# DIET QUALITY, PHYSICAL ACTIVITY, OBESITY AND HYPERTENSION AMONG ADULTS IN AKWA IBOM AND CROSS RIVER STATES, NIGERIA

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## CERTIFICATION

I certify that this research work was carried out by Nkereuwem Ndaeyo, Ekerette in the Department of Human Nutrition and Dietetics, Faculty of Public Health, University of Ibadan, Ibadan, Nigeria.

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# DEDICATION

This research work is dedicated to God almighty, who in his boundless love poured out his grace upon me to enrol on and complete this programme.

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## ABSTRACT

Obesity and hypertension are risk factors for diet-related non-communicable diseases and are associated with poor quality of life, increased morbidity and mortality. There is a growing burden of obesity in Nigeria, especially the South South geopolitical zone. However, information on the interplay between diet quality, lifestyle factors, burden of obesity and hypertension in the zone is scarce. This study was designed to assess the associations between diet quality, physical activity, obesity and hypertension among adults in Akwa Ibom and Cross River states, Nigeria.

This descriptive cross-sectional study adopted a three-stage random sampling technique to select 12 Local Government Areas, 36 communities and 1,320 adults from Akwa Ibom and Cross River states. Information on socio-demographic characteristics, dietary intakes and physical activity were obtained using interviewer-administered questionnaire. Dietary intake was assessed using multi-pass 24-hour dietary recall to determine diet quality (Diet Quality Index-International, DQI-I), categorised into terciles. Physical activity was assessed using International Physical Activity (PA) Questionnaire and analysed using standard procedures. Weight (kg) and height (m) were measured to calculate Body Mass Index (BMI) to define overweight and obesity as BMI 25.0-29.9kg/$m^2$ and ≥30.0kg/$m^2$ respectively. Waist Circumference (WC) was measured to define Abdominal Obesity (AO) as WC ≥102cm for men and WC ≥88cm for women. Blood Pressure (BP) measurements were taken and hypertension was defined as Systolic BP (SBP) ≥140mmHg and or Diastolic BP (DBP) ≥90mmHg. Data were analysed using descriptive statistics, Chi square test and logistic regressions at $\alpha_{0.05}$.

Respondents' age was 35.4±11.2 years, 50.4% were female and 54.1% were married. Total DQI-I score was 56.4±7.4 comprising variety (11.4±3.9), adequacy (24.8±4.9), moderation (19.6±6.0) and overall balance (0.7±1.5). Physical activity score was 4306.0 Met-minutes/week, 29.7% and 60.7% had moderate and high PA patterns, respectively. Prevalence of overweight and obesity were 20.5% and 12.5%, respectively. Waist circumference scores were 82.7±11.3cm for men and 85.5±15.1cm for women and prevalence of AO was 37.6%. The SBP and DPB were 122.2±14.9 mmHg and 79.1±12.6 mmHg, respectively and prevalence of hypertension was 29.5%. There were non-significant increases in the risks of obesity (Adjusted Odds Ratio (AOR) = 1.1; CI: 0.8-1.4) and AO (AOR = 1.0; CI: 0.8-1.4) across DQI-I terciles. Risk of hypertension increased significantly across DQI-I terciles (AOR = 1.4; CI: 1.0-1.8). There was a significant decrease in the risk of obesity (AOR = 0.5; CI: 0.3-0.7) and a non-significant decrease in the risk of AO (AOR = 0.7; CI: 0.43-1.1) among adults with moderate-to-high PA patterns, compared to low PA patterns. There was a non-significant increase in the risk of hypertension among adults with moderate-to-high PA patterns (AOR = 1.14; CI: 0.7-1.8). The risk of hypertension increased significantly among adults with higher BMI values (AOR = 2.3; CI: 1.7-3.1).

The risk of obesity was not related to high diet quality, but was inversely related to increased physical activity in Akwa Ibom and Cross River States, Nigeria. Increased physical activity should be promoted to reduce the burden of obesity.

**Keywords:** Diet Quality Index-International, International Physical Activity Questionnaire, Obesity, Anthropometric indices, Hypertension.

