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DEVELOPMENT OF DIETS FOR MANAGEMENT OF OVERWEIGHT AMONG UNDERGRADUATES IN DELTA STATE, NIGERIA

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ABSTRACT

This study investigated the prevalence and determinants of dietary habits among undergraduates in Delta State, Nigeria, with a focus on developing interventions for weight management. The study aimed to explore the dietary behaviors, health challenges, and the nutritional value of locally developed diets. Four research questions and one hypothesis guided the study. The research adopted a survey and experimental design, involving a population of 89 overweight undergraduates and 950 health and nutrition professionals. The sampling techniques included non-proportionate random sampling and purposive sampling, leading to the selection of 72 students, 275 professionals, and 12 Wistar rats for experimental purposes. Data were collected using structured questionnaires, a 9-point hedonic scale, and the AOAC (2019) handbook for nutritional analysis. Two diets, Pota Snack (PS) and Unripe Plantain Pottage (UPP), were developed and analyzed. The findings revealed that 77.7% of the respondents relied on fast foods, while only 22.3% prepared their own meals. Additionally, 65.3% and 56.9% of the students did not consume vegetables and fruits daily, respectively. The main determinants of dietary habits included income size (mean = 2.91) and access to food (mean = 2.86). Health challenges linked to poor dietary habits included overweight (mean = 2.92), learning problems (mean = 2.81), and memory issues (mean = 2.96). Nutritional analysis showed that PS had a moisture content of 25.97%, crude protein of 3.70%, and carbohydrates of 68.48%, while UPP had 49.85%, 14.20%, and 30.23%, respectively. Mineral and vitamin contents were also analyzed, showing adequate levels for weight management. The study concluded that poor dietary habits are prevalent among undergraduates in Delta State, and interventions such as promoting healthy snacking and nutrition education are necessary. It was recommended that nutrition counseling be integrated into university programs to enhance students' awareness of healthy eating habits.

Keywords: Dietary habits, overweight, undergraduates, Delta State, nutrition, Pota Snack, Unripe Plantain Pottage, weight management.

Introduction

Background to the Study

Overweight can be described as anomalous accumulation of excessive body fat which may be harmful to health. There is no single cause to explain all cases of obesity and overweight but most studies implicate imbalance in the amounts of calories consumed and those expended (de Onis et al., 2010). Energy breakdown is said to be less than energy buildup. The disruption of the normal satiety feedback mechanisms, hyperinsulinism, insulin resistance, and genetics are some of the biophysiological causes of obesity and overweight (Abbasi et al., 2017). Some researchers also attribute overweight to environments where people are frequently exposed to and consume savory foods with hidden fats and sugars that can impair metabolism and lead to obesity (Anderson et al., 2017). Such environments include schools/higher institutions where students are exposed to certain dietary habits which may impose overweight and obesity risks on them. Some public health experts also associate the development of obesity and overweight with socioeconomic status, urban lifestyle, family size, physical inactivity, educational status, cultural factors, and poor eating habits (Hallal et al., 2022; Fagg et al., 2015). For example, these researchers noted that persons who spend their leisure inactively such as in prolonged watching of television and playing of video games as well as phone habitual phone calls and social media usage have been said to be at risk of obesity (Hallal et al., 2022). Overweight is a sign of unhealthy weight management. These are the reasons undergraduates – generally referred to as young persons constitute the largest populations in higher institutions around the world are the subject of concern in this study.

The prevalence of overweight among undergraduate is usually the result of certain lifestyles and poor management of an individual's weight among the students. A lifestyle is a way of life that one has developed and cultivated over a period of time, and usually influenced by circumstances. For example, nutrition lifestyle can described as a persons' predisposition to nutrition or diets – how the persons eats; what is eaten, how and when one eats. Other lifestyles include sedentary lifestyle which implies a lifestyle of limited physical activities caused by excessing gaming as a factor that influencing excess weight in undergraduate. Others are television viewing and habitual addiction to information communication technology gadgets such as phones and the social media. It has been reported that extended periods of inactivity can reduce metabolism and impair the body's ability to control blood sugar levels, regulate blood pressure, and break down fat (Fagg et al., 2015). In all Nigerian campuses, including Delta State, and around the developing world, poor nutrition habits and the inextricability of ICT gadgets from the life of an average undergraduate which imposes a sedentary lifestyle on the student combine to increase the prevalence of overweight and obesity risks among them.

The management of weight in students has become an important research focus in recent times. This is because there are concerns over the health of students, as well as their participation in full academic works. Management of overweight and obesity is an intervention technique which involves addressing the lifestyles of the individual – nutrition and activity lifestyles. It also involves the utilization of diet therapies in the regulation of excessive calories intake and the breakdown of fats.

Intervention techniques such as transformation of dietary habits of undergraduates imply examining what, how and when a student eats. A person's eating patterns can have a major influence on whether he/she maintains a healthy weight. Some overweight parents may be less concerned about their children also being overweight than parents who have a healthy weight

(Maggio et al., 2014). Diet plays an important role in the pathogenesis of obesity; fatty foods are energy dense and gives 9calories per gram compared to carbohydrate and protein that gives 4calories per gram (Rideout & Hamel, 2016). Also, if physical activity is inadequate, excess consumption of fat can result into weight gain.

However, it is important to know that a person's dietary habits can be influenced by nutritional challenges. Such challenges include poor nutrition education; lack of access to healthy foods; and addiction such as the consumption of excessive junk foods which students are usually associated with. Understanding these challenges, and which is peculiar to the student is significant in the provision of ameliorative strategies such as the development of a diet for the control of overweight and obesity.

The use of diets (diet therapy) has been found to be effective in the control of the risk of obesity. It has been recommended, for example that a lower-calorie diet such as 1,200 to 1,500 calories a day for women and 1,500 to 1,800 calories a day will help control overweight (Stolley & Fitzgibbon, 2017). The calorie level depends on the body weight and physical activity level. A lower calorie diet with a variety of healthy foods will give the nutrients needed to stay healthy. Whole foods-whole grains, vegetables, fruits, nuts and seeds such as beans, sweet potato are considered as a healthy alternatives to normal potatoes and have scientifically been proven to help in weight loss (de Onis et al., 2020). Yet, the nutritional values and organoleptic characteristics (tastes, aroma, texture of foods) of such diets compounded from these food crops require evaluations for them to be recommended to students.

While the majority of the researches done highlight obesity and overweight as problems of the developed countries, recent studies also show that the third world countries are no exception (Fagg et al., 2015). However, very few studies have paid attention to interventions on overweight and obesity among students in higher institutions of learning in Nigeria, and Delta State in particular. This has resulted in the gradual rise of the phenomenon among undergraduates in these institutions. It was against this background that this study was consummated.

Statement of the Problem

The public health system in Nigeria, and Delta State specifically, is facing a new challenge as a result of the global increase in overweight and obesity among young people. Due to variations in socioeconomic status, culture, ethnicity, and geography, risk factors for overweight and/or obesity may vary from place to place. Nevertheless, the consequences of students' unhealthful weight have made it necessary for undergraduates and other young people to adopt healthier lifestyles. Not only is unhealthy weight, as demonstrated by obesity and overweight among students, pathologically chronic, but it is also rising. Other comorbidities in the younger populations have been linked to this. Poor weight control has been linked to heart disease, visual issues, cancer, hepatic impairment, diabetes, and other medical diseases, as well as the financial burden of managing these conditions. Students who are obese or overweight face additional stigmas. In several Delta State campuses, as well as in many higher education institutions in Nigeria, people associate obesity and overweight with an illness and view these individuals as being lethargic.

