing to increased body weight and hence promotes the risk of developing T2DM in later years. Studies have consistently revealed strong relationship between consumption of sugar-sweetened beverages and general obesity (Bleich & Vercammen, 2018; Elliott-Green et al., 2016; Veerman et al., 2016; Eykelenboom *et* al., 2019).

Additional risk factors for diabetes include age, family history, diets high in sugar, overweight and general obesity, abdominal obesity and physical inactivity (Malik & Hu, 2019; Bhattacharya et al., 2023; Papier et al., 2017). Several of these risk factors can be modified through behavioral changes, such as adopting a healthier diet. In addition, the studies of Gudjinu and Sarfo (2017) and Imamura et al. (2015) showed that the rise in diabetes is largely driven by these modifiable risk factors including high consumption of foods and beverages containing added sugars, overweight and obesity, as well as physical inactivity.

While most studies on risk of developing T2DM in Nigeria have focused on older adults (Oladoyinbo et al., 2019; Akinbule et al., 2021) the declining age of onset has made this disease increasingly prevalent among young people and emerging adults. Many behavioral factors contributing to T2DM development are established during adolescence and early adulthood, often neglected during these stages (Oladoyinbo et al., 2019). Information arising from this study will inspire intervention programs targeted at changing the behaviors of young people and emerging adults to a healthier behavior which will promote healthy body weight and hence, reduce their risk of developing T2DM in their adulthood sustainably, and hence morbidity and mortality associated with diabetes. Such information will also be valuable for dietary counselling and clinical diabetes management. Hence, this study seeks to evaluate the consumption patterns of sugar-sweetened beverages and associated risk factors for T2DM development within ten years among young people and emerging adults.

# 2 Methods

## 2.1 Study design

This study employed a descriptive cross-sectional design.

## 2.2 Study Population

The study population consisted of students registered in the public tertiary institutions in Abeokuta (Nigeria) who were adolescents and young adults, and within the age-range of 15 – 29 years. Abeokuta is the capital, and the largest city in Ogun State, Southwest, Nigeria. It is located in the 7°09′–7°39′ E and latitude 3°20′–3°54′ N, on the east bank of the Ogun River, around a group of rocky outcroppings that rise above the surrounding wooded savanna (Taiwo et al., 2023). The primary source of livelihood is farming, stone quarrying, and the making of indigo tie and die textile popularly known as *adire*. Abeokuta is made up of three local government areas known as Abeokuta North, Abeokuta South and Odeda local government areas. In addition, there are three public tertiary institutions in Abeokuta which include: Federal University of Agriculture, Abeokuta (FUNAAB), Moshood Abiola Polytechnic (MAPOLY), and Federal College of Education, Abeokuta (FCE).

## 2.3 Sample size determination

The sample size was determined using Yamane's formula (1967):

$$n = \frac{N}{1+N(e)^2}$$

N (population size of students in the selected tertiary institutions) = 40, 742

e = precision number = (0.05)2

$$n = \frac{40742}{1+40742(0.025)}$$

n = 400

A total of 400 respondents were initially recruited for this study. However, only 350 participants completed the study, resulting in an 87.5% response rate. Potential participants were informed about the study's purpose, and voluntary participation was obtained. Data collection was conducted from 9:00 AM to 6:00 PM, Monday to Friday, during times when students were not engaged in academic activities. The data collection process lasted approximately 30 minutes.

Among the participating institutions, FUNAAB contributed 38.0% of respondents, while MAPOLY and FCE accounted for 44.9% and 17.1%, respectively.

## 2.4 Sampling Technique

A multistage random sampling technique was employed to select respondents across the three institutions. In the first stage, a simple random sampling was utilized to select departments within the respective college or faculty of the tertiary institutions. All departments within the selected college or faculty were included in the study. In the second stage, stratified random sampling was applied to select respondents from each academic level (year of study), ensuring proportional representation across all levels.

## 2.5 Eligibility criteria

Participants were required to be apparently healthy individuals with no prior diagnosis of diabetes.

## 2.6 Ethical approval

Ethical approval was granted by the Ogun State Health Research Ethics Committee (OGHREC/467/13). Informed consent was obtained orally from all respondents prior to data collection.

## 2.7 Data collection procedure

### 2.7.1 Personal characteristics, perception and pattern of SSB consumption

All questionnaires used in this study were pre-tested, interviewer-administered and validated. The questionnaires were administered in English. Respondents were asked to provide information on their personal characteristics, consumption patterns, and perception of SSBs using a semi-structured pre-tested questionnaire.

### 2.7.2 Anthropometric assessment

Respondents' height (m), weight (kg) and waist circumference (cm) were measured using a height meter, digital weighing scale, and non-elastic measuring tape, respectively, following standardized World Health Organization procedures (Nishida et al., 2009). Body mass index (BMI) was calculated as weight (kg) divided by height square ($m^2$) and categorized as underweight (<18.49 kg/m2), normal weight (18.50 – 24.99 kg/$m^2$), overweight (25.00 – 29.99 kg/$m^2$) and obesity (>30.00 kg/$m^2$). BMI-for-age was analyzed using AnthroPlus for respondents under 20 years of age (Nishida et al., 2009) and categorized as underweight (<-2SD), normal weight (-2SD – +1SD), overweight (>+1SD), and obese (+2SD). Waist circumference was used to assess abdominal obesity (Nishida et al., 2009).