**Word count:** 486

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## ACRONYMS

| | | |
|---|---|---|
| AHEI | - | Alternate Mediterranean dietary quality index |
| AI | - | Adequate Intake |
| AK | - | Akwa Ibom |
| AKS | - | Akwa Ibom State |
| AMDRs | - | Acceptable Macronutrient Distribution Ranges |
| BMI | - | Body Mass Index |
| CDC | - | Center for Disease Control |
| CR | - | Cross River |
| CRS | - | Cross River State |
| CVD | - | Cardiovascular Diseases |
| DASH | - | Dietary Approaches to Stop Hypertension |
| DBP | - | Diastolic Blood Pressure |
| DDS | - | Dietary Diversity Scores |
| DGA | - | Dietary Guidelines for Americans |
| DHA | - | Docosahexaenoic Acid |
| DII | - | Dietary Inflammatory Index |
| DQI | - | Diet Quality Index |
| DQI-I | - | Diet Quality Index-International |
| DQIr | - | Diet Quality Index-revised |
| DRIs | - | Dietary Reference Intakes |
| EAR | - | Estimated Average Requirement |
| EER | - | Estimated energy requirement |
| ENTERED | - | *échantillon national témoin représentatif des personnes diabétiques* |
| EPA | - | Eicosapentaenoic Acid |
| FAO | - | Food and Agriculture Organization |
| FFL | - | Forgotten Foods List |
| FMS | - | Fibromyalgia Syndrome |
| FVS | - | Food Variety Score |
| GPAQ | - | Global Physical Activity Questionnaire |
| HDI | - | Healthy Diet Index |

| | | |
|---|---|---|
| HEI | - | Healthy Eating Index |
| HRQoL | - | Health-Related Quality of Life |
| INDDEX | - | International Dietary Data Expansion |
| IOM | - | Institute of Medicine |
| IPAQ | - | International Physical Activity Questionnaire |
| IQR | - | Interquartile Range |
| JNC-8 | - | Eighth Joint National Committee |
| LDL | - | Low Density Lipoprotein |
| LGAs | - | Local Government Areas |
| LTPA | - | Leisure Time Physical Activity |
| MAR | - | Mean Adequate Ratio |
| MDS | - | Mediterranean Diet Score |
| Med-DQI | - | Mediterranean Dietary Quality Index |
| MET | - | Metabolic Equivalent |
| MUFAs | - | Mono-unsaturated Fatty Acids |
| MVPA | - | Moderate-to-Vigorous Physical Activity |
| NAR | - | Nutrient Adequacy Ratio |
| NCDs | - | Non-Communicable Diseases |
| NAFLD | - | Nonalcoholic Fatty Liver Disease |
| OR | - | Odd ratio |
| PA | - | Physical Activity |
| PANDiet | - | Probability of Adequate Nutrient Intake |
| PUFAs | - | Poly-unsaturated Fatty Acids |
| RCI | - | Recommendation Compliance Index |
| RDA | - | Recommended Daily Allowance |
| RNI | - | Reference Nutrient Intake |
| SBP | - | Systolic Blood Pressure |
| SDs | - | Senatorial Districts |
| T2D | - | Type II diabetes |
| USDA | - | U.S. Department of Agriculture |
| USDHHS | - | U.S. Department of Health and Human Services |

| | | |
|---|---|---|
| WC | - | Waist Circumference |
| WHO | - | World Health Organization |

# CHAPTER ONE
# INTRODUCTION

## 1.1 Background to the Study

**Diet Quality:** Good quality diets constitute those that combine all foods and beverages in adequate proportions, quantities, and consumption frequencies to meet all nutritional needs while limiting the risk of diet-related diseases. Over the years, selected health and nutrition-related national authorities have drawn scientific evidence from nutrition research to develop and periodically review dietary guidelines to guide individuals adopt and maintain healthy dietary patterns (National Health and Medical Research Council, 2013; USDA, 2015; Health Canada, 2019). A healthy dietary pattern is one that encourages increased consumption of diverse food items, especially those from nutrient dense food groups. Most countries, when issuing recommendations on appropriate ways of eating through dietary guidelines, place much emphasis on messages that capture certain aspects of diet quality. In addition to adequacy, the recommendations for variety within and across major food groups, moderation in relevant dietary components (such as solid fats, added salt and sugars, as well as alcohol), while ensuring balance in dietary energy sources constitute common features in most dietary guidelines.

