

## Assessment of nutritional status and anthropometric compositions of over-nourished adults (36-64 years) in Imo State, Nigeria

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### ABSTRACT

Nutrition deals with the utilization of food nutrients by the body for growth, development, maintenance, and physical activities. Often, ignorance, misunderstanding and malpractice lead to malnutrition, especially among adults. The nutrition status of overnourished adults is characterized by lifestyles, excessive energy and nutrient intake, leading to health complications. This study was conducted to assess the nutritional status and anthropometric composition of overnourished adults (36-64 years) in Imo State, Nigeria. This longitudinal study recruited 432 overnourished adults through multi-stage random sampling techniques as the subjects. It was divided into before intervention, intervention and after intervention stages with subjects grouped into groups 1, 2, and 3 (the experimental groups) and group 4 (the control group). Anthropometric and dietary methods of nutrition assessment were applied to assess the nutrition status before and after the intervention. While a combination of nutrition education/counseling, dietary reduction and planned physical activities were used as the intervention in the experimental groups, no intervention was carried out on the control group. Data was collected using conventional machine tools and manually produced plaster-of-Paris-based food model visual aids and analyzed using statistical package for social science (version 25) and double method. The results showed that there were statistically significant reductions in nutrient intakes of group 1 and group 3 ( $p = 0.001$ ), statistically significant in the planned physical activities of group 2 and group 3 ( $p = 0.000$ ), and statistically significant improvements in overnutrition indices ( $p < 0.05$ ) in the experiment groups after the intervention, with no noticeable change on group 4. In conclusion, this study established that a combination of nutrition education/counseling, dietary reduction and planned physical activities have positive effects on the anthropometric indices of overnourished adults (36-64 years). Therefore, overnutrition indices among adults (36-64 years) in Imo State can be improved and sustained through a combination of nutrition education/counseling, healthy dietary reduction (healthy rations) and planned physical activities. And nutrition status and lifestyle modifications should be a compulsory subject/course of its own in all levels of education in Imo State.

**Keywords:** nutrition assessment, nutrient deficiencies, dietary patterns, malnutrition, preventive counselling

### INTRODUCTION

Nutrition is the art and science of food use and how the body utilizes food nutrients for growth, development, maintenance and physical activities [1]. In contracting, malnutrition can be regarded as a condition that refers to a deficit or excess of various nutrients. A lot of studies showed

that when individuals grow older, their energy intake decreases, and anorexia is the most common cause of malnutrition among such age of individuals [2]. Sufficient diet and proper nutrition are important health determinants in the older population. It was reported that nutritionists use knowledge or ideas from molecular biology, biochemistry, genetics and sociodemographic characteristics to understand how nutrients affect the human body [1, 2]. Nutrition also

focuses on how people can use dietary choices to reduce the risk of diseases. The following nutrients are derived from foods as they include; proteins, carbohydrates, fats/oils, vitamins, minerals, fiber, and water. According to Life Sciences Research Office (LSRO) [3], they are classified into two groups, as macronutrients (those needed in large quantities) and micronutrients (those needed in small quantities). Holmes and Racette opined that the body composition assessment in nutrition help to understand the right balance of nutrients through the dietary intake, and nutritional status determine the quantity of food nutrients gained by the body. It also indicate if there is a significant risk of developing certain health conditions among populace [4].

The study in [5] opined that nutritional status is the physiological state of an individual resulting from the multiple relationships between nutrient intakes, requirements and storage, and from the body's ability to digest, absorb and utilize these nutrients. It is the current body status of an individual or a population group, related to their state of nourishment. Nutritional status is determined by a complex interaction between internal/constitutional factors such as age, sex, nutrition, behavior, physical activity and disease and external environmental factors such as food safety, cultural, social and economic circumstances [6]. Therefore, nutritional status is the condition of the body as a result of the intake, absorption and use of nutrition, as well as the influence of disease-related factors. In an individual or population of interest, nutritional status is determined through assessment.

According to United States Department of Health and Human Services (USDHH) [7], Nutritional assessment is an in depth evaluation of both objective and subjective data related to an individual's food and nutrient intake, lifestyle and medical history. According to [8], nutritional assessment can be defined as a structured way to establish the nutritional status and energy requirements by objective measurements and whereby, accompanied by objective parameters and in relation to specific disease indications, an adequate (nutritional) treatment can be developed for a patient and occurs preferably using multi-sectoral approaches. It is a comprehensive analysis of a person's nutritional status that uses health, socio-economic, drug and dietary history, anthropometric measurements, physical examination/clinical symptoms and biochemical/laboratory tests. Patterson et al [9] added. National Research Council (NRC) [10] stated that nutritionists agree that the general purpose of nutritional assessment is to identify individuals or population groups at risk of becoming malnourished, identify individuals or population group who are malnourished, develop healthcare programs that meet the community needs which are defined by the assessment and to measure the effectiveness of the nutritional programs and interventions once initiated. Once data is collected and analyzed, the nutritionist can interpret the results. A nutritional assessment can be used for patients at risk for malnutrition and patients in whom it can contribute to determination of the diagnosis.

According to World Health Organization (WHO) [11], normal/optimal nutritional status is a body mass index (BMI) range of 18.5 kg/m<sup>2</sup>-24.9 kg/m<sup>2</sup>. In line with the definition, there are four nutritional indicators, such as stunting, wasting, overweight and underweight. These indicators are used for determining imbalances/malnutrition resulting from undernutrition or over nutrition, which join normal/optimal

nutrition to form the three general categories of nutritional status.

Malnutrition, in every form, presents significant threats to human health. Today, the world faces a double burden of malnutrition that includes both undernutrition and over-nutrition, especially in low-and-middle income countries like Nigeria [12]. The study in [13] noted that there are multiple forms of malnutrition, including undernutrition (wasting or stunting), inadequate vitamins or minerals (hidden hunger), over nutrition (overweight and obesity), and resulting diet-related non-communicable diseases (NCDs). The developmental, economic, social, and medical impacts of the global burden of malnutrition are serious and lasting for individuals, families, communities and countries.

Over nutrition is a form of malnutrition in which the body receives excessive supplies of food nutrients leading to the accumulation of fats that impairs health and well-being [14]. That is, the quantity of intake surpasses the quantity needed for normal growth, development, maintenance, physical activities and metabolism, which adversely affect health status. Generally speaking, over-nutrition and hunger are global health challenges that require to be properly addressed. WHO [12] reported that 2.9 billion adults were overweight and 900 million (35%) adults globally were over nourished while 42 million children were overweight or obese. And 42% of the USA have obesity according to Center for Disease Control and Prevention (CDC) [15], while over nutrition costs the worldwide economy \$2.1 trillion yearly. WHO concluded that over nutrition is a serious threat to public health. Before, it was generally believed by the public that only developed nations would face the challenges brought by over-nutrition, but it is not the case now. WHO precisely observed that the phenomenon of over-nutrition is now plaguing more frequently among countries with prevalent hunger and undernutrition, and hence over-nutrition is a growing global challenge.