### 2.7.3 Risk of developing diabetes in the next ten years

The Finish diabetes risk score (FINDRISC) questionnaire developed by Lindstrom and Tuomilehto (2003) and described by Nnamudi et al (2020) was used to predict the 10-year risk of developing diabetes mellitus. The questionnaire consists of eight variables: age, body mass index, waist circumference, physical activity, vegetables and fruits or berries consumption, blood pressure medication, earlier diagnosis of high blood sugar, and family history of diabetes.

Individual components were scored to determine a participants' diabetes risk score. Age was scored as 0 point for < 45 years, 2 points for 45 – 54 years, 3 points for 55 – 64 years, and 4 points for > 64 years. BMI was scored as 0 point for < 25 kg/m2, 1 point for 25 – 30 kg/$m^2$, and 3 points for > 30 kg/$m^2$. Waist circumference was scored as 0 point for < 94 cm for men or < 80 cm, 3 points for 94 – 102 cm for men or 80 – 88 cm for women, and 4 points for > 102 cm for men or > 88 cm for women. Physical activity was scored as 0 point for > 30 min daily exercise, and 2 points for < 30 minutes daily exercise. Vegetables, fruits or berries consumption by respondents was scored as 0 point for daily consumption, and 1 point for consumption below 5 – 7 days. Antihypertensive drug use was scored as 2 points for regular use and 0 point for non-regular use. A prior diagnosis of high blood sugar was scored as 5 points and non-diagnosis was scored 0 point. Family history of diabetes was scored as 5 points for history of nuclear family member and 3 points for extended family member, while no family history was scored 0 point. Total score obtained was summed up and categorized as: low (< 7) – an estimated 1% will develop disease; slightly elevated (7 – 11) — an estimated 4% will develop diabetes; moderate (12–14)— an estimated 16.6% will develop diabetes; high (15–20)—an estimated 33.3% will develop diabetes; and very high risk (> 20)—an estimated 50% will develop diabetes.

## 2.8 Statistical analysis

Data were analyzed using statistical packages for social sciences (SPSS) for descriptive and reported using frequencies and percentages. Fisher's exact test was used to test for significant associations among categorical variables. Binary logistic regression was conducted to determine factors associated with the risk of developing diabetes according to the FINDRISC tool. Significance was set at $p < 0.05$.

# 3 Results

## 3.1 Personal characteristics, pattern and perceptions of SSBs consumption, and anthropometric status of respondents

**Table 1.** Personal characteristics and risk factor components of developing diabetes among respondents (n=350)

| Variables | Frequency | Percent |
|---|---|---|
| **Gender** | | |
| - Male | 130 | 37.1 |
| - Female | 220 | 62.9 |
| **Marital status** | | |
| - Single | 323 | 92.3 |
| - Married | 27 | 7.7 |
| **Age (years)** | | |
| - 15-19 | 38 | 10.9 |
| - 20-24 | 230 | 65.7 |
| - 25-29 years | 80 | 22.9 |
| **Body mass index (kg/m2)** | | |
| - Underweight | 38 | 10.9 |
| - Healthy weight | 238 | 68.0 |
| - Overweight | 50 | 14.3 |
| - Obese | 24 | 6.9 |
| **Abdominal obesity** | | |
| - No | 255 | 72.9 |
| - Yes | 95 | 27.1 |
| **Daily Physical activity Duration** | | |
| - < 30 minutes | 252 | 72.0 |
| - > 30 minutes | 98 | 28.0 |
| **Daily consumption of vegetables, fruits or berries** | | |
| - Everyday | 55 | 15.7 |
| - Not everyday | 295 | 84.3 |
| **Regular use of anti-hypertensive** | | |
| - Yes | 54 | 15.4 |
| - No | 296 | 84.6 |
| **Previous diagnosis of high blood glucose** | | |
| - Yes | 8 | 2.3 |
| - No | 342 | 97.7 |
| **Family history of type 2 diabetes** | | |
| - No | 243 | 69.4 |
| - Yes (grandparents) | 67 | 19.1 |
| - Yes (parents) | 40 | 11.4 |

Table 1 presents the background characteristics of study respondents. The majority (62.9 %) of the respondents were female, aged 20 – 24 years. Additionally, 14.3% and 6.9% of the respondents were categorized as overweight and obese, respectively while 27.1% exhibited abdominal obesity. Only 28.0% and 15.7% engaged in at least 30 minutes physical activity and consumed fruits and vegetables daily, respectively. Approximately 15.4% took high blood pressure medication, 2.3% had a medical history of high blood glucose level and 30.5% had family history of type 2 diabetes. All respondents (100%) consumed SSBs (Table 2). Carbonated beverages (99.7%), beverage drinks (96.0%) and malt drinks (83.4%) were the most commonly consumed SSBs. Half (50.9%) of respondents consumed SSBs in the afternoon, 36.6% replaced meals with SSBs, particularly lunch. Respondents consumed SSBs to quench thirst (80.0 %), satisfy their appetite (72 %), obtain instant energy (57.7%), perceive them as highly nutritious (56.3%), find them easily accessible (71.1%), and readily available (87.4%). Moreover, respondents reported that SSBs are energy dense (26.0%) and lead to piles (85.4%). Less than half (43.7%) reported that SSBs increase body weight (Table 2). Figure 1 illustrates the expenditure of respondents on SSBs. Approximately 74.6%, 42.9% and 38% of the respondents spent between $0.33 – 0.65 on SSB daily, weekly, and monthly, respectively, while 4.9%, 13.7% and 35.4% respondents spent $1.64 – 3.28 on SSBs daily, weekly, and monthly, respectively.