The importance of food variety in ensuring optimal diet draws from the assumption that no one food contains all the essential nutrients. Selecting food items from diverse sources, (especially when such selections are drawn from within and across nutrient dense groups), guarantees the possibility of meeting daily requirements for essential nutrients and limits the chances of developing both nutrient deficiency diseases and those pertaining to over-nutrition. Dietary adequacy contributes to the overall diet quality in screening how well a diet can provide the daily needs for both energy and essential nutrients. Dietary adequacy takes into account, the individual nutrients, together with selected food items of interest that are important in attaining desired nutrient intakes while limiting the risk of over-nutrition. Moderation emphasizes minimal consumption of foods or nutrients detrimental to health, with particular emphasis on the contributions of fats (total, saturated and trans-fats) to overall energy intake, as well as daily consumptions of cholesterol, sodium, and empty calorie foods. Selecting dietary fat that primarily includes unsaturated fats, while keeping total dietary fats within acceptable macronutrient distribution ranges (AMDRs) is protective against chronic diseases by reducing several disease biomarkers. Overall balance is crucial for ensuring adequate intakes of essential nutrients within specific energy levels without any fear of nutrient deficiencies or over-nutrition (Institute of Medicine, 2005).

**Physical Activity:** The role of nutrition in ensuring optimum health is often enhanced when other lifestyle factors are taken into consideration. The combined health effects of adequate diet and physically active lifestyle have, over the years served as the basis for establishing effective strategies for acquiring healthy body composition, musculoskeletal health, physical and cognitive performance, including those for preventing metabolic diseases across the lifespan (Koehler and Drenowatz, 2019). The World Health Organization (WHO) defines physical activity (PA) as any bodily movement produced by skeletal muscles that require energy expenditure (WHO, 2014). Recommendations have been developed as a result of its relevance in overall wellbeing (Alricsson, 2013; Pfeifer, Banzer, Ferrari, Eszter, Geidl, Graf, Hartung, Klamroth, Völker, and Vogt, 2017; Rhodes, Janssen, Bredin, Warburton, and Bauman, 2017), and are set based on identified health benefits for specific age group. Adults are encouraged to undertake moderate-intensity PA that spans over a hundred and fifty minutes or engage in not less than 75 minutes of vigorous-intensity PA in a week. An equivalent combination of the recommendations above can also be of equal health benefits (WHO, 2010).

Additional health benefits can be derived when weekly physical activity of moderate or vigorous intensity exceed the recommended durations and extend to 300 or 150 minutes, respectively (WHO, 2010). The overall health benefits of PA depends on the number of times (within a specified time frame) that is invested in such endeavours. Any PA performed under 10 minutes in a bout does not render any significant health benefit (WHO, 2014), as such, it is advisable to increase the durations spent on PA as much as possible. Physical activity amounting to values below 2.9 METs is considered to be of low intensity and does not confer any known health benefits, rather it is advisable to increase activities to levels corresponding to at least moderate intensity (Pfeifer *et al.,* 2017). Thus the frequency, duration, intensity and type (in which case, aerobic activities are preferable) all constitute important considerations in conferring the associated health benefits of PA (Alricsson, 2013). Notwithstanding, smaller volumes of PA performed over time can lead to clinically remarkable improvements in health indicators (Sattelmair, Pertman, Ding, Kohl, Haskell, and Lee, 2011; Wen *et al*., 2011; Rhodes *et al.,* 2017), and when people who never engaged in any form of physical activity begin to participate regularly in the exercise, they stand the chances of benefitting maximally from it (Pfeifer *et al.*, 2017). Physical activity impacts positively on muscular, cardiorespiratory, bone, emotional, psychological, and metabolic health parameters (Sattelmair *et al.*, 2011; Wen *et al.*, 2011; Alricsson, 2013; WHO, 2014; Rhodes *et al.,* 2017). Hence, not only does it impact positively on metabolic and physiological health indicators, it also enhances greater longevity among participants.