Nutrition in adults (overweight and obesity), which is a risk factor of type II diabetes, cancers, joint/mobility challenges, mental health problems (like depression and anxiety), hyperlipidemia, hypertension and other cardiovascular diseases including stroke, is usually a product of dietary habits and lifestyle [16, 17]. It is characterized by excessive energy and nutrient consumption, which leads to unhealthy outcomes that include complications if interventions are not initiated. The key indicators are BMI greater than or equal to 25 kg/m<sup>2</sup> (overweight) and/or greater than or equal to 30 kg/m<sup>2</sup> (obesity), men's waist circumference greater than 102 cm, women's waist circumference greater than 88cm, fat intake greater than 35% daily calories, salt intake greater than 2,300 mg/day and sedentary/low physical activity level (less than 150 minutes/week).

Over-nutrition (overweight and obesity), which was previously seen as a nutritional challenge of the industrialized countries, is now being experienced as a serious emerging public health challenge in both low-and-middle-income countries. There were about 21 million overweight and 12 million obese Nigerians, respectively, in 2022. It is possible that Nigeria is the most affected African country. Sedentary and low levels of exercise, rural-urban drift, unhealthy dietary habits, psychological factors, etc., are mainly implicated in this high burden [17]. Research has shown that over-nutrition significantly increases the risks of type II diabetes, hypertension, other cardiovascular diseases and premature

deaths worldwide [18]. According to WHO [11], apart from genetic and other socio-demographic factors, environments which include unhealthy dietary habits, sedentary lifestyles, alcohol and tobacco intake etc., are the precursors of hyperlipidemia and over-nutrition.

Diet has been described as the sum total of foods consumed by a person or population groups at a mealtime [19]. It is food and drink regularly/habitually provided for nourishment to the body. Diet is also a kind and amount of food regimen prescribed for a person for a special reason. Diet can be adequate when it contains all the food classes in both the right proportions and qualities, or inadequate in nature when the reverse is the case. Nutritionists believe that living on a healthy diet throughout one's lifetime helps one to prevent malnutrition in all its forms as well as a range of NCDs including cardiovascular diseases and other conditions [20]. Nowadays it has been observed that, increased consumption of unhealthy foods such as processed meats, refined grains, added salts and sugars, low consumption of fruits and vegetables, whole grains and lean meats, rapid urbanization and changing lifestyles.

An estimated 1.28 billion adults aged 30-79 years worldwide are over nourished, most of them (two-thirds) living in low-income and middle-income countries. The prevalence is expected to increase to 29% by 2025 driven by ignorance, negligence and change in value systems mostly in the developing nations [21]. An estimated 46% of adults with over-nutrition are unaware of the condition. This nutritional/health condition is overlooked until organic damage is done in the body systems. Over-nutrition which often manifests through hyperlipidemia can incubates many NCDs asymptotically, therefore mere look may not confirm over-nutrition [11]. WHO [12] report indicates that prevalence of overweight ranges from 20.3-35.0% while obesity ranges from 8.1-14.5% and pool prevalence of over-nutrition stands at 14.5%. In a systematic review in [22] in the 6 geopolitical zones of Nigeria, puts prevalence of over-nutrition among men 27.6% and woman 14.5%, respectively. They estimated prevalence among urban 39.2 % and rural 37.5% dwellers, respectively. It was observed that this varies among the geo-political zones with South-East having 29.3%, highest. Related report indicates further revealed that NCDs contribute to 29% of deaths in Nigeria and cardiovascular diseases with route to over-nutrition account for 11% of the deaths [11]. Hypertension linked to over-nutrition is a primary contributor to heart disease and stroke, the first and third leading causes of death worldwide, as well as the top modifiable risk factor for disability adjusted life-years lost worldwide in 2020 [15].

Following the data results critically reviewed from the two approaches in a work done in [23]; physical activities were combined with a low-trans fats diet and the results reduced LDL cholesterol from 15-7% and triglycerides (TGs) levels from 18-4% while HDL cholesterol increased from 5-14%. And later physical activities combined with food supplements (fish oil, oat bran and plant sterols) with reduced LDL cholesterol reduced from 8-3% while HDL cholesterol increased from 2-8% [23].

Although lifestyle which include unhealthy dietary habits and lack of physical exercise among other factors have been implicated as risk factors for over-nutrition among adults, there is limited research on the influence of lifestyle modifications of dietary habit and physical exercise achieved through sustained nutrition counseling/education and follow-ups on the nutritional profile of patients suffering from over-

nutrition in Imo State. There is no research that has combined nutrition counselling/education, dietary assessment and physical activities in the both management and control of both overweight and obesity (over-nutrition) in Imo State. Therefore, this research paper titled assessment of nutritional status and anthropometric composition of over-nourished adults (36-64 Years) in Imo State, Nigeria is considered necessary for the control and prevention of nutritional associated health problems.

Meta-analysis subjected data as observed in [24], showed that a positive effect of regular aerobic physical activities was raised HDL cholesterol levels by an average of 1.9-2.5 mg/dL (0.05-0.06 mmol/L). Other effects included decreases in LDL cholesterol, total cholesterol and TG levels by an average of 3.9; 3.9 and 7.1 mg/dL (0.10, 0.10, and 0.08 mmol/L), respectively [25]. According to [26], increased adiposity is a key driver of TG elevation and it contributes to insulin resistance. It was observed that patients without overweight or obesity (BMI < 25 kg/m<sup>2</sup> or < 23 kg/m<sup>2</sup>), should be avoiding weight gain while maintaining healthy lifestyle habits among themselves. For patients with overweight or obesity, weight loss decreases TGs in a dose-dependent manner. Medically, there is always significant reductions in TGs with sustained weight loss of 3-5% of body weight [26, 27]. It was also stated that the minimum amounts of physical activities required to raise HDL cholesterol level is 900 kcal of energy use/week or 150-minute of moderate aerobic physical activities [25]. While HDL cholesterol rose by average of 9% (3.7 mg/dL or 0.01 mmol/L) while TG reduced by 11% (19.3 mg/dL or 0.22 mmol/L) among the patients of cardiovascular diseases [28]. According to [29], the improvement in the level of HDL cholesterol could be attributed to more amount of the physical activities than the intensity in the fitness.

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## MATERIALS AND METHODS

### Study Design

The study adopted a cross-sectional survey to identify the vulnerable (those at risk) subjects and then followed by the case control experimental intervention design involved only the vulnerable respondents as participants [28]. The research study was in three phases that lasted for 24 weeks (6 months) as suggested by AHA [29, 30]. The three phases were: Baseline assessment phase, Intervention phase, and post-intervention phase.

