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Research paper

Evaluation of the Effect of Ultra-Processed Food (UPF) Consumption of Cardiometabolic Risk in Professional Nigerian Adults: A Quantitative Study

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Abstract

Background and objectives: to evaluate the effect of ultra-processed food (UPF) consumption on cardio-metabolic risk in professional Nigerian adults.
Methods: Using standard methods, frequency, prevalence, and health implications of UPF consumption of respondents were determined. A cross-sectional study design was adopted, with a simple random sampling method in selecting 250 participants from five faculties in the College of Medical Sciences, University of Calabar, Nigeria. Data were collected using a structured web-based questionnaire, collated using Microsoft Excel software, and analysed using a combination of Chi-square (X2) test, one-sample t-test, and Pearson's correlation analysis using SPSS software.
Findings: The overall frequency of UPF intake was relatively low, with a significant ($P<0.05$) relationship with participants' age. The impact of participants' UPF consumption frequency on body mass index, systolic, and diastolic blood pressure was insignificant ($P >0.05$). The participants' high level of knowledge of UPFs is a key factor in explaining this finding. However, a significant ($P<0.05$) moderate correlation between BMI and systolic blood pressure was observed, which is consistent with existing information in scientific literature.
Conclusion: This study revealed that the overall UPF consumption frequency was significantly low, which correlated positively with the low BMI and BP, which may be due to a high level of knowledge of UPF consumption and its effect on overall health. However, the study recommends a similar study with a larger sample size.

Keywords: *Blood Pressure; Body Mass Index; Cardio-Metabolic Risk; Food Choice; Ultra-Processed Foods*

1. Introduction

In recent years, there has been a steady rise in the incidence of metabolic disease conditions globally, and several factors have been implicated as the major drivers of this trend. A study by Wang et al. [1] indicated that rapid economic development and social advancements have greatly contributed to an increased in the incidence of metabolic disease risk factors such as high systolic blood pressure (SBP), high low-density lipoprotein cholesterol (LDL-c), high fasting plasma glucose (FPG), and high body mass index (BMI). Historically, the prevalence of metabolic diseases in Africa has been relatively low, and there has been a dramatic change in the incidence of these diseases in Africa in the last two decades. [1] Factors such as dietary changes, rapid urbanization, socioeconomic factors (such as poverty and food insecurity), environmental factors (such as increased use of plastics and packaging leading to exposure to endocrine disrupting chemicals such as phthalates and bisphenol A as well as increased air pollution due to industrialization), poor sleep and chronic stress, lack of access to healthcare and education, etc. [2 - 4] A study by Oguoma et al. [5] implicated demographic changes such as ageing, and undesirable risk factors such as obesity and sedentary life as the key drivers of the rapid epidemiological transition to increasing number of metabolic disorders that Nigeria is currently undergoing. Another study by Okafor [6] implicated the dramatic departure from traditional African lifestyles to Western lifestyles in the last few years as a major driver of the reported rise in metabolic disorders on the African continent.
The traditional Nigerian diet is composed of foods that either exist in their whole or minimally processed forms, like root tubers, cereals, pulses, nuts, and seeds. [7] Whole and/or minimally processed foods offer protection against a wide array of chronic metabolic diseases. [8] On the other hand, ultra-processed foods have been shown to induce chronic systemic inflammation, which promotes the activation and proliferation of inflammatory mediators such as free radicals/reactive oxygen species that attack cell membrane-bound polyunsatu-