## 3.2 Association of anthropometric status and SSBs consumption frequency

Table 3 presents the frequency of SSBs consumption and the nutritional anthropometry of the respondents. Almost half (47.4%) of respondents consumed energy drink once a week, 40.3% consumed fruit drink at least once a week, 48.3% consumed milk drink at least once a week, and 64.3% consumed malt drink at least once a week. About 60.0% consumed carbonated beverages at least four times per week, 61.7% never consumed coffee drink, and 66.2% consumed beverage drink 2-3 times/week. Overweight, gross obesity and abdominal obesity were prevalent among respondents who consumed energy drink (9.6%, 10.0% and 30.7%, respectively), fruit drink (12.1, 4.3, and 22.0% respectively) and milk drink (12.4, 3.6 and 23.1%, respectively) at least once a week. Similarly, respondents who consumed carbonated beverages (17.6, 10.5 and 32.9%, respectively) and beverage drink (22.5, 18.3, and 39.4%) at least four times per week, as well has those who never consumed coffee drink (17.1, 8.8, and 29.6%, respectively) had higher prevalence of overweight, obesity and abdominal obesity compared to those who consumed carbonated beverages and beverage drink them less than four times per week, and coffee drinks. Abdominal obesity had significant associations with consumption of fruit drinks (p=0.00), milk drinks (p = 0.02), malt drinks (p = 0.00), carbonated beverages (p=0.00), and beverage drinks (p = 0.02).

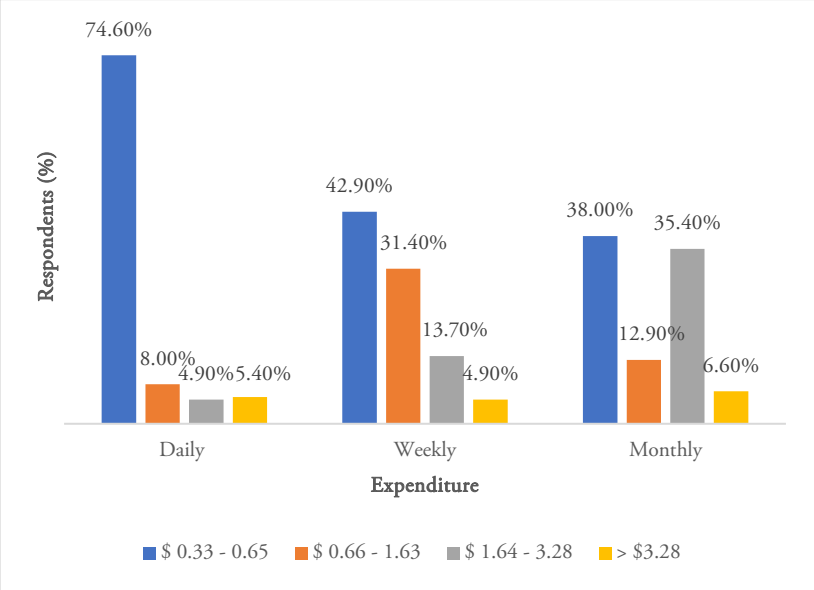


**Figure 1.** Respondents' expenditure on sugar-sweetened beverages ($1 = ₦300)

**Table 2.** Pattern and reasons for consuming sugar sweetened beverages (n=350)

| Variables | Frequency | Percent | Variables | Frequency | Percent |
|---|---|---|---|---|---|
| **Consumption of SSBs** | | | **SSBs are quick to quench thirst** | | |
| - Consumers | 350 | 100.0 | - Yes | 280 | 80.0 |
| - Non-consumers | 0 | 0.0 | - No | 70 | 20.0 |
| ***Type of SSBs consumed** | | | **SSBs quench appetite** | | |
| - Energy drink | 143 | 40.9 | - Yes | 252 | 72.0 |
| - Fruit drink | 176 | 50.3 | - No | 98.0 | 28.0 |
| - Milk drink | 202 | 57.7 | **SSBs give instant energy** | | |
| - Malt drink | 292 | 83.4 | - Yes | 202 | 57.0 |
| - Carbonated drink | 349 | 99.7 | - No | 148 | 42.3.0 |
| - Coffee | 134 | 38.3 | **SSBs are energy dense** | | |
| - Beverage | 3361 | 96.0 | - Yes | 91 | 26.0 |
| **Time of the day consume SSBs** | | | - No | 259 | 74.0 |
| - Morning | 70 | 20.0 | **SSBs are highly nutritious** | | |
| - Afternoon | 178 | 50.9 | - Yes | 197 | 56.3 |
| - Evening | 102 | 29.1 | - No | 153 | 43.7 |
| **SSBs Consumption habit** | | | **SSBs are readily available** | | |
| - Replace meal with SSBs | 156 | 44.6 | - Yes | 306 | 87.4 |
| - Consume SSBs with meals | 194 | 55.4 | - No | 44 | 12.6 |
| **Main meal SSBs replaced** | | | **SSBs are easily accessible** | | |
| - Breakfast | 15 | 4.3 | - Yes | 249 | 71.1 |
| - Lunch | 128 | 36.6 | - No | 101 | 28.9 |
| - Dinner | 13 | 3.7 | **SSBs causes piles** | | |
| - None | 194 | 55.4 | - Yes | 299 | 85.4 |
| **SSBs can increase body weight** | | | - No | 51 | 14.6 |
| - Yes | 153 | 43.7 | | | |
| - No | 197 | 56.3 | | | |
| **SSBs are too sugary** | | | | | |
| - Yes | 326 | 93.1 | | | |
| - No | 24 | 6.9 | | | |