### Area of Study

The study was carried out in the three senatorial zones (Owerri, Orlu, and Okigwe) of Imo State. Imo State is one of the states in south-eastern Nigeria and has its capital in Owerri. The state lies approximately between latitudes 40.45IN and 70.15IN of the equator, and latitudes of 60.50IE and 70.25IE between the Greenwich meridian with an area of about 5,100 km<sup>2</sup>. Imo State's population of 2023 is 5, 459, 300, with 2,

713,272 (49.7%) males and 2, 746, 028 (50.3%) females, ranking 14th of the 36 states of Nigeria.

Imo State is bounded on the north by Anambra State, to the east by Abia State, to the south by Rivers State and on the west by Rivers State. Because of its central location in the South-East geopolitical zone of Nigeria, the state is nicknamed the Eastern Heartland and the inhabitants are called the Imolites. The state economy is highly dependent on agricultural production, especially production of oil palm produce, which the majority of the inhabitants use for their cooking, in addition to civil/public service. The key minor industry is the extraction of crude oil and natural gas going-on in both northern and western parts of the state.

### Study Population

The study population composed of male and female middle-aged adults (36-64 years) who are either overweight or obese in all the selected local government areas (LGAs) in Imo State.

### Sample Size Determination

The following formula in [31] was used to determine the sample size for the indefinite population:

$$n = \frac{Z^2 \times P \times (1-P)}{d^2}, \quad (X)$$

where  $n$  is the sample size,  $Z$  is the confidence level (1.96 for 95%),  $P$  is the adult pool prevalence of over nutrition (= 14.5%), 1 is the constant, and  $d$  is the precision/marginal error test of significance (0.05). Sample size can be calculated as follows:

$$n = \frac{1.96^2 \times 0.145 \times (1-0.145)}{0.05^2} = 191. \quad (X)$$

$n$  is 20% of 191. Thus,  $n = 38$  (to nearest whole number) and  $n = 38 + 25\%$  of 38 (in case of withdrawal).  $n = 38 + (25/100 \times 38) = 38 + (950/100) = 38 + 9.5 = 47.5$ . Hence,  $n = 48$  approximately for each LGA. Therefore,  $n$  for the 9 LGAs =  $48 \times 9 = 432$  subjects. For each gender =  $432/2 = 216$  subjects and for each of the 4 groups =  $432/4 = 108$  (male and female subjects).

### Sampling Technique

The study area has three senatorial zones, namely; Okigwe Zone with 6 LGAs. Owerri Zone has a total of 9 LGAs and Orlu Zone has a total of 12 LGAs, giving a total of 27 LGAs. In the first stage, simple random randomization was used to select 9 LGAs out of 27 LGAs in the state through a ballot process.

One LGA in every 3 LGAs in each zone. In each senatorial zone, 1 LGA was selected from every cluster of 3 LGAs. Therefore, 2 LGAs were selected from Okigwe Zone, which has 6 LGAs, 3 LGAs from Owerri Zone with a total of 9 LGAs and 4 LGAs were selected from Orlu Zone with a total of 12 LGAs. In all, a total of 9 (2 + 3 + 4) LGAs were selected as the participating LGAs in the study. In Okigwe Zone: Okigwe and Obowo; Owerri Zone: Owerri Municipal Council, Ikeduru and Ngor/Okpala while in Orlu Zone Njaba, Oguta, Ideato North and Nkwere LGAs were all selected.

Using the simple random sampling technique, all the LGAs in a given zone were written on a piece of white paper and folded with the writing inside hidden in a ball-like piece. For example, in the Okigwe zone with 6 LGAs, 6 white paper balls with each bearing 1 LGA each were put inside a bowl and reshuffled several times. A research assistant closed his/her

eyes and picked 1 white paper bearing 1 LGA and opened without replacement. The LGA selected stood automatically as a participating LGA. The whole process was repeated till the number of required LGAs were selected from that zone. At the end, 9 LGAs were selected to participate in the research and the Comprehensive Primary Health Center served as the meeting venue. At each LGA, all autonomous communities are listed and mobilized by the LGA's nutrition officer through their Traditional Rulers (Ndi Eze) for free nutritional screening and counseling. People were screened serially as they came using BMI measurements. The first 48 overweight and obese within the age range of 36-64 years old (24) males and (24) females ( $BMI \geq 25 \text{ kg/m}^2$ ), respectively, were identified by study participants. A simple random sampling technique involving balloting was used to select the experimental groups and the control group, respectively. For each gender, 24 white pieces of paper were used to categorize participants. The 24 white pieces of paper were divided into 4 groups and named groups 1 to 4, respectively (6 white papers in each group). Number 1, 2, 3, and 4 were boldly written on each white paper in groups 1, 2, 3, and 4, respectively. Each of these number on the white papers was folded in a ball form with an inscription inside/hidden. All of them were put inside a bowl and reshuffled many times to ensure a thorough mixture.

The identified subjects in each gender were encouraged to queue up in a single line, picked and opened before everyone, only one number-bearing ball of paper. A research assistant was behind the 24th person in the queue to avoid re-entrance after the first attempt. He or she followed the queue till the last person picked up and publicly opened the ball-like white paper. Those who picked numbers 1, 2, 3, and 4 were assigned 'reduced food intake per day (½ of the usual portion size intake) only', 'daily vigorous/moderately active physical exercise only', 'reduced food intake per day (½ of the usual portion size intake) and 1-hour daily physical exercise only' and 'control group receiving no intervention' but asked to have blood pressure check daily, respectively. The whole process was repeated for the other gender group. At the end, four subject groups were established with each group having 6 male and 6 female participants, respectively.

### Validation of the Study Instruments

The study instruments were validated by the lecturers of nutrition and dietetics department, Imo State University, Owerri, Imo State. This helped with necessary adjustments in the instruments. Also, approval to use Comprehensive Primary Health Centers on a weekly basis was sorted and obtained from the Imo State Primary Health Care Development Agency.

### Lifestyle modification intervention

This was carried out in the following three phases.

**Baseline phase:** In the baseline, assessments of the dietary habits and physical activity levels of the subjects were carried out. It was reported that dietary intake and physical activity can be determined using assessment tools developed to record dietary food intake [32]. It was reported that aerobic vigorous/moderately physical activity level, bioelectric impedance and digital glucometer with strips [33]. The dietary food intake records and international physical activity questionnaires were administered to each individual for 3 consecutive days (2 working weekdays and 1 weekend day, which were Thursday, Friday, and Saturday) for each subject. These dietary food intake record tools contain questions on

socio-demographic variables. There were assessments of height, weight, waist and wrist for the body frame and waist-hip ratio (WHR) calculations. The results were analyzed as a baseline nutritional status and physical activity level of each subject. In each LGA, LGA's nutrition officer served as a research assistant. The study excluded community members who were less than 36 years and above 64 years old, pregnant, breastfeeding and very ill.