rated fatty acids, leading to lipid peroxidation, oxidative cellular damage, and potential cellular dysfunction. [9] Mounting evidence has demonstrated a direct link between the consumption of ultra-processed foods and an increased risk of metabolic derangements, thus underscoring its role in the aetiology of metabolic disorders such as cardiovascular diseases (CVDs), hypertension, obesity, diabetes, etc. [10], [11] The prevalence of cardiovascular diseases has been increasing steadily over the last 20 years. [12] Systematic review data shows a CVD prevalence of between 2.1% and 4.14% for Nigeria.7 While this range is generally lower or comparable to other countries in sub-Saharan Africa, it is indicative of the epidemiological data challenges that Nigeria faces, including incomplete health records, underreporting in rural areas, and limited access to diagnostics, which can lead to underestimation of actual prevalence. [13]
Certain components of ultra-processed foods (such as saturated fats, trans-fats, sodium, refined sugar, and additives such as preservatives and emulsifiers) have been identified as influencers of metabolic processes that ultimately result in deterioration in health. [14] Cardiometabolic conditions such as cardiovascular disease, hypertension, and obesity are associated with very high health costs, which are often borne by the affected individuals and their families, and to some extent by the government. The poor economic situation in Nigeria makes handling a cardio-metabolic disease diagnosis very difficult. The importance of carrying out an investigation on the possible drivers of dietary behaviour is crucial as mounting evidence continues to show links between poor dietary choices and the onset of cardio-metabolic problems. [15] To effectively promote healthy nutrition among working professionals, the determinants of dietary behaviour and behavioural change must be properly understood. Behavioural theories such as the social cognitive theory (SCT) may help to address some personal, behavioural, and environmental factors that may influence health behaviour by encouraging sustainable and translatable behavioural change. [16] This theory informs interventions that target UPFs' consumption by emphasizing the role of social influence, personal agency, and environmental change. [17] A study by Anton et al. [17] demonstrated that SCT constructs, such as enhancing self-efficacy, can be employed to support the initiation of behavioural changes in weight loss interventions. SCT can also be used to shape behavioral change interventions by modelling healthy behaviours (using peers, influencers, or community leaders to demonstrate healthy eating habits), altering outcome expectations (via educating individuals about the health risks associated with UPFs) and modifying environments (by increasing the availability and accessibility of healthier food choices in workplaces and stores/restaurants). [18]
Using standard population methods, this study examined the frequency of ultra-processed food consumption relative to age, level of knowledge of the health implications of ultra-processed food consumption, evaluated the level of cardio-metabolic risk, and determined the drivers of ultra-processed food consumption behaviour among working professionals (university lecturers). This type of participant was chosen to represent working professionals in this study because of the increasing prevalence of cardio-metabolic conditions (such as heart disease and strokes) among this segment of the population.19

2. Research methods

2.1 Study design

This study adopted a cross-sectional study design.

2.2 Sampling strategy

The simple random sampling method was adopted for the recruitment of participants for this study, and the randomization process was achieved by adopting the following strategies:

2.3 Research setting

The setting of a study is crucial in determining the outcome and significance of the study. The College of Medical Sciences, domiciled at the University of Calabar (a second-generation University in Nigeria), is composed of five faculties, from which participants (lecturers) were recruited for the study.

2.4. Recruitment strategy

Participant recruitment was conducted using web-based questionnaires. An email containing a link to a Google questionnaire was sent to participants (lecturer). These forms contained a participant information sheet on the front page (that explained what the study is all about, the benefits of the study to participants and the wider society, as well as the ethical considerations and how identified ethical issues were resolved) and an informed consent form on the second page of the form. The participants were only allowed to complete the form after giving their consent by selecting the “agree” check box.

2.5. Sample size

The sample size for the study was determined based on the total number of eligible lecturers available at the four selected faculties (250). The study utilized 20% of the total number of finite samples as the sample size, which equates to 50. This sample size agrees with the sample sizes used in other population-based studies with a similar study protocol.[20], [21].

2.5.1 Inclusion criteria

i) Age: This study included only participants between the ages of 18 and 44 years.
ii) Employment: Only academic staff (lecturers) in the selected faculties (Allied Medical Sciences, Basic Medical Sciences, Clinical Sciences, and Medical Laboratory Science) were eligible for this study. The participants were recruited based on the following designations: graduate assistant, assistant lecturer, senior lecturer, associate professor, and professor. This was done to ensure that respondents are familiar with the subject matter of the research and therefore do not require any form of explanation during the data collection process.
iii) Ownership of a blood pressure test kit or willingness to obtain personal blood pressure readings from a personal clinic or hospital to allow for self-reporting of blood pressure on the day of completing the form.

iv) Ability to self-report anthropometric measures such as height and weight was important to allow the investigator to calculate the body mass index of each participant using the formula: weight (kg)/square of height in metres (m2).12

2.5.2 Exclusion criteria

i) Age: People below the age of 18 and above the age of 44 were excluded from taking part in the study.
ii) Employment: Non-academic staff and lecturers in faculties outside the five faculties stated in the inclusion criteria were excluded from the study.
iii) Inability to self-report blood pressure reading due to either a participant's inability to obtain a blood pressure test kit or a lack of willingness to obtain personal blood pressure readings from a clinic or hospital.
iv) Inability to self-report anthropometric measures such as height and weight.