Whether they are overweight or underweight, students who struggle with weight control may face a variety of physical health problems. These can include insufficient intake of certain nutrients, compromised immune systems, exhaustion, lethargy, and heightened vulnerability to diseases. Problems with weight can have a detrimental impact on a student's body image and sense of self. A negative self-perception and body dissatisfaction can cause social disengagement,

low confidence, and even the emergence of eating disorders such as binge eating disorder, bulimia nervosa, or anorexia nervosa. Academic performance might be impacted by poor weight management. Students who, for instance, do not eat a balanced diet or miss meals may find it difficult to focus, concentrate, or perform cognitively. When malnutrition is severe, it might cause cognitive problems.

Being underweight or overweight hinders a student's participation in physical activities. This can lead to a sedentary lifestyle, which further exacerbates weight management issues and negatively impacts overall health and fitness levels. In area under study, many students are found engaging in risky food patterns. The extent of impact of these practices is not known about the students. Yet, no study on recipe for promoting healthy nutrition lifestyles has been found by this researcher. This was the motivation for this study.

Aim and Objectives

The aim of this study was to develop diets for management of overweight among undergraduates in Delta State, Nigeria. Specifically, the study:

i. Examined the dietary habits of undergraduates in Delta State, Nigeria;
ii. Examined the determinants of dietary habits of undergraduate in Delta State, Nigeria;
iii. Examined the health challenges of dietary habits of undergraduates in Delta State;
iv. Examined the nutritional values of diets developed for the management of overweight among undergraduates in Delta State, Nigeria;

Research Questions

The study was guided by the following research questions:

i. What are the dietary habits of undergraduates in Delta State, Nigeria?
ii. What are the determinants of dietary habits of undergraduates in Delta State, Nigeria?
iii. What are the health challenges of dietary habits of undergraduates in Delta State, Nigeria?
iv. What are the nutritional values of diets developed for the management of overweight among undergraduates in Delta State, Nigeria?

Hypotheses

The following hypotheses were tested at 0.05 level of significance.

$H0_1$: There is no significant difference in the nutritional values of diets developed for the management of overweight among undergraduates in Delta State, Nigeria.

METHODOLOGY

Design of the Study

This study adopted the experimental and survey designs.

Area of the Study

The study was carried out in Delta State. Delta State is a state in the South-South geopolitical zone of Nigeria.

Population for the Study

The study involved four categories of population, each contributing to different aspects of the research. First, 89 overweight students from six public universities in Delta State were identified based on medical records. The universities included the Federal University of Petroleum Resources, Effurun (11 students), Delta State University, Abraka (28), Delta State University of Science and Technology, Ozoro (13), Dennis Osadebe University, Asaba (9), University of Delta, Agbor (16), and Admiralty University of Nigeria, Ibusa/Sapele (12). Secondly, 950 health

and nutrition professionals from major health institutions in Ugheli and across Delta State, identified through records from the Delta Ministry of Health, were involved. The third category included two diets compounded from selected food crops purchased within the study area. Lastly, 12 young adult Wistar rats were acquired from the breeding unit of the Animal and Environmental Biology Department at Rivers State University, Port Harcourt, to aid in the study.

Sample and Sampling Technique

The sampling involved four categories as well. Seventy-two undergraduate students (23 males and 49 females) aged 18–25 years from the six universities were selected using a non-proportionate random sampling technique. The number of students from each university varied, and the selection was random, ensuring representation from all universities. The Krecje and Morgan (1970) sample table was employed to determine the sample size. Ten students from Delta State University were purposively selected for an organoleptic assessment of the developed diets. Additionally, 275 health and nutrition professionals (142 males and 133 females) were selected from major health institutions in Delta State using purposive sampling. Finally, 12 young adult Wistar rats were included for experimental purposes

Instruments for Data Collection

The instruments for data collection were varied and tailored to the specific research questions. A structured questionnaire, designed on a 4-point rating scale, was used for health and nutritional professionals and undergraduate students to address specific research questions. A 9-point hedonic scale was employed for sensory evaluation, assessing flavor, taste, color, texture, temperature, and general acceptability. The Association of Analytical Chemists (AOAC, 2005) instruments were utilized for determining the nutritional values of the developed diets. A pretested, self-administered, semi-structured food frequency questionnaire (FFQ) was used to assess dietary intake and anthropometric measurements of the students, capturing information on socio-demographic characteristics, dietary practices, and consumption frequency of different food groups.

Validation and Reliability of the Instruments

The two sets of questionnaires (for students and health/nutritional professionals) were validated by three senior staff at of the Rivers State University Teaching Hospital in Port Harcourt. The reliability of the questionnaires were trial tested on 10 students and 11 health/nutrition professionals for two weeks using Cronbach Alpha to obtain a reliability score of 0.876, 0.896^{a} and 0.957^{a} respectively.

Method of Data Collection

Questionnaire Distribution

A total of 72 (for the students) and 275 (for health/nutrition professionals) copies of the questionnaire forms were printed and distributed to the respondents using the direct contact method, with the help of five research assistants who were sensitized on methods of administration of the forms. In the end, 100% return rate was obtained for the students (23 males and 49 females) and 140 males and 130 females (from the health and nutrition professionals) were retrieved, giving 98% return rate.

The structured pretested interviewer administered questionnaire was used to obtain information in this study. With the aid of 24-hour dietary recall format, the respondents were asked to recall all foods and drinks including in-between meals consumed within the previous 24 hours. The nutrient intakes of the individual subjects were then calculated using a combination of Food Composition tables compiled by FAO (2017) and Trefry et al. (2014).

Diet Development

Sourcing of Raw Materials

The raw materials which were used in this study (sweet potato unripe plantain, tigernuts, dates**,** **g**arlic) were purchased from the popular markets within Delta State.

Processing of Raw Materials

The raw materials (sweet potato, unripe plantain, tigernuts, dates**,** **g**arlic) were thoroughly washed before the processing began.

Preparation of Pota Snack (PS)

The Pota snack were made from sweet potato flour, garlic and dates flour. It is also represented as PS. Ingredients: 10 grammes of garlic flour, 200 grammes of sweet potato flour, 50 grammes of dates flour, 15 grammes of baking powder, 30ml turmeric oil, 30ml water, 1 egg and salt to taste (mild)

Method of Preparation

The procedure is as follows: Mixed garlic flour, sweet potato flour and dates flour together until very smooth; Mixed the egg with water and mix together with the mixed flours; Molded into balls or any shape of choice and Baked under moderate heat

Preparation of Unripe Plantain Pottage (UPP)

Ingredients: 100 grammes of unripe plantain, 100 grammes of spinach, 20 grammes of garden egg, pepper (very few since many young people may not like peppery foods), salt (to taste), onions (1/2g), 20 ml of red oil, 100 ml of tigernut and dates juices and 100 grammes of crayfish and shrimps

Method of Preparation: The procedures are as follow: washed all ingredients and materials, peel off the plantains and slice the vegetable, garden eggs, cook the unripe plantain for 20 minutes with the tigernut and dates juices and added the garden egg and vegetable with other ingredients, including the crayfish and shrimps

The diets are represented as follows:

Pota Snack (PS): sweet potato flour, garlic and dates flour.