**Intervention phase:** After the baseline assessments, the subjects were counselled and followed-up daily through group WhatsApp platforms, phone calls, SMS and weekly unannounced home visits for each group member in the experimental groups. And there were physical meetings twice-weekly, which were at each LGA's Comprehensive Health Center for nutrition education and nutrition counselling for 24 weeks using developed curriculum on nutrition education/counselling and physical activities according to the group's assigned role(s). Lesson notes for groups 1, 2, and 3 were on 'reduced food intake by (1/2 usual portion sizes) per day only', 'physical exercise only' and 'reduced food intake by (1/2 portion sizes) per day and physical exercise', respectively. Those using 'physical exercise' were asked to perform physical exercise of their choice for 1 hour daily. Group 4 (control group) had no lesson notes and members were asked to live their normal lifestyles with a daily blood pressure check. The double-blind method was adopted, meaning that both the respondent participant and the nutritionist statistician did not know the group each subject belonged to. The nutrition education and counselling curriculum using education for effective nutrition in action methods for lifestyle modifications was used, which incorporated recipes for the DASH diet and examples of aerobic physical activities according to groups adopted from the food guide pyramid (21<sup>st</sup> century food guide pyramid). These were organized lesson notes and checklists for the three groups receiving interventions. All subjects, no matter what group, were strictly monitored and followed up.

Every subject in the experiment group posted pictures of home intervention activities assigned to his or her group on the group's platform daily as an indication of compliance and encouragement to others. There were both individual and group corrections when the need arose. The tools for the nutrition education and counseling/follow-up were a 7-day DASH menu plan and a check list for lifestyle modifications.

**Post intervention phase:** At the end of the 24 weeks, there were post intervention phase assessments. The whole process carried out during the baseline assessments phase were repeated. The results were analyzed and compared with the baseline assessment data, among the experimental groups and between the experimental groups and the control group.

### Method of Data Collection and Processing

Data were collected and processed in phases as follows.

#### Dietary habit assessments

The tool used was quantitative and qualitative 24-hour dietary record. This was used for 3 days, 2 working weekdays and 1 weekend day which were Thursdays, Fridays, and Saturdays, for each subject on each assessment phase as advised by USDH [7]. The tool contained questionnaire for socio-demographic data. Other tools were food model visual aids (VAs) 1, 2, 4, 5, and 6 for food portion size estimations. These VAs were food models, some which were designed and molded by researchers with a mixture of plaster-of-Paris (PoP),

fibre, and water and acquired commercial ones. Dimensions of local and foreign commercial cooked dishes of foods following food groups in the food guide pyramid (grains and cereals, milk and dairy products, meat, poultry and fish, roots and tubers, fruits, vegetables, nuts, seeds and dry beans, fats and oils, alcohol, soft drink, and other beverages and sweet/sugar groups), were used in molding the food models. Some of the food items were plates of rice, maize, beans, fufu/akpu, garri, yam, cocoyam, potato, Bambara nut paste, fish, meat, plantain etc., local commercial fruits such as pawpaw, orange, pineapple, banana, mango, carrot were bought and their respective dimensions used to produce the local food models. Equally, models of commercial confectionaries/snacks such as groundnuts, bean cake (akara), burns, bread, cake, etc., were produced. The models were used to estimate the quantities/portion sizes of foods consumed by each subject. They were produced in two sets. The first set was used for the baseline assessment, while the second set was used for the intervention activities and post-intervention assessments. Those for intervention were labelled VAs 7, 8, 9, 10, 11, and 12. The nutritional labels of canned/packaged foods, biscuits of all kinds, wines/drinks and beverages of all kinds were used to estimate the quantities consumed. Standard utensils were also used to quantify palm wines, oil of all kinds, sugar, and condiments consumed. The West African food composition table and Nigerian food composition table [34, 35] were used to calculate the estimated nutrients therein in the estimated quantities of foods and drinks/wines/beverages consumed by each subject. Data values obtained were compared with the daily UK reference nutritional intake and USA daily recommended dietary allowance [34], in other to draw inference on nutrient consumption status of each subject.

#### Method of data analysis

The collected data was processed and coded using Excel spreadsheets for analysis. It was analyzed using computer software called statistical package for social science.

#### Ethical clearance and letter of informed consent

Ethical approval was obtained from the Imo State Ministry of Health Ethical Committee. Approval for the release of the LGA nutrition officers to function as assistants and testimonials of the research were obtained from the Imo State Primary Healthcare Development Agency, Owerri, Imo State. The subjects were provided with letters of informed consent each before the study started.

## RESULTS

### The Socio-Demographic Characteristics of the Subjects by the Groups

In **Table 1**, age distribution reveals that 36-40 years represent the largest proportion of the study population with 111 (25.6%) and group 4 has the highest number of subjects with 32.4% compared to others. Those who fell between 60-64 years recorded the second highest percentage (19.4%) and more subjects were seen in group 1 with 25.0%. Those in 55-59 years had least percentage (8.5%) with highest number of the subjects 12.0%, came from group 3 and group 4, respectively. Chi-square test ( $\chi^2 = 28.318$ ,  $p = 0.057$ ) shows statistical significance, suggesting potential differences in the age distribution.