SSBs – Sugar Sweetened Beverages, *Respondents drank more than one sugar sweetened beverages

**Table 3.** Association of anthropometric status and sugar sweetened beverages consumption frequency

| | BMI/BMI for age | | | | Total | | Abdominal obesity | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variables | UW | HW | OW | Ob | | p-value | No | Yes | | p-value |
| | 38(10.9) | 238 (68.0) | 50(14.3) | 24(6.9) | 350(100.0) | | 255(72.9) | 95(27.1) | 350 (100.0) | |
| **Energy drinks** | | | | | | | | | | |
| - Never | 16 (9.9) | 110 (67.9) | 30 (18.5) | 6 (3.7) | 162 (46.3) | 0.05 | 119 (73.5) | 43(26.5) | 162 (46.3) | 0.08 |
| - Once a week | 22 (13.3) | 110 (66.3) | 16 (9.6) | 18 (10.0) | 166 (47.4) | | 115(69.0) | 51(30.7) | 166 (47.4) | |
| - 2 – 3 times/week | 0(0.0) | 16 (80.0) | 4 (20.0) | 0(0.0) | 20 (5.7) | | 19(95.0) | 1(5.0) | 20 (5.7) | |
| - 4 – 7 times/week | 0(0.0) | 2(100.0) | 0(0.0) | 0(0.0) | 2 (0.6) | | 2(100.0) | 0(0.0) | 2 (0.6) | |
| **Fruit drinks** | | | | | | | | | | |
| - Never | 17(9.8) | 108(62.1) | 31(17.8) | 18(10.3) | 174(49.7) | 0.02* | 111(63.8) | 63(36.2) | 174(49.7) | 0.00** |
| - Once a week | 13(9.2) | 105(74.5) | 17(12.1) | 6(4.3) | 141(40.3) | | 110(78.0) | 31(22.0) | 141(40.3) | |
| - 2 – 3 times/week | 8(23.5) | 24(70.6) | 2(5.9) | 0(0.0) | 34(9.7) | | 33(97.1) | 1(2.9) | 34(9.7) | |
| - 4 – 7 times/week | 0(0.0) | 1(100.0) | 0(0.0) | 0(0.0%) | 1(0.3) | | 1(100.0) | 0(0.0) | 1(0.3) | |
| **Milk drinks** | | | | | | | | | | |
| - Never | 11(7.4) | 91(61.5) | 29(18.9) | 18(12.2) | 148(42.2) | 0.00** | 96(64.9) | 52(35.1) | 148(42.2) | 0.02* |
| - Once a week | 25(14.8) | 117(69.2) | 21(12.4) | 6(3.6) | 169(48.3) | | 130(76.9) | 39(23.1) | 169(48.3) | |
| - 2 – 3 times/week | 2(6.7) | 27(90.0) | 1(3.3) | 0(0.0) | 30(8.6) | | 26(86.7) | 4(13.3) | 30(8.6) | |
| - 4 – 7 times/week | 0(0.0) | 3(100.0) | 0(0.0) | 0(0.0) | 3(0.9) | | 3(100.0) | 0(0.0) | 3(0.9) | |
| **Malt drinks** | | | | | | | | | | |
| - Never | 1(1.7) | 51(87.9) | 6(10.3) | 0(0.0) | 58(16.6) | 0.00** | 53(91.4) | 5(8.6) | 58(16.6) | 0.00** |
| - Once a week | 37(16.4) | 147(65.3) | 29(12.9) | 12(5.3) | 225(64.3) | | 167(74.2) | 58(25.8) | 225(64.3) | |
| - 2 – 3 times/week | 0 (0.0) | 28(50.9) | 15(27.3) | 12(21.8) | 55(15.7) | | 23(41.8) | 32(58.2) | 55(15.7) | |
| - 4 – 7 times/week | 0(0.0) | 12(100.0) | 0(0.0) | 0(0.0) | 12(3.4) | | 12(100.0) | 0(0.0) | 12(3.4) | |
| **Carbonated drinks** | | | | | | | | | | |
| - Never | 0(0.0) | 1(100.0) | 0(0.0) | 0(0.0) | 1(0.3) | 0.01* | 0(0.0) | 1(100.) | 1(0.3) | 0.00** |
| - Once a week | 0(0.0) | 5(100.0) | 0(0.0) | 0(0.0) | 5(1.4) | | 4(80.0) | 1(20.0) | 5(1.4) | |
| - 2 – 3 times/week | 18(13.4) | 101(75.4) | 13(9.7) | 2(1.5) | 134(38.3) | | 110(82.1) | 24(17.9) | 134(38.3) | |
| - 4 – 7 times/week | 20(9.5) | 131(62.4) | 37(17.6) | 22(10.5) | 210(60.0) | | 141(67.1) | 69(32.9) | 210(60.0) | |
| **Coffee drinks** | | | | | | | | | | |
| - Never | 14(6.5) | 146(67.6) | 37(17.1) | 19(8.8) | 216(61.7) | 0.00** | 152(70.4) | 64(29.6) | 216(61.7) | 0.24 |
| - Once a week | 24(18.2) | 92(69.7) | 11(8.3) | 5(3.8) | 132(37.7) | | 101(76.5) | 31(23.5) | 132(37.7) | |
| - 2 – 3 times/week | 0(0.0) | 0(0.0) | 0(0.0) | 0(0.0) | 0(0.0) | | 0(0.0) | 0(0.0) | 0(0.0) | |
| - 4 – 7 times/week | 0(0.0) | 0(0.0) | 2(100.0) | 0(0.0) | 2(0.6) | | 2(100.0) | 0(0.0) | 2(0.6) | |
| **Beverage drinks** | | | | | | | | | | |
| - Never | 0(0.0) | 14(100.0) | 0(0.0) | 0(0.0) | 14(4.0) | 0.00** | 31(92.9) | 1(7.1) | 14(4.0) | 0.02* |
| - Once a week | 3(9.1) | 25(75.8) | 4(12.1) | 1(3.0) | 33(9.4) | | 22(66.7) | 11(33.3) | 33(9.4) | |
| - 2 – 3 times/week | 32(13.8) | 160(69.0) | 30(12.9) | 10(4.3) | 232(66.2) | | 177(76.3) | 55(23.7) | 232(66.2) | |
| - 4 – 7 times/week | 3(4.2) | 39(54.9) | 16(22.5) | 13(18.3) | 71(15.4) | | 43(60.6) | 28(39.4) | 71(15.4) | |