2.6 Data collection

A structured web-based questionnaire was used to collect participant data. Google Forms was used as the data collection platform of choice. Following recruitment for the study, participants accessed the online questionnaire through web links in the survey request e-mail that they had received before the recruitment process.

2.6.1. Description of the web-based questionnaire

The first page of the questionnaire consists of an informed consent form, which the participants were mandated to read before selecting the "agree" check box to proceed to take part in the study. Selection of the "disagree" check box by participants led to termination of the study. The pages after the consent page contain the structured questions. Participants were required to self-report their blood pressure readings, weight, and height, to allow for calculation of body mass index by the researcher. The types of ultra-processed foods listed in the questionnaire are standard ultra-processed foods that are sold in fast-food restaurants, grocery stores, and regular shops in Nigeria.

2.7. Data analysis

Following collation, the data from participants were analysed using a combination of Chi-square (X2) test, one-sample t-test, and Pearson's correlation analysis through the statistical package for social sciences software system (version 27.0.1.0).

2.8. Ethical considerations

During the preparatory phase of this study, a few ethical considerations were made, including:
i) Participant informed consent: The study ensured that potential participants were up to the age of 18 and therefore able to voluntarily make informed decisions without any coercion or assistance, thereby ensuring that participants' right to opt in or opt out was guaranteed.[13].
ii) Data Protection/Storage: The participant information sheet was used to inform participants about the kind of information (age, height, weight and blood pressure) that they were expected to provide, what exactly would happen to such personal information (for the study only), where this information would be stored (on the researchers encrypted USB stick and laptop computer to prevent unauthorised access) and for how long such information would be stored (two months post-study).

3. Results

3.1 Analysis of the frequency of ultra-processed food consumption data

Study participants were given three consumption frequency options to select the option that best describes their ultra-processed foods consumption frequency. A total of 14 common ultra-processed food categories were provided, and participants were asked to choose which ultra-processed foods they consume and the frequency with which they are consumed. The data obtained was then collated, and the average frequency of intake was calculated using Microsoft Excel, and a chi-square test was conducted as shown below.

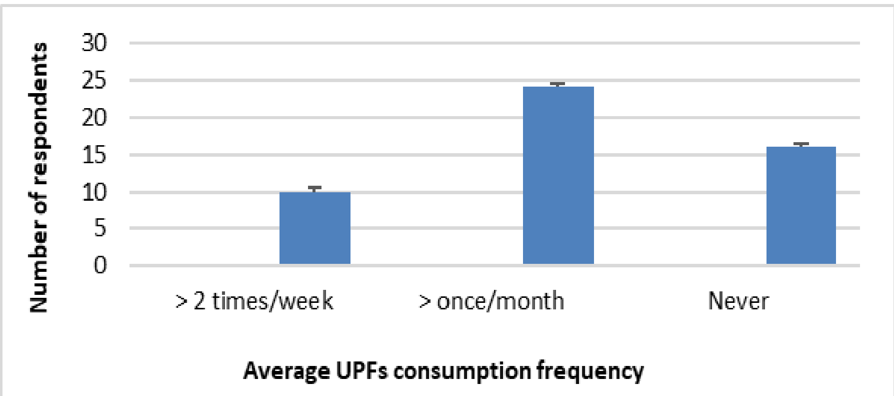

Fig. 1: Average Frequency of UPFs Consumption.