**Table 1.** Socio-demographic characteristics of the subjects by the groups

Variables	Group 1	Group 2	Group 3	Group 4	Total	X <sup>2</sup> -value	p	
Age group (years)	36-40	25 (22.5%)	25 (22.5%)	26 (23.4%)	35 (31.5%)	111 (100%)	<b>28.318<sup>a</sup></b>	<b>0.057</b>
	41-45	19 (22.6%)	30 (35.7%)	21 (25.0%)	14 (16.7%)	84 (100%)		
	46-50	17 (23.6%)	15 (20.8%)	23 (31.9%)	17 (23.6%)	72 (100%)		
	51-54	13 (29.5%)	14 (31.8%)	4 (9.1%)	13 (29.5%)	44 (100%)		
	55-59	7 (18.9%)	4 (10.8%)	13 (35.1%)	13 (35.1%)	37 (100%)		
	60-64	27 (32.1%)	20 (23.8%)	21 (25.0%)	16 (19.0%)	84 (100%)		
Gender	Male	54 (50.0%)	54 (50.0%)	54 (50.0%)	54 (50.0%)	216 (50.0%)	<b>0.007<sup>a</sup></b>	<b>1.000</b>
	Female	54 (50.0%)	54 (50.0%)	54 (50.5%)	54 (50.0%)	216 (50.0%)		
Marital status	Same sex	2 (50.0%)	2 (50.0%)	0 (0.0%)	0 (0.0%)	4 (100%)	<b>19.608<sup>a</sup></b>	<b>0.355</b>
	Mixed sexes	89 (23.1%)	95 (24.8%)	99 (25.8%)	100 (26.1%)	383 (100%)		
	Widow/widower	9 (28.1%)	8 (23.5%)	9 (28.1%)	6 (18.8%)	32 (100%)		
	Single	2 (40.0%)	2 (40.0%)	1 (20.0%)	0 (0.0%)	5 (100%)		
	Cohabit/mixed	3 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (100%)		
	Divorcee	1 (33.3%)	1 (33.3%)	0 (0.0%)	1 (33.3%)	3 (100%)		
Family size	Separated	2 (66.7%)	0 (0.0%)	0 (0.0%)	1 (33.3%)	3 (100%)	<b>12.871*</b>	<b>0.169</b>
	1-3	33 (34.4%)	19 (19.8%)	22 (22.9%)	22 (22.9%)	96 (100%)		
	4-7	61 (23.2%)	70 (26.6%)	68 (25.9%)	64 (24.3%)	263 (100%)		
	8-11	14 (20.3%)	16 (23.2%)	18 (26.1%)	21 (30.4%)	69 (100%)		
Monthly income in Naira	Above 11	0 (0.0%)	3 (75.0%)	0 (0.0%)	1 (25.0%)	4 (100%)	<b>21.277*</b>	<b>0.011</b>
	N10,000-30,000	55 (25.8%)	50 (23.5%)	61 (28.6%)	47 (22.1%)	213 (100%)		
	N40,000-70,000	27 (20.3%)	30 (22.6%)	28 (21.0%)	48 (36.1%)	133 (100%)		
	N80-110,000	18 (32.7%)	15 (27.3%)	11 (20.0%)	11 (20.0%)	55 (100%)		
Education level	N150,000+	8 (25.8%)	13 (41.9%)	8 (25.8%)	2 (6.5%)	31 (100%)	<b>25.761*</b>	<b>0.002</b>
	No formal	13 (28.9%)	9 (20.0%)	11 (24.4%)	12 (26.7%)	45 (100%)		
	Primary	26 (25.7%)	27 (26.7%)	28 (27.7%)	20 (19.8%)	101 (100%)		
	Secondary	32 (18.1%)	38 (21.5%)	45 (25.4%)	62 (35.0%)	177 (100%)		
Occupation	Tertiary	37 (33.9%)	34 (31.2%)	24 (22.0%)	14 (12.8%)	109 (100%)	<b>24.147*</b>	<b>0.150</b>
	Trader	50 (27.3%)	35 (19.1%)	56 (30.6%)	42 (23%)	183 (100%)		
	Artisan	12 (17.9%)	20 (29.9%)	12 (17.9%)	23 (34.3%)	67 (100%)		
	Civil/Public	23 (22.3%)	31 (39.1%)	25 (24.3%)	24 (23.32%)	103 (100%)		
	Farmer	21 (28.3%)	21 (28.3%)	15 (20.3%)	17 (23.0%)	74 (100%)		
	Student	2 (100%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (100%)		
	Housewife	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (100%)	1 (100%)		
Religion	Others	0 (0.0%)	1 (50.0%)	0 (0.0%)	1 (50.0%)	2 (100%)	<b>5.859*</b>	<b>0.439</b>
	Christianity	104 (24.8%)	107 (25.5%)	105 (25.0%)	104 (24.8%)	420 (100%)		
	Islam	1 (12.5%)	1 (12.5%)	3 (37.5%)	3 (37.5%)	8 (100%)		
Area of residence	African traditional religion	3 (75.0%)	0 (0.0%)	0 (0.0%)	1 (25.0%)	4 (100%)	<b>9.750*</b>	<b>0.136</b>
	Rural	87 (25.4%)	89 (26.0%)	83 (24.2%)	83 (24.2%)	342 (100%)		
	Semi-Urban	11 (22.9%)	6 (12.5%)	19 (39.6%)	12 (25.0%)	48 (100%)		
	Urban	10 (9.3%)	13 (12.0%)	6 (5.6%)	13 (12.0%)	42 (100%)		

Sex distribution showed that males and females had equal percentage (50%) in each study group. The Chi-square test ( $X^2 = 0.007$ ,  $p = 1.0$ ) confirms that there was no significant difference in the sex composition of subjects among the groups. This homogeneity ensures that gender is not a confounding variable in subsequent analyses across subject groups.

The majority of respondents are in mixed-sex relationships (88.5%) across all groups, with widow(er)s (7.2%), singles (1.2%), and same-sex relationships (0.9%) representing much smaller proportions. The Chi-square test ( $X^2 = 19.608$ ,  $p = 0.355$ ) indicates that marital or relationship status does not vary significantly across groups. This lack of significant variation ensures that relationship status is not likely to influence intervention outcomes or groups comparisons.

Most subjects (60.7%) reported having a family size between 4 and 7 members, with group 2 exhibiting the highest proportion (64.8%) in this range. Although smaller family sizes (1-3 members) had lesser percentage, accounting for 22.4% of the total sample size. The Chi-square test ( $X^2 = 12.871$ ,  $p = 0.169$ ) suggests that family size distribution is not significantly different among the groups, although there are slight

variations that might reflect socio-cultural or economic factors within the subjects studied.

Income distribution across the subjects shows that nearly half (49.2%) of the subjects earned between N10,000 and N30,000 per month. Group 3 has the highest proportion (56.0%) in this low-income category, while group 4 showed a higher responses in income status as seen in N40,000-70,000 range (44.4%). The Chi-square test ( $X^2 = 21.277$ ,  $p = 0.011$ ) revealed a statistically significant difference in income distribution across the groups, suggesting that income may be an influential factor in determining intervention outcomes..

Educational attainment varies significantly across groups, with secondary education being the most common level (40.9%) and tertiary education accounting for 25.2%. Group 4 has the highest proportion of subjects with secondary education (57.4%), while tertiary education was common among in group 1 (34.3%). The Chi-square test ( $X^2 = 25.761$ ,  $p = 0.002$ ) confirms a significant difference in educational levels among the groups. This finding suggests that educational background may need to be controlled in subsequent studies, as it could influence subjects' nutrition/health, literacy, intervention adherence, or outcomes.

**Table 2.** The macro-nutrients intakes of the subjects before and after the intervention

Variable	Group 1				Group 2				Group 3				Group 4			
	M	SD	t	p	M	SD	t	p	M	SD	t	p	M	SD	t	p
Carbohydrate (g)																
Before	503.40	±232.5	7.290	<0.001	551.77	±281.61	-1.780	0.08	544.08	±257.2	9.080	<0.001	522.80	±221.79	-0.015	0.988
After	278.16	±221.5	7.290	<0.001	811.56	±1,490	-1.780	0.08	291.84	±131.2	9.080	<0.001	523.26	±230.06	-0.015	0.988
Fat (g)																
Before	30.37	±10.7	3.058	0.003	36.25	±26.42	0.758	0.45	36.16	±9.13	4.464	<0.001	24.93	±11.97	0.183	0.855
After	21.44	±28.4	3.058	0.003	34.10	±13.08	0.758	0.45	23.52	±27.97	4.464	<0.001	24.64	±10.72	0.183	0.855
Protein (g)																
Before	43.44	±14.6	12.64	<0.001	47.16	±19.50	0.198	0.84	42.22	±12.31	14.11	<0.001	42.20	±14.60	0.855	0.393
After	23.79	±6.9	12.64	<0.001	46.64	±19.47	0.198	0.84	23.39	±6.39	14.11	<0.001	40.53	±14.14	0.855	0.393
Energy (kcal)																
Before	2,849.6	±820.7	16.04	<0.001	2,888.5	±1,111	-0.120	0.90	2,983.5	±880.93	10.25	<0.001	2,524.8	±934.76	-0.679	0.498
After	1,432.9	±411.4	16.04	<0.001	2,906	±1,085	-0.120	0.90	1,648.2	±1,028	10.25	<0.001	2,689.7	±2,356.7	-0.679	0.498