Unripe Plantain Pottage (UPP): unripe plantain, spinach, garden egg, tigernut and dates juices

Chemical Analysis of Samples

Determination of Proximate Composition

Proximate composition (total moisture content, crude protein, crude fat, crude fiber, total ash, total carbohydrate and gross energy values) of the three samples (PS and UPP) were determined by the following methods.

Determination of Moisture Content: Moisture content (%) was determined in an oven drying methods at 105 ± 5°C using the procedure described in the Association of Analytical Chemists (AOAC, 2019). Five grams of each fresh sample was accurately weighed in triplicate and placed in a pre-weighed aluminum dish and dried in an oven at 105 ± 5°C till the constant weight of dry matter was obtained. The moisture content in the sample was determined as:

$$\text{Moisture (\%)} = \frac{\text{Wt. of fresh sample} - \text{Wt. of dried sample}}{\text{Wt. of fresh sample}} \times 100$$

Determination of Crude Protein*:* The samples were analyzed for crude protein content according to the Kjeldahl's method described in the Association of O¼cial Analytical Chemists (AOAC, 2019). Five grammes of the sample was weighed in an ash less filter paper and put into 250 ml digestion flask. Then 3 g of a catalytic mixture, tablet (75 g of CuSO4 and 0.7 g of

K2SO4) and 15 mL of 98% H_2SO_4 were added into a digestion flask. The whole mixture was subjected to heating in a digestion chamber until transparent residue (clear light green) content was obtained. Then, it was allowed to cool. After cooling, the digest was transferred into a 100 mL volumetric flask and made up to the mark (100 mL) with distilled water and then distilled using distillation apparatus.

Protein Distillation: Before use, the distillation apparatus was steamed for 15 min, afer which, 100 ml conical ¦ask containing 20 ml of 40% boric acid and 2 or 3 drops of Tashiro's indicator was placed under the distillation apparatus with its out let tubes inserted into the conical flask. The digest was washed down with distilled water followed by addition of 3–4 drops of phenolphthalein and 20 mL of 40% (w/v) NaOH solution. The distillation was continued until about 25 mL of distillate was trapped into the boric acid plus indicator solution changed from red to light grey, showing that all the ammonia liberated had been trapped. That means the digest in the condenser was steamed through until enough ammonia gas captured by the boric acid.

Titration: The solution in the receiving flask was titrated with 0.1 mM HCl to a brown color. After titration the % of nitrogen was calculated as:

$$\text{Nitrogen (\%)} = \frac{(2)\ (Vs - VB) \times mMHCl \times 0.014008}{\text{Wt. of sample}} \times 100, \quad (2)$$

where Vs = Volume (mL) of HCl required to titrate sample; VB = Volume (mL) of acid required to titrate the blank; mM acid = Molarity of acid; _ = Weight of sample (g). Then, percentage of crude protein in the sample was calculated from the % nitrogen as:

$$\text{Crude protein (\%)} = \% N \times F, \quad (3)$$

where, *F* (conversion factor) is equivalent to 6.25 (AOAC, 2019). A blank was run through along with the sample and triplicate analysis was conducted for samples.

Determination of Crude Fibre

Six gram of the samples (*E*) was taken into 50 mL tube and 2.5 mL of alphaamylase was added and incubated at room temperature for 10ºmin. Then, 60 mL of a mixture composed of 700 mL 70% acetic acid, 100 mL 65% nitric acid and 20 g trichloroacetic acid was added. Digestion was undertaken in 250 mL ¦ask by heating at 200°C by continuous string at 500 rpm for 30ºmin. Then a.er cooling on ice, filtrated with vacuum filtration on dry filter paper with known mass (M*f*) by using distilled water until the .ltrate became neutral. The residue on the filter paper was washed with 10 mL ethanol for 3 times and 10mL acetone for 2 times to dissolve organic constituent. Then after transferring the dried residue with the filter paper into pre-weighted crucible, the residue was oven dried at 105°C overnight to drive off moisture. The oven dried crucible containing the residue and filter paper was cooled in a desiccator and weighted (M1). The residue and filter paper were burned first in Bunsen burner and then 550°C. The crucible containing white and grey ash (free of carbonaceous material) was cooled in a desiccator and weighted to obtain M2. The % of crude fiber was calculated as:

$$\text{Crude fiber (\%)} = \frac{(M1 - Mf) - M2}{E} \text{ X } 100 \quad (4)$$

Determination of Crude Fat*:* The crude fat in the samples was determined by automated Soxhlet extraction method (AOAC, 2019). After weighting the dried flask containing sand to constant weight, 15 g of homogenized samples were measured by using filter paper of known mass and placed in extraction flask. The dried ¦asks (250 mL) were weighed correspondingly and filled with 150 mL of petroleum ether. The extraction thimbles were plugged tightly with cotton wool and run for 2 h. The extraction chamber continuously filled with the sample there by

extracting the fat. When the optimum sensor reached, the magnetic valve was opened and the samples were washed with freshly filled solvent (petroleum ether). Finally, the solvent was recovered by collection in solvent tank. The fat was collected in filter paper and the extract was gently evaporated to dryness. The remaining petroleum ether was removed by sonication. The extraction flask containing crude fat in the filter paper was dried in 105°C to constant weight. The % fat in the sample was calculated using the formula:

$$\text{Fat (\%)} = \frac{\text{Wt. of flask containing the crude fat in filter paper} - \text{Wt. of flask plus filter paper}}{\text{Wt. of sample}} \times 100$$

Determination of Total Ash Content*:* A crucible was dried at 550°C for 30 min and cooled down in a desiccator for 1 h. The weight of crucible was measured (M1). Five grams of powdered sample was added in the dried crucible and the crucible containing sample was measured (M2). Then the sample was burned by using Bunsen burner until the steam of and then in oven at 550°C for 5 h. Ash is an inorganic residue remaining a.er the material has been completely burnt. The crucible containing ash was cooled in a desiccator and then re-weighted (M3) (AOAC, 2019). The % of ash contents in the cocoyam sample was calculated as:

$$\text{Ash (\%)} = \frac{M3 - M1}{M2 - M1} \times 100. \quad (6)$$

Determination of Total Carbohydrate*:* Total carbohydrate content was calculated adding the total values of crude protein, crude fat, crude fiber and total ash contents of the sample and subtracting it from 100%.

$$\text{Total carbohydrate (\%)} = 100 - \%\,(\text{Crude fiber} + \%\text{Crude protein} + \%\text{Crude fat} + \%\text{Ash})$$

Determination of Energy Value: Gross energy value (kcal/100 g) of the samples was determined by multiplying the protein content by 4, carbohydrate content by 4 and fat content by 9 (AOAC, 2005).

$$\text{Energy value} = (\text{Crude protein} \times 4) + (\text{Total carbohydrate} \times 4) + (\text{Crude fat} \times 9)$$

Determination of Mineral Content*:* Iron, Zinc, Copper, Magnesium, Manganese, Sodium and Potassium and Calcium were determined according to the standard method of AOAC (2019) using an Atomic Absorption Spectrophotometer (Varian SAA-20 Plus). Ashing of the samples was followed by digestion and absorption. Phosphorus was determined by AAS method of AOAC (16).