HW: healthy weight; Ob: Obese; OW: overweight; UW: underweight; *p < 0.05, **p < 0.01, ***p < 0.001

## 3.3 Association between frequency of consumption of SSBs and risk category of developing type 2 diabetes

Table 4 presents the association between SSBs consumption and the risk of developing T2DM within ten years. Approximately 40.0% of the respondents who consumed energy drinks two to three times per week were categorized as having a moderate risk. Only 2.9% of the respondents who drank fruit drinks two to three times per week were classified as having a moderate risk. One-tenth of respondents who drank milk drink two to three times per week were categorized as having a moderate risk, while 6.7% were classified as having a very high risk. Additionally, 21.8% of respondents who drank malt drinks two to three times per week were categorized as having a very high risk. In addition, 10% of those who consumed carbonated drink for four to seven times per week had high risk and 1.0% had very high risk. Furthermore, 17.1% of those who consumed beverage drink four to seven times per week had high risk of developing diabetes.

## 3.4 Logistic regression of risk factors associated with risk of developing diabetes

Logistic regression analysis revealed that single individuals were three times more likely to develop diabetes compared to married individuals. Increasing age was associated with a twofold increase in the risk of developing diabetes (OR = 1.757, 95% CI: 1.051-2.934). Moreover, an increase in BMI was associated with a 13-fold increase in the risk of developing diabetes (OR = 12.837, 95% CI: 7.144, 23.068). Conversely, abdominal obesity had a protective effect, decreasing the risk of developing diabetes by 0.3 times (OR = 0.296, 95% CI: 0.174, 0.502). Consuming fruit drinks for at least twice per week was associated with a 15-fold increase in the risk of developing diabetes (OR= 15.212, 95%

**Table 4.** Association of sugar sweetened beverages consumption and risk category of developing type 2 diabetes within ten years