The chi-square test was not statistically significant at (X^2 (2) = 5.92, p<0.05) and showed that although 'more than once a month' was the most common response, it was not significantly different from other responses, especially the 'never' response. Therefore, the high frequency of UPFs consumption among the Nigerian professionals who took part in this study was once per month.

i) Analysis of Demographic Data

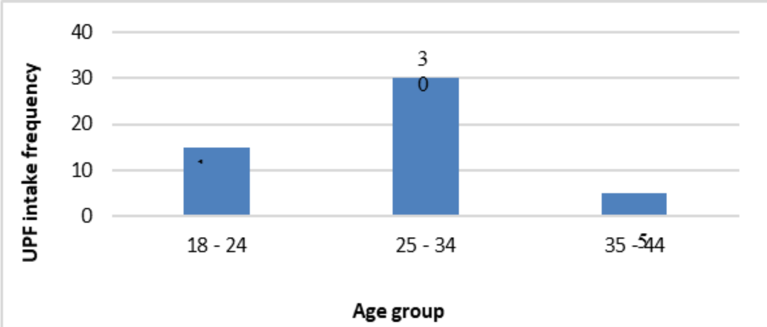

Fig. 2: Relationship between Participants' Age and Frequency of Ultra-Processed Foods Consumption.

The chi-square test was statistically significant, a (X^2 (2) = 19.00, p<0.05, and showed that Participants in the 25-34 age group had the highest response to how frequently UPFs are consumed, followed by participants in the 18-24 and 35-34 age groups, respectively.

ii) Designation and Frequency of Ultra-processed Foods Consumption

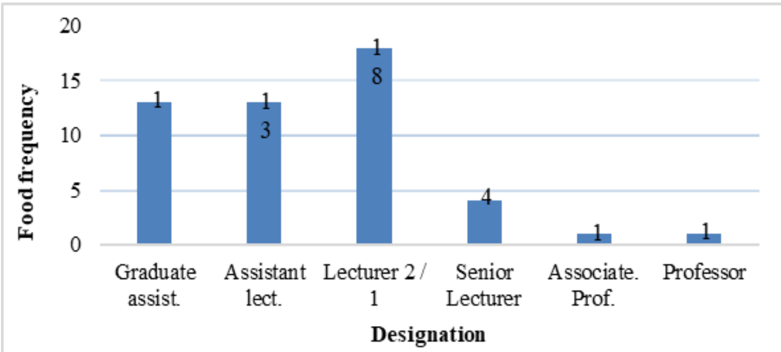

Fig. 3: Relationship between Participants' Designation and Frequency of UPF Consumption.

The chi-square test was statistically significant a (X2 (5) = 31.60, p<0.05) and showed that participants with lecturer 2/1 as designation had the highest response of 18, which was significantly different from other responses. Therefore, professionals in the lecturer 2/1 group consume UPFs more frequently than any other group.

3.2 Analysis of anthropometric measures of adiposity and cardiovascular disease indicators data

i) Body mass index analysis

BMI was determined by the participant's weight in kilograms divided by the square of height (in meters). The resultant BMI was then collated for each participant. Based on the participants' responses, the individual body mass index was then grouped according to the WHO [12] classification system and tallied against participant responses to the original body mass index question. The average response was then determined and tabulated as shown in Table 1 below. The responses were then analysed using the one-sample t-test. The one-sample t-test compared the BMI data in this study against the WHO's normative value of 24.9.

Table 1: Classification of Participants' BMI

BMI Class	Number of participants
Underweight	5
Normal weight	29
Pre-obesity	10
Class 1 Obesity	5
Class 2 Obesity	1
Class 3 Obesity	0

The one-sample T-test showed that BMI in this group of participants was not significantly (mean = 23.46 ± 4.82 kg/m^2) greater than the normative value of 25 (t (49) = 2.26, P<0.05).

ii) Blood Pressure Analysis

Responses to the question on BP were collated and classified according to the WHO [6] classification system. The average response was calculated and tabulated as shown in Table 2 below. The responses were then analysed using the one-sample t-test. The one-sample t-test compared the systolic and diastolic BP data in this study against the WHO's normative value of 120 and 80 for systolic and diastolic BP, respectively.

Table 2: Classification of Participants' Systolic BP

Blood Pressure Class	No of participant
Low	9
Normal	18
Pre-hypertension	16
Stage 1 hypertension	7
Stage 2 hypertension	0

The one-sample T-test showed that systolic BP in this group of participants was not significantly (mean = 124.46 ± 11.89 mmHg) higher than the normative value of 120 (t (49) = 2.41, P<0.05).