Note. M: Mean & SD: Standard deviation

**Table 3.** The micro-nutrients intakes of the subjects before and after the intervention

Variable	Group 1				Group 2				Group 3				Group 4			
	M	SD	t	p	M	SD	t	p	M	SD	t	p	M	SD	t	p
Retinol (iu)																
Before	382.54	±135.53	12.4	<0.001	376.97	±142.53	-1.165	.245	398.05	±99.46	16.404	<0.001	386.47	±153.94	0.600	0.549
After	204.33	±62.96	12.4	<0.001	482.46	±930.39	-1.165	.247	217.40	±56.61	16.404	<0.001	374.03	±152.06	0.600	0.549
Riboflavin (mg)																
Before	1.31	±0.75	4.97	<0.001	1.09	±0.65	-4.168	<0.001	0.95	±0.49	-6.537	<0.001	1.03	±0.50	2.889	0.004
After	0.93	±0.24	4.97	<0.001	1.38	±0.33	-4.168	<0.001	1.33	±0.35	-6.537	<0.001	0.87	±0.32	2.889	0.004
Thiamin (mg)																
Before	1.15	±0.95	2.33	<0.021	1.04	±0.90	-2.824	0.005	0.95	±0.60	-4.978	<0.001	0.97	±0.77	1.237	0.217
After	0.92	±0.32	2.33	<0.021	1.29	±0.28	-2.824	0.006	1.28	±0.37	-4.978	<0.001	0.86	±0.41	1.237	0.218
Zinc (mg)																
Before	15.86	±10.55	5.84	<0.001	17.72	±10.66	0.069	0.945	17.13	±9.06	6.460	<0.001	16.46	±11.52	0.154	0.878
After	9.27	±5.14	5.84	<0.001	17.62	±10.05	0.069	0.945	10.88	±4.39	6.460	<0.001	16.22	±10.95	0.154	0.878
Potassium (mg)																
Before	1771.52	±903.07	5.20	<0.001	1,977.69	±1,131.30	-1.438	0.152	1,928.85	±989.28	5.163	<0.001	1,871.62	±1,204.64	-0.120	0.905
After	1,011.12	±1,220.82	5.20	<0.001	2,430.95	±3,073.53	-1.438	0.153	1,205.49	±1,068.37	5.163	<0.001	1,891.27	±1,218.28	-0.120	0.905
Iron (mg)																
Before	38.84	±171.97	1.54	0.125	28.86	±28.38	0.844	0.400	23.13	±9.20	9.268	<0.001	23.92	±10.25	0.911	0.363
After	13.29	±9.83	1.54	0.126	26.25	±15.02	0.844	0.400	13.66	±5.28	9.268	<0.001	22.71	±9.40	0.911	0.363
Calcium (mg)																
Before	790.63	±642.76	5.84	<0.001	753.06	±497.34	-0.707	0.480	786.73	±549.06	4.969	<0.001	752.76	±526.69	-0.710	0.479
After	394.88	±287.83	5.84	<0.001	811.30	±696.74	-0.707	0.480	447.26	±450.10	4.969	<0.001	815.94	±765.50	-0.710	0.479

Note. M: Mean & SD: Standard deviation

**Table 1** also shows the socio-demographic characteristics of the subjects by groups in occupation, religion and area of residence. Trading was the most common occupation across all groups (42.3%), where group 3 had 51.8%, followed by civil/public service (23.8%) and farming (17.1%). Chi-square test ( $X^2 = 24.147$ ,  $p = 0.150$ ) indicates no statistically significant difference in occupation distribution among groups.

Christianity was the dominant religion (97.0%) across all groups, with very few subjects identified as Muslim (1.8%) and adherents of African traditional religions were 1.2%. The Chi-square test ( $X^2 = 5.859$ ,  $p = 0.439$ ) shows no significant variation in religious affiliation among the groups. A large proportion of subjects reside in the rural areas (79.0%), with semi-urban (11.1%) and urban residents (9.9%) forming the smallest subset of the study population. The Chi-square test ( $X^2 = 9.750$ ,  $p = 0.136$ ) indicates no significant difference in residency distribution among groups, though the rural-urban divide may still be relevant when examining access to nutrition/healthcare services, infrastructure and other socio-environmental factors that could impact on the intervention outcomes. However, since there were statistical differences in the average monthly income and educational level ( $p < 0.05$ ) and observable differences in occupation, religion, family size and area of residence, (although not statistically significant), the **H1** hypothesis is hereby accepted, which indicated there is significant difference in average body index (BMI) values of the subjects on independent variables: average monthly income,

educational level, occupation, religion, family size and area of residence.

From **Table 2** and **Table 3**, the analysis of macronutrients intake before and after the intervention across the four groups reveals that group 1 showed a significant reduction in all macronutrient intakes ( $p = 0.001$ ), including carbohydrates, fats, proteins, and total energy, indicating a substantial decrease in overall nutrient consumption post-intervention. Group 2 showed no significant changes in all the macronutrients' intake, suggesting a relatively stable intake with no adjustments. Group 3 exhibited significant ( $p = 0.001$ ) reductions in all the macro nutrients: carbohydrate, fat, protein, and energy intake, like group 1, highlighting a broad decrease in nutrient intake after the intervention. Group 4 showed no significant changes in macronutrients intake, indicating that the intervention had no effect on this group's nutrient consumption.

The analysis of micronutrients intake across three intervention groups before and after the study reveals that group 1 experienced significant ( $p = 0.001$ ) decreases in all micronutrients except iron ( $p > 0.05$ ), indicating a substantial reduction in nutrient intake. Group 2 saw significant increases ( $p = 0.001$ ) in all micronutrients except in riboflavin and thiamine ( $p > 0.05$ ) intake, while other micronutrients showed no significant changes, suggesting targeted improvement in specific nutrients. Group 3 showed significant decreases ( $p =$

**Table 4.** The physical activity levels of the subjects before and after the intervention

Variable	Before intervention		After intervention			
	Usual/routine physical activities only	Usual/routine physical activities and planned physical exercises/activities				
<b>Physical activity carried out in the last 7 days</b>						
Group 1	108	100%	108	100%	0	0.0%
Group 2	108	100%	0	0.0%	108	100%
Group 3	108	100%	0	0.0%	108	100%
Group 4	108	100%	108	100%	0	0.0%
Total	432	100%	216	50.0%	216	50.0%