| Sugar Sweetened Beverages | Slightly elevated | Moderate risk | High risk | Very high risk | Total | p-value |
|---|---|---|---|---|---|---|
| | n (%) | n (%) | n (%) | n (%) | n (%) | |
| | 239(68.3) | 88(25.1) | 21(6.0) | 2(6.0) | 350 (100.0) | |
| **Energy drinks** | | | | | | |
| - Never | 107(66.0) | 47(29.0) | 6(3.7) | 2(1.2. | 162(46.3) | 0.05* |
| - Once a week | 118(71.1) | 33(19.9) | 15(9.0) | 0(0.0) | 166(47.4) | |
| - 2 – 3 times/week | 12(60.0) | 8(40.0) | 0(0.0) | 0(0.0) | 20(5.7) | |
| - 4 – 7 times/week | 2(100) | 0(0.0) | 0(0.0) | 0(0.0) | 2(0.6) | |
| **Fruits drinks** | | | | | | |
| - Never | 100(57.5) | 54(31.0) | 18(10.3) | 2(1.2) | 174(49.7) | 0.40 |
| - Once a week | 105(74.5) | 33(23.4) | 3(2.1) | 0(0.0) | 141(40.3) | |
| - 2 – 3 times/week | 33(97.1) | 1(2.9) | 0(0.0) | 0(0.0) | 34(9.7) | |
| - 4 – 7 times/week | 1(100.0) | 0(0.0) | 0(0.0) | 0(0.0) | 1(0.3) | |
| **Milk drinks** | | | | | | |
| - Never | 89(60.1) | 41(27.7) | 18(12.2) | 0(0.0) | 148(42.3) | 0.02* |
| - Once a week | 130(76.9) | 36(21.3) | 3(1.8) | 0(0.0) | 169(48.3) | |
| - 2 – 3 times/week | 17(56.7) | 11(36.7) | 0(0.0) | 2(6.6) | 30(8.6) | |
| - 4 – 7 times/week | 3(100) | 0(0.0) | 0(0.0) | 0(0.0) | 3(0.8) | |
| **Malt drinks** | | | | | | |
| - Never | 48(82.8) | 10(17.2) | 0(0.0) | 0(0.0) | 58(16.6) | 0.00** |
| - Once a week | 160(68.1) | 56(23.8) | 9(3.8) | 0(0.0) | 235(67.1) | |
| - 2 – 3 times/week | 26(47.3) | 15(27.3) | 12(21.8) | 2(3.6) | 55(15.7) | |
| - 4 – 7 times/week | 5(41.7) | 7(58.3) | 0(0.0) | 0(0.0) | 12(3.4) | |
| **Carbonated drinks** | | | | | | |
| - Never | 0(0.0) | 1(100) | 0(0.0) | 0(0.0) | 1(0.3) | 0.01* |
| - Once a week | 5(100) | 0(0.0) | 0(0.0) | 0(0.0) | 5(1.4) | |
| - 2 – 3 times/week | 112(83.6) | 22(16.4) | 0(0.0) | 0(0.0) | 134(38.3) | |
| - 4 – 7 times/week | 122(58.1) | 65(31.0) | 21(10.0) | 2(1.0) | 210(60.0) | |
| **Coffee drinks** | | | | | | |
| - Never | 135(1.2) | 61(52.6) | 18(15.5) | 2(1.7) | 216(61.7) | 0.90 |
| - Once a week | 102(77.3) | 27(20.5) | 3(2.3) | 0(0.0) | 132(37.7) | |
| - 2 – 3 times/week | 0(0.0) | 0(0.0) | 0(0.0) | 0(0.0) | 0(0.0) | |
| - 4 – 7 times/week | 2(100.0) | 0(0.0) | 0(0.0) | 0(0.0) | 2(0.6) | |
| **Beverage drinks** | | | | | | |
| - Never | 12(85.7) | 2(14.3) | 0(0.0) | 0(0.0) | 14(4.0) | 0.00** |
| - Once a week | 28(66.7) | 4(9.5) | 1(2.4) | 0(0.0) | 42(12.0) | |
| - 2 – 3 times/week | 163(70.3) | 59(25.4) | 8(3.4) | 2(0.9) | 232(66.3) | |
| - 4 – 7 times/week | 6(8.6) | 23(32.9) | 12(17.1) | 0(0.0) | 70(20.0) | |

*p < 0.05, **p < 0.01, ***p < 0.001

CI= 1.971, 117.400). Similarly, consuming malt drinks at least twice per week increased the risk of developing diabetes by three times (OR= 3.221, 95% CI= 01.862, 5.571). On the other hand, consuming beverage drink for at least two times per week increased the risk of developing diabetes by three times (OR= 2.986, 95% CI = 1.293, 6.899). However, sex, number of times of SSBs per day, frequency of intake of energy drink, frequency of intake of carbonated beverage, frequency of intake of milk drink had no association with risk of developing diabetes within ten years.

## 4 Discussion

This study investigated the consumption pattern of SSBs and the associated risk of developing T2DM within ten years among undergraduate students, utilizing the FINDRISC tool. The findings reveal that one-third of the undergraduate participants in this study had a family history of T2DM, over one-quarter had a medical history of diabetes, and more than ten percent were taking blood pressure medication. In addition, more than three-quarters were physically inactive and exhibited abdominal obesity. Overweight (14.3%), general obesity (6.9%) and abdominal obesity were prevalent among respondents.

Previous research has identified age, family history, overweight, general obesity, abdominal obesity, and physical inactivity as risk factors for developing T2DM (Malik & Hu, 2019; Oladoyinbo et al., 2019; Veerman et al., 2016). These findings suggests that a significant proportion of these young people and emerging adults may be at risk of developing T2DM.