Analysis of Anti-nutritional Factors

Determination of Phytate*:* The phytate contents of two samples (PS and UPP) were determined according to method described by Latta and Eskin (17). Dried sample was extracted with 10 mL 2.4% HCl for 1 h at room temperature and centrifuged at 3000 rpm for 30 min. The clear supernatant was used for the phytate estimation. One ml of Wade reagent (0.03% solution of FeC13·6H2O containing 0.3% sulfosalicylic acid in water) was added to 3 mL of the sample solution and the mixture was centrifuged. The absorbance at 500 nm was measured using UV–VIS spectrophotometer. The phytate concentration was calculated from the difference between the absorbance of the control (3 mL of water + 1 mL Wade reagent) and that of assayed sample and expressed as mg/100 g.

Determination of Cyanide*:* Cyanide contents of the three samples were determined using the method of Burns (18). ¦ (0.25 g) was weighed in a screw capped test tube and 10 mL of 1% HCl in methanol was added to each test tube containing the samples. Then the tubes were put on mechanical shaker for 24 h at room temperature. After 24 h of shaking, the tubes were centrifuged at 1000 rpm for 5 min. One milliliter of the clear supernatant was taken and mixed with 5 mL of vanillin–HCl reagent in another test tube and this mixture was allowed to stand for 20 min to complete the reaction. After 20 min, the absorbance was read at 500 nm using spectrophotometer. The tannin concentration was calculated from the difference between the absorbance of control and that of the sample and expressed as mg/100 g.

Sensory evaluation

Sensory evaluation was carried out on the samples. A nine-point Hedonic scale was used to collect data from the judges. Data for this study was collected using direct contact approach. The samples were fed to the participants, and they were expected to express their opinions on the hedonic scale of from 1 = like extremely to 9 = dislike extremely.

Animal Care and Management

A total of 12 young adult wistar rats were purchased from the breeding unit of Animal and Environmental Biology Department Rivers State University Nkpolu Oroworukwo Port Harcourt. The experimental animals were divided into four different groups, 1-4 and separated into four different cages. The negative control served as group 1, pota snack group 2, unripe plantain pottage group 3 and pota snack and unripe plantain pottage combined group 4. The experimental animals were allowed to acclimatise for two weeks before administration. Body weight for each group was taken for four weeks during administration. The experimental animals were given clean tap water and fed ad libitum with the designated feed. The negative control group (1) were given normal rodents pellets and clean tap water, group 2 were given pota snack and clean tap water, group 3 were given unripe plantain pottage and group 4 were given both pota snack and unripe plantain pottage.

At the end of exposure period, the experimental animals were euthanized using chloroform and blood samples were collected for further analysis. Lipid profile which included total cholesterol (T chol), high density lipoprotein (HDL), low density lipoprotein (LDL) and triglycerides (TG) were determined using Randox Monza molecular kit and specification for the different parameters determined. One way analysis of variance was used to determine significant difference between the negative control group and the other experimental groups.

Method of Data Analysis

Mean and standard deviation were used to analyze the data from the questionnaires. Adequacy of nutrient intakes was compared with Dietary Reference intakes (DRI).

A comparative statistics and comparative analysis was conducted to present the difference in proximate composition (moisture, crude protein, crude fiber, crude fat, total ash, total carbohydrate and gross energy values), mineral contents (Ca, K, Na, Mg, Mn, Cu, Fe Zn and P) and vitamins. The formulated hypotheses were analyzed using Analysis of Variance (ANOVA) at the significant level of 0.05. Consequently, the H0 was retained when the p-value was greater than 0.05 ($p>.05$), otherwise rejected if the $p<0.05$.

EpiData Software (version 3.0.2, The EpiData Association, Odense, Denmark), and SPSS (version 25.0) were used for data entry and data management. All statistical analysis was undertaken using STATA version 15.0 (StataCorp, College Station, TX, USA). Results were presented as means ± standard deviations, frequencies and percentages.

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RESULTS PRESENTATION AND DISCUSSION

4.1 Results

The results from the research questions are presented in the following tables below.

4.1.1 Research Question 1: What are the dietary habits of undergraduates in Delta State, Nigeria?

Answer to this research question is presented in Table 4.1

Table 4.1: Scores (%) on Dietary Habits of Undergraduates

Dietary Habits	Males (n=23) F	%	Females (n=49) F	%	Total (72)	Average %	p-value
1. Depend on fast foods	17	73.9	39	79.6	56	77.7	0.7689
2. Own preparation	6	26	10	20.4	16	22.3	
3. Eat 1-2 times daily	8	34.7	15	30.6	23	31.9	0.6754
4. Eat 3 times or more	15	65.2	34	69.4	49	68.1	
5. Consume breakfast daily	18	78.2	36	73.5	54	75	0.8742
6. Consume breakfast sometimes	4	17.3	10	20.4	14	19	
7. No breakfast	1	4.3	3	6.1	4	6	
8. Lunch everyday	14	60.8	30	61.2	44	61.1	0.8954
9. Lunch sometimes	7	30.4	10	20.4	17	23.6	
10. No lunch	2	8.6	9	18.4	11	15.3	
11. Dinner everyday	20	86.9	39	79.6	59	81.9	0.7643
12. Dinner sometimes	3	13	9	18.4	12	16.7	
13. No dinner	0	0	1	2.0	1	1.4	
14. Snacking everyday	3	13	13	26.5	16	22.2	0.9152
15. Snacking sometimes	17	73.9	30	61.2	47	65.3	
16. No snacking	3	13	6	12.2	9	12.5	
17. Fried foods 1-2 times daily	9	39.1	15	30.6	24	33.3	0.8642
18. Fried foods 3 times or more	13	56.5	32	65.3	45	62.5	
19. No fried foods	1	4.3	2	4.1	3	4.2	
20. Eat vegetables 1-2 times daily	6	26	7	14.3	13	18.1	0.7653
21. Eat vegetables 2-more times	7	30.4	5	10.2	12	16.7	
22. No vegetables	10	43.5	37	75.5	47	65.3	
23. Eat fruits 1-2 times daily	4	17.3	10	20.4	14	19.4	0.8644
24. Eat fruits 3-more times	8	34.7	9	18.4	17	23.6	
25. No fruits	11	47.8	30	61.2	41	56.9	

Keys: F=frequency; %=percent

Table 4.1 shows the respondents' scores (%) on dietary habits of undergraduates in Delta State. The table shows that 77.7% (56) of the respondents depend on fast foods, while 22.3% (16) depend on foods prepared on their own. The table also shows that 31.9% (23) of the respondents had meals 1-2 times daily; while 68.1% (49) had meals 3 times or more daily. According to the table, 75% (54) of the respondents consumed breakfast daily; 19% (14) had consumed breakfast sometimes; and 6% (4) had no breakfast daily. The table further shows that 61.1% (44) of the respondents had lunch every day; 23.6% (17) had lunch sometimes, and 15.3% (11) did not have lunch. On dinner, 81.9% (59) had dinner every day; 16.7% (12) had dinner sometimes, and 1.4% (1) did not have dinner.