Table 3: Classification of Participants' Diastolic BP

BP Class	No of participant
Low	1
Normal	23
Pre-hypertension	18
Stage 1 hypertension	6
Stage 2 hypertension	1

The one-sample T-test showed that diastolic BP in this group of participants was not significantly (mean = 79.26 ± 12.16 mmHg) greater than the normative value of 79 (t (49) = 0.43, P<0.05). However, the responses show that a relatively high number of participants are in the pre-hypertensive stage.

iii) Comparison between Body Mass Index and Systolic Blood Pressure Data

Participant body mass index and systolic blood pressure data were subjected to a Pearson's correlation analysis as shown in Figure 4 below.

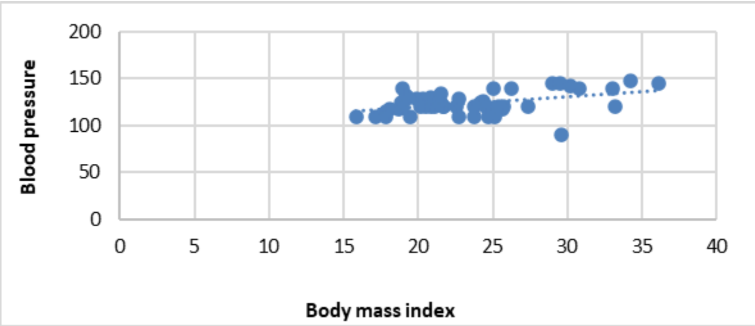

Fig. 4: Relationship Between BMI and Systolic BP.

The correlation analysis showed that there was a significant moderate correlation between BMI and systolic BP (r = 0.43, P < 0.05).

iv) Comparison between BMI and Diastolic BP

Participant BMI and diastolic BP data were subjected to a Pearson's correlation analysis as shown in Figure 5 below.

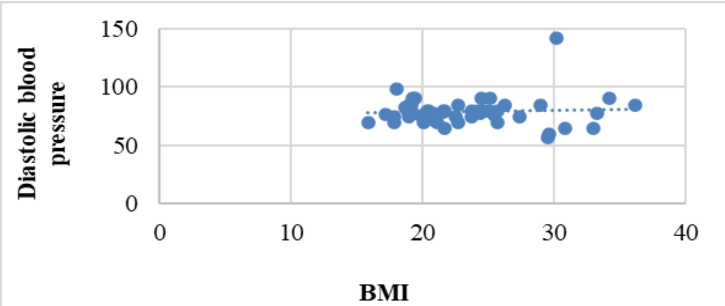

Fig. 5: Relationship between BMI and Diastolic BP.

The correlation analysis showed that there was no significant correlation between BMI and diastolic BP (r = 0.12, P < 0.05).

3.3 Analysis of perception data

i) Knowledge of Metabolic Conditions Associated with Ultra-processed Foods Consumption. Participants were required to pick from a list of eight different health conditions they think may be associated with UPF consumption. Their response data was then analysed using the chi-square test.

ii) Level of Ultra-Processed Food Knowledge and UPFs Consumption Frequency. Participants were required to select from a list of 10 popular food items the foods that they considered to be ultra-processed. Their responses were then collated and analysed using a chi-square test (as shown in Figure 6 below).

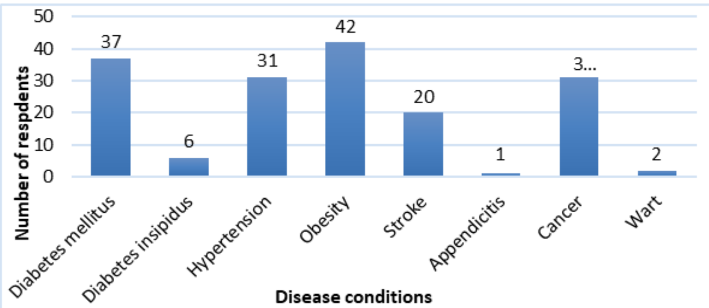

Fig. 6: Disease Conditions Reported by Respondents.

The chi-square test was significant a (X^2 (5) = 88.64, $p<0.05$) and showed that respondents were more concerned about obesity than other health conditions. On average, 32.2 responses (64.5%) were associated with the five health conditions (cancer, DM, hypertension, obesity, and stroke) on the list that have a scientifically proven relationship with UPFs. This shows that participants in this study have a significant level of knowledge about the health implications of consuming UPFs. The result, therefore, explains why participants' frequency of UPFs consumption (as shown in Figure 6) was insignificant.