Our results reveal that over two-third of respondents spent between $0.33 – 0.65 on SSB daily, while more than one-third spent the same amount on SSBs weekly and monthly. Notably, all undergraduates in the studied tertiary institutions consumed SSBs. Previous research (Madiba *et* al.,

**Table 5.** Logistic regression of factors associated with risk of developing diabetes within ten years+

| Variables | OR (95 % CI) | p-value |
|---|---|---|
| **Sex** | Ref | |
| - Female | | |
| - Male | 1.286 (0.744, 2.224) | 0.368 |
| **Marital status** | | |
| - Single | Ref | |
| - married | 2.956 (1.334, 6.550) * | 0.008 |
| **Age** | | |
| - < 25 years | Ref | |
| - > 25 years | 1.757 (1.051, 2.934) * | 0.031 |
| **Body mass index (kg/m2)** | | |
| - < 25.0 | Ref | |
| - > 25.0 | 12.837 (7.144, 23.068) *** | 0.000 |
| **Abdominal obesity** | | |
| - No | Ref | |
| - Yes | 0.296 (0.174, 0.502) *** | 0.000 |
| **Number of times of SSBs per day** | | |
| - < 3 times | Ref | |
| - > 3 times | 1.026 (0.837, 1.258) | 0.804 |
| **Frequency of intake of energy drink** | | |
| - < 2 times/week | Ref | |
| - > 2 times/week | 1.243 (0.508, 3.068) | 0.629 |
| **Frequency of intake of fruit drink** | | |
| - < 2 times/week | Ref | |
| - > 2 times/week | 15.212 (1.971, 117.400) * | 0.009 |
| **Frequency of intake of malt drink** | | |
| - < 2 times/week | Ref | |
| - > 2 times/week | 3.221 (01.862, 5.571) *** | 0.000 |
| **Frequency of intake of carbonated beverage** | | |
| - < 2 times/week | Ref | |
| - > 2 times/week | 2.350 (0.271, 20.360) | 0.438 |
| **Frequency of intake of beverage drink** | | |
| - < 2 times/week | Ref | |
| - > 2 times/week | 02.986 (1.293, 6.899) * | 0.010 |
| **Frequency of intake of milk drink** | | |
| - < 2 times/week | Ref | |
| - > 2 times/week | 1.453 (0.695, 3.038) | 0.321 |

+ Risk of developing diabetes within ten years. *p < 0.05, **p < 0.01, ***p < 0.001

2017; Ahmad *et* al., 2019) among undergraduate students reported similar findings. SSBs have been identified as a primary source of added sugar in the diet, suggesting that these young people and emerging adults may be obtaining a significant portion of their added sugar from SSBs.

Among the consumed SSBs, carbonated drinks, beverage drinks and malt drinks were the most prevalent, followed by fruit drinks and milk drinks. Energy drinks and coffee drinks were less frequently consumed. In a previous study, Nakhooda and Wiles (2018) observed that undergraduate students primarily consumed carbonated soft drinks, followed by fruit juices/drinks and energy drinks more. Bawadi et al. (2019) also found out that college students predominantly consumed hot (beverage) drinks, followed by carbonated drinks, fruit drinks and energy drinks. Deliens et al. (2015) reported a similar trend among university students, with carbonated drinks being the most consumed, followed by energy drinks. These findings align with the results of the present study, although, some discrepancies exist in the order of SSB consumption frequency reported in other studies (Bawadi et al., 2019; Gan et al., 2019). These variations suggest that while carbonated drinks and beverage drinks are commonly consumed by most undergraduates, individual preferences may influence consumption patterns.

The study also revealed that over one-third of respondents consumed energy, fruit, milk, and coffee drinks at least once a week, while carbonated drinks were consumed by almost two-thirds of respondents four to seven times per week and more than two-third of them two to three times per week. Beverage drinks were consumed by two-thirds of respondents two to three times per week, and one-fifth consumed them four to seven times per week. Conversely, less than one-fifth

consumed malt drinks two to three times per week and two-third consumed it once a week. Previous studies have reported that undergraduate students consume SSBs at least once daily, although the specific type of SSBs consumed frequently were not reported (Madiba *et* al., 2017; Norliza-Ahmad et al., 2019). The high frequency consumption among respondents in this study may contribute to increased added sugar intake, as SSBs are major carriers of added sugar. Diets high in sugar have been implicated as a risk factor for diabetes (Malik & Hu, 2019).

Furthermore, this study shows that SSBs are primarily consumed by respondents during the daytime, with some consuming them at any time of day. Respondents often replaced meals with SSBs, particularly lunch. The demanding academic schedule of undergraduate students, which involves attending classes from morning to evening, may contribute to their high consumption of SSBs during the day and the tendency to replace meals with these beverages. In addition, respondents reported various reasons for consuming SSBs, including quenching thirst, appetite, convenience, and perceived nutritional benefits. However, over two-third of respondents acknowledged that SSBs are too sugary and may cause health issues. Previous studies assessing the reasons for SSBs consumption among undergraduates have found that taste, convenience, accessibility, cost-effectiveness, and perceived nutritional content are major factors influencing their consumption (Bipasha et al., 2017; Lee et al., 2018; Luger et al., 2017). These findings suggest that accessibility and perceived nutritional content are key driving SSBs consumption among undergraduate students.