Note. Pair sample t-test = 432.000 & p < 0.001

**Table 5.** The anthropometric measurements (BMI, frame size, and WHR) of the subjects before the intervention

Variable	Group 1	Group 2	Group 3	Group 4	Total	X <sup>2</sup> -value	p	
<b>BMI classification</b>								
Before	Underweight (< 18.5 kg/m <sup>2</sup> )	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	<b>11.564<sup>b</sup></b>	<b>0.239</b>
	Normal (18.5-24.9 kg/m <sup>2</sup> )	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)		
	Overweight (25-29.9 kg/m <sup>2</sup> )	26 (28.3%)	27 (29.3%)	21 (22.8%)	18 (19.6%)	92 (100%)		
	Obesity (≥ 30 kg/m <sup>2</sup> )	82 (29.3%)	81 (18.2%)	87 (34.8%)	90 (32.1%)	280 (100%)		
Frame size classification	Small frame size (male > 10.4 & female > 11)	9 (37.5%)	4 (16.7%)	6 (25.0%)	5 (20.8%)	24 (100%)	<b>4.296<sup>b</sup></b>	<b>0.637</b>
	Medium (male 9.6-10.4 & female 10.1-11)	23 (22.3%)	24 (23.3%)	25 (24.3%)	31 (30.1%)	103 (100%)		
	Large (male < 9.6 & female < 10.1)	76 (24.9%)	80 (26.3%)	77 (25.2%)	72 (24.9%)	305 (100%)		
WHR classification	Excellent (male WHR < 0.85 & female WHR < 0.75)	6 (40.0%)	2 (13.3%)	2 (13.3%)	5 (33.3%)	15 (100%)	<b>16.066<sup>b</sup></b>	<b>0.188</b>
	Good (Male WHR 0.85-0.90 & female WHR 0.75-0.80)	7 (16.7%)	9 (21.4%)	14 (33.3%)	12 (28.6%)	42 (100%)		
	Average (male WHR 0.90-0.95 & female WHR 0.80-0.85)	31 (27.0%)	38 (33.0%)	26 (22.7%)	20 (17.4%)	115 (100%)		
	At risk (male WHR 0.95-1.0 & female WHR 0.85-0.90)	25 (26.6%)	16 (17.0%)	27 (28.7%)	26 (27.7%)	94 (100%)		
	High at risk (male WHR > 1.0 & female WHR > 0.90)	39 (23.4%)	43 (25.7%)	40 (24.0%)	45 (26.9%)	167 (100%)		

0.001) in all the micronutrients, unlike other groups, indicating a broad reduction in nutrient intake. Group 4 showed no significant changes in all micronutrients, suggesting minimal or no impact from the intervention.

**Table 4** present the physical activity levels of subjects before and after the intervention across the four groups. All subjects in each group (100%) reported engaging only in usual or routine physical activities, with no planned physical exercises or activities. This uniformity indicates that none of the subjects were participating in structured physical exercise programs before the intervention.

Group 2 and group 3 indicated that after the intervention, all subjects (100%) in these groups transitioned from only routine activities to incorporating planned physical exercises and activities into their routines. Data on group 1 and group 4 show that subjects in these groups maintained their pre-intervention activity levels, with 100% continuing to engage only in usual/routine physical activities.

Across all groups, after the intervention, 50.0% of the total subjects continued with only routine activities, while 50.0% incorporated planned physical exercises into their routines.

The pair's sample t-test results ( $t = 433.000$ ,  $p < 0.001$ ) indicate a highly significant difference in physical activity levels before and after the intervention between the groups. This suggests that the intervention had a substantial impact on promoting planned physical exercises among the subjects in group 2 and group 3.

**Table 5** presents body composition before the intervention. Most subjects across all the groups were

classified into overweight (21.3%) and obese (78.5%) in BMI, respectively. Most subjects had a large frame size (70.4%), with only a small percentage having a small frame size (5.8%). In terms of WHR, a significant portion of the subjects were classified as "high at risk" (38.6%), while only a small percentage were in the "excellent" category (3.5%). No significant differences were observed across the groups for BMI, frame size, or WHR classifications prior to the intervention, as indicated by the p-values (0.239, 0.637, and 0.188). These results suggest that, before the intervention, most subjects were already in higher-risk categories for body composition measures.

**Table 6** shows that, after the intervention, significant differences in body composition were observed across the groups. Most subjects were classified as obese, with group 4 showing the highest obesity rates (80.6%). Frame size also varied significantly, with group 4 having the largest proportion of subjects with a large frame size (66.7%). WHR classifications further highlighted these differences, as group 4 had the highest percentage of the subjects in the "high at risk" category (40.7%), while group 3 had the highest proportion in the "excellent" category (33.9%). These findings demonstrate that the intervention led to notable changes in the anthropometric measurements, with statistically significant differences across the groups 1, 2, and 3 with better p-values (0.001), while group 4 witnessed little or no change after the intervention.

Therefore, the **H1** hypothesis is hereby accepted, which means there is a significant difference between the experimental groups and the control group in the anthropometric measurements.

**Table 6.** The anthropometric measurements (BMI, frame size, and WHR) of the subjects after the intervention

Variable	Group 1	Group 2	Group 3	Group 4	Total	X <sup>2</sup> -value	p	
BMI classification								
After	Underweight (< 18.5 kg/m <sup>2</sup> )	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	<b>37.437<sup>c</sup></b>	<b>&lt;0.001</b>
	Normal (18.5-24.9 kg/m <sup>2</sup> )	5 (16.7%)	7 (23.3%)	17 (56.7%)	1 (3.3%)	30 (100%)		
	Overweight (25-29.9 kg/m <sup>2</sup> )	30 (26.5%)	31 (27.4%)	38 (33.6%)	17 (15.0%)	113 (100%)		
	Obesity (≥ 30 kg/m <sup>2</sup> )	73 (25.5%)	70 (24.5%)	53 (18.5%)	90 (31.4%)	286 (100%)		
Frame size classification								
Frame size classification	Small frame size (male > 10.4 & female > 11)	31 (29.2%)	21 (19.8%)	48 (45.3%)	6 (5.7%)	106 (100%)	<b>64.850<sup>c</sup></b>	<b>&lt;0.001</b>
	Medium (male 9.6-10.4 & female 10.1-11)	38 (26.2%)	41 (28.3%)	36 (24.8%)	30 (20.7%)	145 (100%)		
	Large (male <9.6 & female < 10.1)	39 (21.5%)	46 (25.4%)	24 (13.3%)	72 (39.8%)	181 (100%)		
WHR classification								
WHR classification	Excellent (male WHR < 0.85 & female WHR < 0.75)	7 (12.1%)	10 (17.2%)	36 (62.1%)	5 (8.6%)	58 (100%)	<b>100.152<sup>c</sup></b>	<b>&lt;0.001</b>
	Good (Male WHR 0.85-0.90 & female WHR 0.75-0.80)	14 (16.9%)	28 (33.7%)	29 (34.9%)	12 (14.5%)	83 (100%)		
	Average (male WHR 0.90-0.95 & female WHR 0.80-0.85)	31 (33.3%)	26 (28.0%)	16 (17.2%)	20 (21.5%)	93 (100%)		
	At risk (male WHR 0.95-1.0 & female WHR 0.85-0.90)	32 (29.9%)	32 (29.9%)	16 (15.0%)	27 (25.2%)	107 (100%)		
	High at risk (male WHR > 1.0 & female WHR > 0.90)	24 (26.4%)	12 (13.2%)	11 (12.2%)	44 (48.4%)	91 (100%)		

## DISCUSSION

This study deals with nutrition and how the body utilizes the food nutrients for growth. This nutritional aspect of public health practice is very important. The findings of this study titled assessment of nutritional status and anthropometric composition of over-nourished adults (36-64 Years) in Imo State, Nigeria showed that there were statistically significant differences between before and after intervention data among the experimental groups ( $p = 0.001$ ) and between the experimental groups ( $p < 0.05$ ) with group 3 having the highest number of improvements compared to the control group ( $p > 0.05$ ).