According to the table, snacking was reported every day for 22.2% (16) of the respondents; while 65.3% (47) and 12.5% (9) snacked sometimes and none at all respectively. As shown on

the table, 33.3% (24) of the respondents consumed fried foods 1-2 times daily; 62.5% (45) consumed fried foods 3 times or more daily, and 4.2% (3) did not consume fried foods. More so, 18.1% (13) of the respondents consumed vegetables 1-2 times on daily basis; 16.7% (12) consumed vegetables 3 times or more daily, while 65.3% (47) did not consume vegetables. Finally, 19.4% (14) ate fruits 1-2 times daily; 23.6% (17) ate fruits 3 times or more daily, while 56.9% (41) did not eat fruits daily. The p-values ranged between 0.675 to 0.915.

4.1.2 Research Question 2: What are the determinants of dietary habits of undergraduates in Delta State, Nigeria?

Table 4.2: Mean and Standard Deviation On The Determinants Of Dietary Habits Of Undergraduates in Delta State, Nigeria

	n=23 Males			n=49 Females					
Determinants of dietary habits are:	$\overline{X}$	**SD**	**RMK**	$\overline{X}$	**SD**	**RMK**	**AM**	**ASD**	**RM**
1. income size	2.90	.739	A	2.93	.766	A	2.91	0.751	A
2. weight loss regime	2.81	0.629	A	2.83	0.635	A	2.82	0.631	A
3. access to what is available	2.89	0.653	A	2.81	0.706	A	2.86	0.679	A
4. lack of time to prepare food	3.03	0.888	A	2.95	0.866	A	2.99	0.878	A
5. access nutrition information	2.85	0.707	A	2.79	0.631	A	2.82	0.672	A
6. peer pressure	2.70	0.616	A	2.71	0.596	A	2.71	0.606	A
7. addictions	2.89	0.714	A	2.93	0.711	A	2.91	0.712	A
8. food allergies	2.88	0.631	A	2.91	0.729	A	2.89	0.678	A
9. family food patterns	2.89	0.792	A	2.85	0.878	A	2.87	0.832	A
10. availability of healthy foods	3.02	0.862	A	3.14	0.943	A	3.08	0.901	A
11. lack of interest in cooking	2.82	0.707	A	2.80	0.670	A	2.81	0.689	A
12. inability to follow a balanced diet	2.63	0.604	A	2.65	0.566	A	2.64	0.586	A
Grand Mean									

Keys: $\overline{X}$ = mean; SD=Standard Deviation; n=no of sample

Table 4.2 shows the mean ratings of responses on the determinants of dietary habits of undergraduates in Delta State, Nigeria. The tables that the respondents agreed with all 12 items because they have mean scores ≥2.50 which was the cut-off mean mark. From the table, the highest average mean score was $\overline{X}$ 3.08 (item 10), while the lowest was $\overline{X}$ 2.64 (item 12). The average standard deviation ranged from 0.586-0.901.

4.1.3 Research Question 3: What are the health challenges of poor dietary habits of undergraduates in Delta State, Nigeria?

Table 4.3: Mean and Standard Deviation on The Health Challenges Of Poor Dietary Habits Of Undergraduates in Delta State, Nigeria

	n=140 Males			n=130	Females				
Poor dietary habits:	$\overline{X}$	**SD**	**RMK**	$\overline{X}$	**SD**	**RMK**	**AM**	**ASD**	**RMK**
1. leads to obesity/overweight in students	2.89	0.710	A	2.95	0.710	A	2.92	0.710	A
2. cause learning problems	2.82	0.616	A	2.80	0.597	A	2.81	0.606	A
3. cause memory problems	2.89	0.645	A	3.03	0.690	A	2.96	0.669	A
4. increases the risk of high blood sugar levels	2.93	0.776	A	2.97	0.776	A	2.95	0.776	A

5. causes energy problems	2.83	0.638	A	2.79	0.637	A	2.81	0.637	A
6. increases the risk of liver diseases	2.80	0.702	A	2.87	0.652	A	2.83	0.679	A
7. leads to increased risk of diabetes	2.99	0.862	A	2.94	0.882	A	2.97	0.871	A
8. leads to lack of concentration	2.80	0.620	A	2.86	0.706	A	2.83	0.662	A

Keys: $\overline{X}$ = mean; SD=Standard Deviation; n=no of sample; A=Agree; AM= Average Mean; ASD= Average Standard Deviation; RMK=Remark

Table 4.3 shows the mean ratings and standard deviation on the health challenges of poor dietary habits of undergraduates in Delta State, Nigeria. The table shows that the items 1-8 were agreed with because they had mean scores ≥2.5 which was the cut-off mark for the mean. The average standard deviation ranged between 0.606 and 0.871. The table also shows that the highest average mean score was $\overline{X}$ 2.97 (item 7) while the lowest mean score was $\overline{X}$ 2.81 (items 2 and 5).

4.1.4 Research Question 4: What are the nutritional values of diets compounded for the management of overweight among undergraduates in Delta State, Nigeria?

Answers to research questions 4 are presented in Tables 4.4 to 4.8 under the subheading – proximate, vitamins, minerals and anti-nutritional values of Pota Snack (PS) and Unripe Plantain Pottage (UPP).

Table 4.4: Proximate Compositions of Pota Snack (PS) and Unripe Plantain Pottage (UPP)

Samples	Moisture (%wWW)	Protein (%DW)	Fat (%DW)	Crude Fibre (D%W)	Ash (%DW)	Carbohydrate (%DW)	Gross Energy (kcal/100g)
PS	25.97±0.07^{a}	3.70±0.93^{d}	0.28±0.22^{b}	6.40±0.12b^{cd}	1.17±0.02	68.48±0.13^{a}	271.20±0.11^{a}
UPP	49.85±1.00^{c}	14.20±1.05^{e}	2.17±0.10^{d}	3.36±0.02^{cd}	0.19±0.02	30.23±1.06^{a}	241.24±1.06^{a}

Letters in superscript indicate the statistical differences among the samples; DW = Dry Weight, WW = Wet Weight
Data represent means of triplicate determinations

Key:

Pota Snack (PS): sweet potato flour, garlic and dates flour.

Unripe Plantain Pottage (UPP): unripe plantain, spinach, garden egg**,** tigernut and dates juices

Table 4.4 revealed the proximate compositions of Pota Snack (PS) and Unripe Plantain Pottage (UPP) compounded for the management of overweight among undergraduates in Delta state. The table shows that the moisture content of the diets were 25.97% in the PS and 49.85% (UPP). The crude protein contents are 3.70% (PS) and 14.20% (UPP). More so, the crude fibre values are 6.40% in the PS and 3.36% in the UPP. The ash content of the products on the table are 1.17% in the PS and 0.19% in the UPP. The fat contents are 0.28% in the PS and 2.17% in the UPP, while the carbohydrate values are 68.48% in the PS and 30.23% in the UPP. The table also shows significant differences in the proximate contents of the two diets.