In the present study, overweight was more prevalent among those who consumed energy drinks 2-3 times/week when compared to those who drank once a week and never. Underweight was more prevalent among those who drank fruit drink two to three times per week compared to those who consumed them less frequently. Conversely, underweight was more prevalent among those who drank fruit drinks two to three times per week, while overweight was less prevalent in this group. Overweight and obesity were more prevalent among those who consumed malt, carbonated and beverage drinks at least two to three times per week compared to other drinks. However, fruit, coffee, and milk drinks were associated with lower rates of overweight and obesity. These findings suggest that frequent consumption of malt, carbonated and beverage drinks may predispose consumers to overweight and obesity, while consumption of fruit, coffee and milk drinks may reduce the occurrence of overweight and obesity among consumers. While previous studies (Fadupin et al., 2014; Madiba et al., 2017; Ahmad et al., 2019; Scharf & DeBoer, 2016) did not observe a direct association between the prevalence of overweight and obesity and SSBs consumption patterns, several studies (Bleich & Vercammen, 2018; Fadupin et al., 2014; Malik & Hu, 2019) have demonstrated a significant relationship between frequent SSBs intake and overweight or obese among children and adults (Luger et al., 2017). However, Ahmad et al. (2019), found no significant association between overweight and obesity and high SSB intake among undergraduate students in their study conducted in Malaysia. It can be inferred that the frequent consumption of malt, carbonated and beverage drinks may elevate the likelihood of overweight and obesity among consumers whereas the intake of fruit-based drinks, coffee and milk may contribute to a reduced risk of overweight and obesity.

Furthermore, this study indicates that abdominal obesity increased with the frequency of consuming milk, malt, carbonated and beverage drinks but decreased with the frequency of consuming fruit, energy, and coffee drinks. Abdominal obesity was significantly associated with the consumption of fruit, milk, malt, carbonated, and beverage drinks but not with energy drinks or coffee drinks. These findings align with previous research ( Malik & Hu, 2019) that observed a positive relationship between SSBs and increased waist circumference, a marker of abdominal of abdominal obesity (Akinbule et al., 2021; Sardesai, 2017). In contrast, fruit juice consumption was found not found to be associated with gross or abdominal obesity, consistent with the findings of Frantsve-Hawley et al. (2018) in a systematic review. Overall, these results suggests that frequent consumption of SSBs may increase abdominal obesity in consumers. Conversely, fruit juice, energy drink and coffee drinks consumption may have protective effects against these health issues.

While energy and milk drinks were moderately consumed among respondents in this study, those who consumed them two to three times per week were at a moderate risk of developing T2DM. The risk of developing T2DM reduced with increase in frequency of consuming fruit and coffee drinks among the respondents, although these associations were not statistically significant. Several studies, including systematic reviews and meta-analyses, have reported similar findings (Crichton et al., 2017; Huang et al., 2017; Li et al., 2023; Papier et al., 2017; Imamura et al., 2015). However, Biggelaar et al. (2019) found no evidence of associations between soft drink and juice intake and beta-cell-function or insulin sensitivity.

In the logistic regression model, although fruit drink consumption for at least two times per week was associated with a 15-fold decrease in the risk of developing T2DM. However, consuming malt or beverage drinks at least twice per week was associated with a threefold increase in the risk. These findings imply that frequent intake of SSBs, except for fruit drinks, may increase the risk of developing T2DM among young people and emerging adults.

# 5 Implications and Conclusion

The findings of this study provide valuable insights for policymakers seeking to promote dietary information and counselling aimed at reducing the risk of developing diabetes among young people and emerging adults. These finding can also be utilized in the design of intervention programs focused on dietary behavior change among this population to foster healthy body weight and reduce diabetes burden.

The present study confirms the high consumption of SSBs, particularly carbonated drinks, beverage drinks, and malt drinks, among young people and emerging adults. One potential explanation for this this trend is the accessibility and calorie content of these beverages. While this population is known to consume SSBs more frequently than other age groups, the prevalence of overweight, obesity and abdominal obesity among them remains evident. Moreover, increased frequency of SSBs consumption is associated with an elevated risk of developing T2DM. However, consuming fruit drinks at least twice per week was found to reduce the odd of developing diabetes by 15 times.

## *Strengths and limitations of the study*

The study's strengths include its exploration of how personal characteristics predicts SSBs consumption and the implication for T2DM. In addition, the study provides valuable information that can educate young people about the effect of SSBs intake. This research fills a gap in the literature on modifiable factors, such as dietary pattern and SSBs consumption, that may contribute to T2DM among young people and emerging adults in Nigeria. Furthermore, the sample selection across the three public tertiary institutions has captured a diverse group of young people and emerging adults, enabling the generalization of findings to the broader population.

However, the study also has limitations. The cross-sectional design, precludes longitudinal analysis, preventing the examination of changes in consumption patterns over time. Future research employing experimental or longitudinal methodologies could address this limitation. Additionally, the sample was predominantly composed of young people with limited representation of emerging adults. Future research should aim for a more representative sample that includes a broader range of young people and emerging adults from various tertiary institutions beyond Abeokuta. In addition, the sample size calculation did not take into consideration the different stratifications made in the results such as BMI, abdominal obesity classes, and the risk categorization of developing T2DM. This may have affected the sample size within each category. Future research should incorporate a statistical analysis plan and an appropriate sample size calculation.

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