From the findings, there were differences in the age distribution across age groups as indicated by the Chi-square test ( $X^2 = 28.318$ ,  $p = 0.057$ ). However, at the 5% level, the observed variations are not statistically significant, implying that the age distribution is relatively balanced across the groups. All the experimental groups showed significant improvements in the anthropometric status. But group 3 recorded the greatest improvements in the 'excellent' category in WHR, 'high at risk', normal BMI and small frame size, both in males and females. These improvements might be attributed to healthy dietary reduction and planned physical activities practiced by these groups, which helped to burn excess body fats, increased insulin sensitivity and production. These findings support the studies in [11, 25, 36], which concluded in different format that planned physical activities help to burn excess body fat, in weight management and increase insulin sensitivity. WHO [11] also stated that subjects with low socio-economic status lacked access to healthy foods, safe physical exercise and sound knowledge, which caused a high obesity rate.

The study in [37] opined from a study in Romania that higher BMI had a higher prevalence rate among rural dwellers, adding that for men over 35 years old (54%), affirmed that they lacked knowledge of weight for their height.

Naturally, people might choose to influence their BMI in medical terms to avoid weight gain due to personal holidays and type of occupation, recreational activities or inactivity, residence and food intakes. Due to these choices, variations in

weight, being either fat or thin could be acceptable according to one's viewpoint, of adhering to the prescriptions by both doctors and public health nutritionists. Concluding from a study in Finland [38], which narrated that rapid economic growth being witnessed in the developing countries was contributing to the growing high obesity rate, adding that body weight was associated with the physical living environment.

Religious taboos and celebrations which prevent adherents from eating forbidden foods but encourage them to eat excessively during festivals also influence BMI [39]. However, at the 5% level, the observed variations are not statistically significant, implying that the age distribution is relatively balanced across the groups.

Educational level and knowledge ( $p = 0.001$ ), employment status ( $p = 0.003$ ), monthly income ( $p = 0.010$ ) among pregnant mothers, as observed factors were significantly associated with the minimum required status. The study also discovered that those with secondary and post-secondary education had a better chance of achieving the minimum nutritional score compared to those who had never attended any school.

From the results, before the intervention, all the subjects did not engage in any planned physical activities. That means, only the routine activity was common. But after the intervention, subjects in group 2 and group 3 began engaging in daily 1 hour planned physical activities of their choice. This was due to planned physical activities incorporated into the nutrition education taught to the two groups. This idea was supported by [11, 39], which stated that the best way to bring positive life modification was through education and mentoring.

Also, the result suggests that educational background may need to be controlled in subsequent studies, as it could influence subjects' nutrition/health, literacy, intervention adherence, or outcomes.

This study is also supported by [40], who discovered high socio-economic status among males and females, respectively, were three and four times more likely to have an active leisure period than their respective low socio-economic counterparts.

In comparison, of the experimental groups with the control group, this study found significant differences between the

experimental groups and the control group, in all the dependable variables (mean difference at 0.05) in all multiple comparisons. After the intervention, group 3 had the highest number of excellent' (33.9%) in WHR, followed by large frame size' (22.0%), the normal BMI (15.6%) and the least number were those falling at high risk, with 9.3%, respectively in both sexes. It was observed that group 4 had the worst values of normal BMI (0%), large frame size (66.7%), excellent and WHR (4.6%) and high risk (40.7%), respectively, for both sexes. The difference in results as observed in group 3 were due to nutrition education, nutrition reduction and planned physical activities. The results confirmed by [11, 29, 41, 42], in their separate studies concluded that the best ways to prevent, control and manage obesity and abdominal fats were through nutrition intervention, nutrition education/counselling and planned physical activities.

A total of 432 subjects and 9 LGAs from the three senatorial zones were multistaged randomly selected. There were anthropometric, biochemical, clinical and dietary assessments of the subjects using conventional equipment and manual PoP-based food mode VAs before and after the nutrition education/counselling and planned physical activity intervention. Before and after intervention, data were compared among the experimental groups and compared between the experimental groups and the control group. The independent variables such as age, gender, relationship/marital status, area of residence, educational level, occupation, average monthly income, family size were linked with knowledge and practice in relation to the dependent variables (BMI, WHR, and body frame size). There were statistically significant differences between before and after intervention between the experimental groups ( $p = 0.001$ ) and between the experimental groups ( $p < 0.05$ ), with group 3 having the highest number of improvements compared to the control group ( $p > 0.05$ ) in group 3. There were statistically significant reductions in all the food nutrients/energy experienced in group 1 and group 3 due to the manually produced PoP-based food model's VAs effectiveness in dietary reduction estimates.

## CONCLUSION

Based on the results, there were significant improvements in the overnutrition indices in the experimental groups (0.05) compared to the control group ( $p < 0.05$ ) after the intervention. And as well, there were significant improvements among the experimental groups in the greatest improvement in the anthropometric indices in group 3. This is no doubt due to the type of intervention carried out in group 3, which combined nutrition education/counseling, healthy dietary reduction and planned physical activities. Unlike in group 1, which had only nutrition education/counseling and dietary reduction, and group 2, which carried out only nutrition education/counseling and planned physical activities. No improvements were noticed in the control group. These greatest significant improvements seen in group 3, corroborated [12, 16, 32, 38, 41], by which concluded that anthropometric indices could be improved through nutrition education/counseling, healthy dietary reduction and planned physical exercises.

Therefore, anthropometric indices among adults (36-64 years) in Imo State can be improved and sustained through a combination of nutrition education/counseling, healthy

dietary reduction (healthy rations) and planned physical activities.

## Recommendations

1. Nutrition status and lifestyle modifications should be a compulsory course of their own in all levels of education in developing and developed countries.
2. There should be daily media adverts in both electronic and print of over-nutrition indices improvements among adults in developing and developed countries.
3. Community leaders, traditional leaders and governments at various levels should build and equip adult lifestyle modification centers where adult nutrition status and lifestyle modifications will be handled.
4. There should be government or philanthropic sponsored monthly adult nutrition status competition in every community in developing and developed countries.

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