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Table 4.5: Mineral Compositions (mg/100g) Of Pota Snack (PS) And Unripe Plantain Pottage (UPP)

Samples	Calcium	Magnesium	Sodium	Potassium	Phosphorus	Iron	Zinc
PS	9.78^{a}±0.03	67.41^{b}±0.05	3.11^{b}±0.08	237.24^{a}±0.09	0.88^{a}±0.04	0.75^{a}±0.02	76.14^{a}±0.02
UPP	9.22^{a}±0.02	71.19^{a}±0.01	11.13^{a}±0.03	241.22^{a}±0.04	0.90^{a}±0.01	0.61^{a}±0.03	78.01^{a}±0.03

The data are mean value ± standard deviation of triplicate results

Key:
Pota Snack (PS): sweet potato flour, garlic and dates flour.
Unripe Plantain Pottage (UPP): unripe plantain, spinach, garden egg**,** tigernut and dates juices
Table 4.5 shows the mineral compositions of Pota Snack (PS) and Unripe Plantain Pottage (UPP) compounded for the management of overweight among undergraduates in Delta state. The table shows that the calcium values are 9.78mg/100g in the PS and 9.22mg/100g in the UPP, while Magnesium values are 67.41mg/100g in the PS and 71.19mg/100g in the UPP. The sodium values are 3.11mg/100g in the PS and 11.13mg/100g in the UPP. The potassium values are 237.24mg/100g in the PS and 241.22mg/100g in the UPP. The phosphorus values are 0.88 mg/100g in the PS and 0.90 in the UPP. The table also shows that the Iron values are 0.75mg/100g in the PS and 0.61mg/100g in the UPP. The Zinc values are 76.14mg/100g in the PS and 78.01 in the UPP.

Table 4.6: Vitamin compositions Of Pota Snack (PS) And Unripe Plantain Pottage (UPP)

	Samples	
	PS	**UPP**
Vit A (IU)	184.40^{a}±0.20	179.42^{b}±0.16
Vit B12 (mg/100g)	1.96^{a}±0.18	1.26^{a}±0.22
Vit C (mg/100g)	0.83^{b}±0.16	1.24^{a}±0.10
Vit E (mg/100g)	0.64^{b}±0.01	1.8^{a}±0.22

Data represent means of triplicate determinations
Key:
Pota Snack (PS): sweet potato flour, garlic and dates flour.
Unripe Plantain Pottage (UPP): unripe plantain, spinach, garden egg**,** tigernut and dates juices
Table 4.6 shows the vitamins compositions of Pota Snack (PS) and Unripe Plantain Pottage (UPP) compounded for the management of overweight among undergraduates in Delta state. The table shows that PS has 184.40IU and the UPP has 179.42IU of Vitamin A, while the two diets have 1.96mg/100g (PS) and 1.26mg/100g (UPP) respectively for Vitamin B_{12}. Also, the table shows that the Vitamin C values are 0.83mg/100g (PS) and 1.24mg/100g (UPP). The Vitamin E values are 0.64 mg/100g and 1.8mg/100g for the PS and UPP respectively.

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Table 4.7: Anti-nutritional Components (mg/100g) Of Pota Snack (PS) And Unripe Plantain Pottage (UPP)

Samples	Phytate (mg/100g)	Oxalate (mg/100g)	Tannin (mg/100g)
PS	0.25^{b}±0.72	1.55^{a}±0.10	0.07^{c}±0.14
UPP	1.15^{b}±0.01	1.25^{a}±0.02	0.11^{c}±0.24

Data represent means of triplicate determinations
Key:
Pota Snack (PS): sweet potato flour, garlic and dates flour.
Unripe Plantain Pottage (UPP): unripe plantain, spinach, garden egg**,** tigernut and dates juices
Table 4.7 shows the mean responses on the anti-nutritional values of Pota Snack (PS) and Unripe Plantain Pottage (UPP) compounded for the management of overweight among undergraduates in Delta state. The table shows that the PS has phytate value of 0.25mg/100g while the UPP has 1.15mg/100g. The oxalate content of the PS is 1.55mg/100g, and 1.25mg/100g for the UPP. The tannin content is 0.07mg/100g in the PS and 0.11mg/100g in the UPP.

4.1.5 Test of Hypotheses

The following hypotheses were tested at 0.05 level of significance.
$H0_1$: There is no significant difference in the nutritional values of diets compounded for the management of overweight among undergraduates in Delta State, Nigeria.
Table 4.11: Summary of ANOVA on the Mean Rating of the Nutritional Values of Diets (Pota Snack – PS and Unripe Plantain Pottage – UPP Compounded for the Management of Overweight among Undergraduates in Delta State, Nigeria

Source of variation	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	4.131[a]	2	0.594	0.922	0.501
Intercept	7216.243	1	7016.243	10888.014	0.000
PS	0.000	1	0.000	0.001	0.001
UPP	0.172	2	0.086	0.013	0.013
Error	23.843	31	0.644		
Total	17433.000	36			
Corrected total	28.000	33			

a. R Squared = .148 (Adjusted R Squared = -.013)
Key:

Pota Snack (PS): sweet potato flour, garlic and dates flour.
Unripe Plantain Pottage (UPP): unripe plantain, spinach, garden egg**,** tigernut and dates juices
Table 4.10 shows that there was no significant difference in the mean rating of the nutritional values of diets (Pota Snack – PS and Unripe Plantain Pottage – UPP compounded for the management of overweight among undergraduates in Delta State, Nigeria, when analysed based on PS ($F1=0.01$, $p<.05$) and UPP ($F2=0.013$, $p<.05$). The hypothesis ($H0_1$) was thus rejected.

Discussion of the Findings

The findings from the research question on the dietary habits of undergraduates in Delta State were identified which aided in the characterization of dietary patterns including snacking frequencies, practices associated with skipping meals/irregular meals intake, low consumption of fruits and vegetables. First, the study revealed that majority of the respondents (77.7%) depended on fast foods, while only 22.3% prepared their own foods. This could be due to several reasons ranging from inability to cook in the hostel, lack of money, lack of time, lack of cooking skills or addiction to eating out. This implies that many students are exposed to several vended food-related risks, including the consumption of junks which make people prone to obesity. This is supported by Abbasi et al. (2017) who noted that fast food is associated with higher body mass index, less successful weight-loss maintenance and weight gain.

Nowadays, the prevalence of both fast food consumption and overweight/obesity has been increased. The percentage of caloric intake from fast foods has increased fivefold over the past three decades among adolescents (Eckstein et al., 2016). In addition, obesity prevalence increased dramatically worldwide as one of the most serious public health problem especially in childhood and adolescents in current century (Anderson et al., 2015). Fast food consumption has increasing' trend due to convenience, costs, menu choices, flavour and taste (Himes & Dietz, 2014). For example, more than 33% of adults and 17% of children and teenagers are obese in United States (Abbasi et al., 2017) where fast food consumption is higher. Increased food consumption and substantial changes in the food habits are the most important factors of obesity epidemic besides the poor diet among young people at recent years. Fast food consumption is strongly associated with weight gain and obesity. Fast food consumption could increase the risk of obesity and obesity-related diseases as a major public health issue. This finding also brings to question what kind of information students receive and its effectiveness in leading to healthy dietary lifestyle.