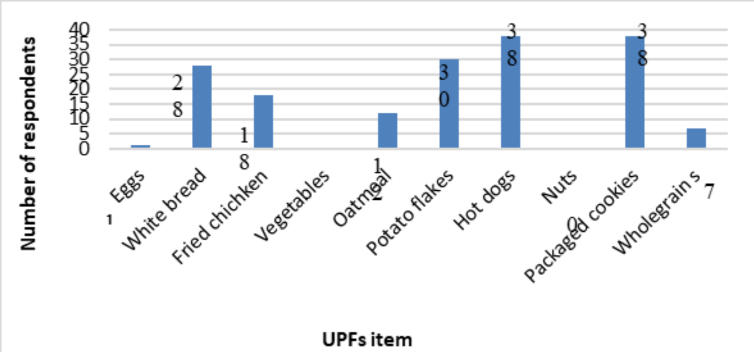

Fig. 7: Level of UPFs' Knowledge.

The chi-square test was significant a (X^2 (5) = 64.74, $p<0.05$) and showed that more participants viewed hot dogs and packaged cookies as UPFs, more than any other UPFs product. On average, 30.4 responses (60%) selected five food items (white bread, fried chicken, potato flakes, hot dogs, and packaged cookies) on the list than any other UPFs product. This shows that participants in this study have a significant level of knowledge about what UPFs are. This result, therefore, explains why participants' UPFs' frequency of consumption (Fig. 2) was insignificant.

iii) Reasons for Consuming UPFs

Participants were given a list of popular reasons for consuming UPFs and were required to select the reasons they considered to be important drivers of their UPFs consumption behaviour.

Table 4: Reasons for UPF Consumption

Reason for UPF consumption	Responses	Percentage
Appealing taste/flavour/texture	37	74%
Limited time to make home meals	6	12%
Less tendency for spoilage	31	62%
Availability	42	84%
Affordability	20	40%
Nutrient content	1	2%

The chi-square test was significant a (X2 (5) = 25.12, $p<0.05$) and showed that availability is the most important reason for consuming UPFs.

4. Discussion

The result of the study found the overall frequency of UPFs intake of the Nigerian professionals to be less than two times a week, with up to a quarter of participants reporting no consumption of UPFs. The results showed a significant ($P<0.05$) relationship between participant age and frequency of UPFs consumption, with participants within the 25 – 34 age group consuming the most amount and those within the 35 – 44 age group consuming the least amount of UPFs. Similarly, there was a significant ($P<0.05$) relationship between participant designation and frequency of UPFs consumption, with participants designated as lecturers 2 or 1 being the most frequent UPFs consumers, followed by assistant lecturers and graduate assistants. Interestingly, there was a significant decline in the consumption pattern of participants in the highest employment cadre (senior lecturer, associate professor, and professor). The study therefore shows a downward trend in UPFs consumption as age and designation increase. Furthermore, the impact of participants' UPFs consumption frequency on BMI and BP was statistically insignificant ($P<0.05$) when compared with the WHO normative value of 25. Also, systolic and diastolic BP were statistically insignificant ($P<0.05$) when compared with the WHO normative value of 120/80. Although the findings revealed an insignificant correlation between BMI and diastolic BP, it also showed a significant ($P<0.05$) moderate correlation between BMI and systolic BP. This agrees with a study by Landi et al. 23 who reported a significant linear relationship between systolic BP and BMI across all levels.

The findings also showed that 42% and 36% of participants in this study were very concerned and extremely concerned respectively about their UPF intake, which could be explained by their significantly ($P<0.05$) high level of knowledge of the health implications of consuming UPFs, which could explain the reported low UPFs consumption frequency. This agrees with findings by Pedro-botet et al. [24], which implicated ignorance as a key driver of consumption frequency. This study also agrees with the report of Anton et al. [17], who revealed that behavioural theories such as the social cognitive theory can be used to shape behavioural change interventions by modelling healthy behaviours and modifying environments. In this regard, since the study population is highly educated individuals, the low UPFs consumption frequency might have been attributed to their knowledge and awareness of the implications of UPFs' excess consumption. In addition, a significant ($P<0.05$) number of participants (84%) in this study reported the availability of UPFs as the major reason for consuming these foods, with nutrient content being the least reason (2%). These findings are at variance with some other studies, which reported affordability as the main driver of UPF consumption. [25] However, the finding that 74% considered appealing taste/flavour/texture as a major reason for UPF consumption agrees with other studies that also consider appealing taste/flavour/texture as a key driver of UPF consumption. [20]