The study revealed that over 68.1% of the respondents ate 3 times or more daily. Further breakdown showed that 75% of the respondents had breakfast daily; 19% had breakfast sometimes; and 6% had no breakfast. More respondents (61.1%) had lunch every day; and 15.3% did not have lunch. Eighty-one percent (81.9%59) had dinner every day; only 1.4% did not have dinner. However, there was irregularity of food intake reported which could have serious implications for overweight and obesity. For example, it has been noted that it is not just what one eats, but also when one eats that affects health (Ipa, 2015). The implication of this is that having irregular meals may set one up for obesity, high blood pressure, and type 2 diabetes—regardless of how many total calories one is consuming.

According to Jackson et al. (2015), eating irregularly is linked to a higher risk of metabolic syndrome (high blood pressure, Type 2 diabetes, and obesity). These authors noted that many nutritionally related metabolic processes in the body follow a circadian pattern such as appetite, digestion and the metabolism of fat, cholesterol and glucose. Food intake can influence our internal clocks, particularly in organs such as the liver and intestine.

In this study's findings, snacking was reported every day for only 22.2% of the respondents; while 12.5% did not snack at all. More respondents (62.5%) consumed fried foods 3 times or more daily, only 4.2% did not consume fried foods. Sixty-three percent (65.3%) and 56.9% of the respondents did not consume vegetables and fruits on daily basis.

These findings reveal poor snacking which will lead to high consumption of calories. Although snacking is frequently linked to negative health outcomes and poor dietary habits, and has thus been considered a contributing factor in overweight or obese individuals, healthy snacking during the day, prevents one from getting ravenously hungry (Kakinami et al., 2015). One is more likely to grab a healthier snack than whatever sugary treat is closest. One is also less likely to overeat at main meals, which saves calories. Having a mid-morning and mid-afternoon snack can also amp up metabolism. When one is eating every few hours, the body is regularly processing food. This keeps metabolism busy burning calories all day. Snacking can also even cut blood sugar levels so one does not experience the spikes of insulin that can lead to weight gain (Jelalian et al., 2013).

The high preference of fried foods reported in this study could lead to risks for overweight and obesity, as well as other health impediments for students. In fact, trans fats are associated with an increased risk of many diseases, including heart disease, cancer, diabetes and obesity (Isco & Adekubi, 2017). Since fried foods are cooked in oil at extremely high temperatures, they are likely to contain trans fats. Because fried foods are made by absorbing oil, the result is a high-fat product. If the oil used is animal-derived, like lard or bacon grease, the resulting fried food will also be higher in cholesterol.

The study observed disproportionate levels of consumption of the different food groups such as consumption of fruits and vegetables which amounts to poor dietary lifestyles. Poor healthy dietary habits among undergraduate students have similarly been reported in many developing countries including sub- Saharan Africa countries such as Rwanda, Nigeria and Namibia (Kakinami et al., 2015). Foods like celery, radishes, leafy greens, citrus fruit, berries, melons and many other fruits and vegetables allow people to eat more, provide better nutrients, and help to satiate hunger because the high water content reduces total caloric intake during meals and snacks (Kano et al., 2015). Water and fiber in foods increase volume and thereby reduce energy density. In their natural state, fruits and vegetables have high water and fiber content and are low in calories and energy density. Fat increases the energy density of foods, while water and fiber decrease energy density.

The study further revealed that the dietary habits of undergraduates in Delta State were determined by income size ($\overline{X}$ 2.91); weight loss regime ($\overline{X}$ 2.82); access to what is available ($\overline{X}$ 2.86); lack of time to prepare food ($\overline{X}$ 2.99); access nutrition information ($\overline{X}$ 2.82); peer pressure ($\overline{X}$ 2.71); addictions ($\overline{X}$ 2.91); food allergies ($\overline{X}$ 2.89); family food patterns ($\overline{X}$ 2.87); availability of healthy foods ($\overline{X}$ 3.08); lack of interest in cooking ($\overline{X}$ 2.81); and, inability to follow a balanced diet ($\overline{X}$ 2.64). These findings are supported by Birdwell-Pheasant and Lawrence-Zúñiga (2019) who identified nutrition as a major challenge that students face while living in school. These authors stated that students are confronted with lack financial resources, personal food preferences or allergies, and the improper nutrition information usually peddled by their mates; all these singly or collectively impose serious nutrition challenges to students especially in developing societies.

Promoting healthy dietary habits can prevent adolescent overweight in which family may play a significant role. The knowledge, attitudes and practices model emphasizes that the acquisition of knowledge is the foundation of beliefs and attitudes that reinforce the intention to adopt healthy behaviours. Birch and Marlin (2012) noted that nutrition education by parents on both types of knowledge is a facilitator for adolescents to eat healthily, specifically, education on nutrition

benefits. For example, disease prevention, weight loss and growth, health consequences of unhealthy eating such as heart and kidney problems, and healthy food choice and cooking skills are areas that parents can impact positively on the children before they proceed to the higher institutions. However, parents with inaccurate knowledge can deliver messages that are inconsistent with what is taught at school, which confuses the adolescents.

More so, the study revealed that the health challenges of poor dietary habits among undergraduates are: obesity/overweight in students ($\overline{X}$ 2.92); learning problems ($\overline{X}$ 2.81); memory problems ($\overline{X}$ 2.96); risk of high blood sugar levels ($\overline{X}$ 2.95); energy problems ($\overline{X}$ 2.81); risk of liver diseases ($\overline{X}$ 2.83); increased risk of diabetes ($\overline{X}$ 2.97); lack of concentration ($\overline{X}$ 2.83). These findings are supported by the notion of Blasingame (2017) which stated that good nutrition, based on healthy eating is one essential factor that helps students to stay healthy and be active.

Students require healthy nutrition to function well. Providing adequate nutrition and rather enhancing diet with super foods improves mental learning performance manifold. Dietz (2017) noted that the spontaneity of student and concentration is much better when they are well nourished; this is turn improves the learning potential. Poor eating habits include under- or over-eating, not having enough of the healthy foods one needs each day, or consuming too many types of food and drink, which are low in fibre or high in fat, salt and/or sugar. These unhealthy eating habits can affect one's nutrient intake, including energy (or kilojoules) protein, carbohydrates, essential fatty acids, vitamins and minerals as well as fibre and fluid (Falkner et al., 2016).

Poor nutrition can impair daily health and wellbeing and reduce students' ability to lead an enjoyable and active life. In the short term, poor nutrition can contribute to stress, tiredness and the capacity to work, and over time, it can contribute to the risk of developing some illnesses and other health problems which can impact on academic outcomes (Hsia et al., 2012).

On the proximate values of the two diets developed for the management of overweight among undergraduate students, the moisture content was high in the snack (PS) at 25.97%, but normal in the UPP at 49.85%. The value of moisture in the snack is higher the value of 11.23% reported by Bo (2014). The moisture levels reported in this study showed that the snack would have shorter life span hence, not durable. The lower moisture content of the snacks will give them a storage advantage. The author noted that the high moisture content of most snacks was responsible for spoilage and the growth of microbes. It is arguable that the lower the risk of spoilage, the higher the possibility for food safety among students. However, the value reported in the portage (UPP) from unripe plantain shows it is normal because it close to the value of 48.3% reported by Kaboloormene (2022) for portage. This quantity of moisture makes it easily digestible. The crude protein contents were 3.70% (PS) and 14.20% (UPP). These values are similar to the values by Bo (2014) and Kaboloormene (2022) which reported 2.98% and 15.01% for snack and portage respectively. Crude proteins are essential because they provide the body with maximum energy (Ashokkumar et al, 2018). The importance of the energy requirement of this population (students) is based on the fact that it is exposed to physical and mental activities requiring significant energy. On the other hand, the crude fibre were 6.40% in the PS and 3.36% in the UPP. The values are close the values presented by Bo (2014) and Kaboloormene (2022) which were 6.99% and 3.1% respectively. The implication of higher fibre content for the diets is to help the consumer to be healthier by keeping the bowels working and moving other foods quickly through the body. Dashti and Mathew (2017) showed that dietary fibre in either soluble or insoluble form helps to reduce weight among overweight or obese.

The ash values were 1.17% in the PS and 0.19% in the UPP. These values are similar to the values of 2.00 found in maize meal by Adams et al. (2022). The analysis of ash content in foods is simply the burning away of organic content, leaving inorganic minerals (Dike et al., 2016). This helps determine the amount and type of minerals in food; important because the amount of minerals can determine physiochemical properties of foods. Also the fat contents were 0.28% in the PS and 2.17% in the UPP which are within the healthy values (0.33% - 2.11%) for young adults reported by Adams et al. (2022). The carbohydrate values were 68.48% in the PS and 30.23% in the UPP. The available carbohydrate content of the diets are close the 73.03% and 29.8% found by Gambo and Da'u (2014) in snack garnished with tiger nuts and sweet potato meal. Also, the energy values are in consonance with that reported by Palmore (2018). The energy requirements of the students especially those who are engaged in academic activities make these diets ideal for them.

The two diets (Pota Snack – PS and Unripe Plantain Pottage – UPP) formulated for the management of overweight among undergraduate students in Delta State showed rich mineral and vitamins compositions which make them healthy for students' consumption, especially in a bid to control body weight. Calcium had 9.78 mg/100g in the PS and 9.22mg/100g in the UPP; Magnesium had 67.41mg/100g in the PTS and 71.19mg/100g in the UPP and sodium had 3.11mg/100g in the PS and 11.13mg/100g in the UPP. These values are similar values reported by Bo (2014) which are 8.99mg/100g and 10.12 mg/100g (calcium); 71.21mg/100g and 66.10 mg/100g (magnesium); 4.14 mg/100g and 10.33mg/100g (sodium). Babu (2015) opined that foods that are high in fibre also tend to be packed with many important nutrients such as calcium, magnesium, and potassium. Calcium is needed for growing and building strong bones and teeth. Understanding calcium needs for different age groups requires a consideration of the variable physiologic requirements for calcium during development.

It has been noted that calcium may elicit its anti-obesity role by modulating fat metabolism, with decreased fat synthesis and increased fat breakdown. Increasing calcium intake through diets can reduce body weight in subjects who have a normal BMI or in children and adolescents, adult men, or premenopausal women (Atay & Bereket, 2016). The authors also added that dietary calcium plays a pivotal role in the regulation of energy metabolism because high-calcium diets attenuate adipocyte lipid accretion and weight gain during the overconsumption of an energy-dense diet and increase lipolysis and preserve thermogenesis during caloric restriction, which thereby markedly accelerates.

Also, Magnesium (Mg^{2+}) deficiency is probably the most underestimated electrolyte imbalance. It is frequent in obese patients, subjects with type-2 diabetes and metabolic syndrome, both in adulthood and in childhood (Baker et al., 2020). Obesity is the result of unhealthy diets, high in calories, but poor in essential nutrients. As a consequence, obese subjects are often Mg^{2+} deficient (Atay & Bereket, 2016). The sodium value reported in this study are adjudge adequate. A study had noted that high salt intake is the major cause of raised blood pressure and accordingly leads to cardiovascular diseases. Recently, it has been shown that high salt intake is associated with an increased risk of obesity through sugar-sweetened beverage consumption (Baker et al., 2020).

The potassium values were 237.24 mg/100g in the PS and 241.22mg/100g in the UPP; phosphorus 0.88 mg/100g in the PS and 0.90 in the UPP, while iron had 0.75mg/100g in the PS and 0.61mg/100g in the UPP. Also, zinc had 76.14mg/100g in the PS and 78.01 in the UPP. These results showed that diets had significant amounts of these minerals which are essential for

the management of obesity and overweight. The values are close to the values reported by Bo (2014) for healthy foods for young people. In the Bo's study, potassium was 229.7 mg/100g; phosphorus was 0.88 mg/100g; iron was 0.81 mg/100g; zinc was 79.3 mg/100g respectively.

Potassium gives the body components necessary to provide energy for physical activity by aiding in its use of metabolism-boosting nutrients, including iron, magnesium and calcium (Allan & Crow, 2019). Adequate daily potassium intake can reduce the risk of obesity. In addition, these findings support adequate intake of fruits and vegetables, which are major sources of potassium. Intake of phosphorus was found to be significantly associated with decreased risk of obesity by Chapman (2019). This author noted that low phosphorus status has been positively associated with increased body weight. This may be attributed to the impact of hepatic adenosine triphosphate (ATP), which depends on adequate dietary supply of phosphorus, on suppressing food intake.

Zinc (Zn) deficiency is a common problem in obese individuals. Zinc helps metabolize protein, carbs, and fat, and when one does not have enough, one can experience reduced energy, and sluggishness (Dooyema et al., 2017). On the other hand, iron has been found to be beneficial for control of overweight. This can be for both medical and lifestyle reasons. For example, if one is trying to improve iron intake through diet and the consumption of iron-rich foods, this is likely to lead to an increase in healthy meals, which can contribute to weight loss.

Conclusion

This study has highlighted the critical role of dietary habits in the management of overweight among undergraduates in Delta State, Nigeria. The research findings indicate that a significant portion of the student population exhibits poor dietary behaviors, such as high dependence on fast foods, irregular meal patterns, and low consumption of fruits and vegetables. These habits contribute to the rising prevalence of overweight and obesity, which poses substantial health risks, including an increased likelihood of metabolic disorders, cardiovascular diseases, and compromised academic performance. The study also identified various determinants of dietary habits, including socioeconomic factors, access to nutritional information, and lifestyle choices, all of which significantly influence students' food consumption patterns. The experimental diets developed in this study—Pota Snack (PS) and Unripe Plantain Pottage (UPP)—were found to be nutritionally adequate, offering a balanced composition of essential nutrients and minerals that can help manage weight and reduce the risk of obesity-related health issues.

Given the complex interplay of factors affecting dietary habits and health outcomes, it is imperative for educational institutions, health professionals, and policymakers to collaborate in promoting healthier lifestyles among students. This can be achieved through targeted nutrition education, increased access to healthy food options, and interventions that address the broader socio-cultural and economic factors influencing students' dietary choices. Implementing such strategies will be essential in mitigating the growing public health challenge of overweight and obesity among undergraduates in Delta State and beyond..

Recommendations

Based on the findings of the study, the following recommendations were made:

i. The recipe for the diets (Pota Snack – PS and Unripe Plantain Pottage – UPP) should be circulated on campus for students to adopt.
ii. Food vendors should be presented with the recipe to be included in their meals.
iii. The processing method of the PS should be reviewed to ensure a further reduction in moisture in order to increase the shelf life of the product.

iv. Students should be encouraged to cultivate a culture of healthy snacking as this will enable a reduction in cravings for food.

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