Although the study showed a significant level of knowledge about UPFs consumption, it also revealed other reasons that could drive the negative behavioural patterns (that is, seen in a small segment of the population, which consumes a relatively modest amount of UPFs). After considering the participant's prior behaviour, cognition, social and physical environment, the study found that the drivers of behaviour toward UPFs consumption is multifaceted, comprising mainly of factors such as the availability, appealing organoleptic characteristics, affordability, and shelf-stability of UPFs as well as other possible environmental factors such as television, social media, and billboard advertisement. This multifaceted causal structure characterizes the social cognitive theory and therefore justifies its use in adopting a reasoned action approach in addressing the negative behavioural patterns associated with the poor food choices of the study population. Because the root causes of the population's behavioural pattern are known, future behaviour can be predicted, and more sustainable interventions initiated. For example, through advocacy, the population can be made to feel that they can exercise restraint in the amount and frequency of UPF consumption, while reasonably expecting that their newly adopted behaviour will have a positive outcome. [16] While the sample size is limited, the findings of this study provide valuable preliminary insights and a foundation for future research. It is important to acknowledge potential limitations in the accuracy of the reported BP and BMI data. However, to enhance accuracy and minimize bias, the study ensured that only participants who had access to measurement tools (BP monitor) were sampled, as well as ensured that participants were provided with clear instructions on how to carry out the required objective measurements. To assess reliability, the self-reported data were compared with objectively measured values provided by the WHO. Though the study sample size may be small, a similar study with a larger sample size is recommended.

5. Conclusion

This study found that the overall UPFs consumption frequency was significantly low. The study also found that participants had insignificant BMI and BP values. There was also no correlation between UPFs consumption frequency and BMI/BP. The participant's high level of knowledge regarding UPFs and their overall impact on health may be a key factor in explaining the low UPFs consumption frequency, low BMI/BP, and the lack of correlation between UPFs consumption frequency and BMI/BP. A high level of knowledge of UPFs, therefore, plays a pivotal role in ensuring that people make informed choices regarding food choices, which is central to the prevention of chronic metabolic conditions. The study therefore revealed that the high level of knowledge and awareness of this population regarding UPFs intake may have been responsible for the reported low UPF consumption frequency.

6. Implications for theory and policy

Since BMI and BP are important cardio-metabolic disease risk indicators [26], their management is necessary to prevent future cardio-metabolic events. [27] The findings of this study provide a means to inform government policy to reduce UPFs' consumption. The findings also provide the immediate benefit of assisting the management of the University of Calabar to develop and implement advocacy programmes to inform academic staff of the negative effects of UPFs, as well as provide information on the importance of reading food product labels and portion control to reduce the negative impact of UPFs on cardio-metabolic health.[28] Also, this study provides the university management with the scientific basis to encourage the proliferation of whole food canteens/restaurants to ensure the availability of UPFs alternatives such as fresh fruits, minimally processed wholegrain snacks, and locally made staple foods. Furthermore, this study highlights the fact that reducing processed food alone may not be sufficient to improve metabolic health, especially in regions where people are facing economic barriers to healthy diets such as high cost of nutritious food, poverty and low income, unstable employment and income, lack of nutrition education, competing financial priorities, etc. [29].

7. Recommendations for research

This study's scope covered the effect of UPFs consumption frequency on anthropometric measures such as BMI, measures of cardiovascular health such as BP, the effect of age and designation on the frequency of UPFs consumption, and the role of knowledge and attitude towards the consumption of UPF. It, however, did not consider the impact of UPFs consumption on other cardio-metabolic conditions such as type 2 diabetes. Therefore, a future study may require potential participants to provide fasting blood glucose readings. More so, because BMI is not sensitive enough in differentiating between body fat and muscle mass,30 it might be beneficial to widen the scope of the study to include other anthropometric measures such as body fat percentage and lean body mass. A larger sample size study is also recommended. Equipment such as callipers and measuring tapes can be used to achieve this.

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