**Obesity:** Deviations from good quality diet and adequate physical activity usually contribute to excessive accumulation of body fat. Low participation in or complete lack of physical activity usually predisposes to increased body fatness. Individuals who accumulate body fat over time beyond healthy ranges stand the risk of developing overweight and or obesity ultimately. Overweight and obesity refer to abnormal or excessive fat accumulation (regionally, globally, or both) that may impair health and or increase the risk of certain diseases (World Health Organisation, 2020). Body mass index (BMI), measured as the ratio of body weight to height is the most common index used in defining obesity. A BMI value greater than or equal to $25km/kg^2$ and $30kg/m^2$ indicates overweight and obesity, respectively.

However, BMI does not independently indicate the proportion of body composition that is accounted for by lean or fat mass, neither does it provide information on fat distributions across the different adipose tissues in the body. It is said that, the location of fat accumulation in the body is a better indicator of the extent to which individuals are predisposed to increased risks of metabolic diseases than BMI (Lukács, Horváth, Máté, Szabó, Virág, Papp, Sándor, Ádány, and Paulik, 2019). Individuals with healthy body weight and BMI can also suffer from disease risks associated with obesity in the presence of increased waist circumference (WC). Abdominal obesity refers to excessive accumulation of fat in the abdominal region and is found among adults with waist circumference amounting to 94 cm and 80 cm for men and women, and waist-hip ratio measurements up to >0.90 and >0.85 for men and women, respectively (WHO, 2011). These measurements constitute indirect indicators of the metabolically active visceral adiposity (Aktar, Qureshi, and Ferdous, 2017), which in turn has stronger correlation with obesity related health complications than the amount of total body fat (Hu et al., 2017).

Obesity often occurs in conditions of excessive food intake and or insufficient physical activity (Tabasum *et al.*, 2018; Munyogwa and Mtumwa, 2018; World Health Organization, 2020), although certain genetic variations, endocrine and or mental disorders as well as certain medications do account for substantial proportions of those with the disease. Obese individuals stand the risk of suffering from chronic low-level inflammation, which in turn constitute the single most important link between obesity and the associated metabolic and vascular complications (Kinlen, Cody, and O'Shea, 2018). Several epidemiological and empirical studies have revealed the central role played by obesity in the development of chronic disease conditions- type II diabetes mellitus, cardiovascular disease, obstructive sleep apnea, and cancer as well as significant decreases in life expectancy and increased mortality (Fruh, 2017; Kinlen *et al.*, 2018). Furthermore, pieces of evidence indicate substantial reductions in these conditions, resulting from modest weight loss (Kinlen *et al.*, 2018) through lifestyle modifications, pharmacological or surgical manipulations.

**Hypertension:** The consequences of poor quality diets and physical inactivity include increased body weight and obesity as well as other chronic conditions that result from either faulty diet, physical inactivity, or both. Inadequate diet, physical inactivity, and consequential obesity are the main drivers of the global rise in non-communicable diseases (NCDs) (World Health Organization, 2016b). Cardiovascular conditions, especially hypertension, are responsible for the highest proportion of premature deaths from NCDs (World Health Organization, 2016b). Persistent rise in both systolic and or diastolic blood pressures over time often lead to unfavourable cardiovascular health and associated conditions.

## 1.2 Statement of the Problem

The global rise in consumption of nutrient-poor energy-dense meals and physical inactivity constitutes the key factors accelerating the rate of non-communicable diseases worldwide. Changing food consumption patterns and physical inactivity constitutes the major contributing factors to the high prevalence of obesity (39.0%) worldwide (World Health Organisation, 2020), a proportion close to those who fall short of recommended PA levels with no improvement in recent years (World Health Organization, 2014).

While faulty diets and physical inactivity have both individual and combined roles in the development of excess body weight and hypertension, obesity itself constitutes a significant risk factor in the development of hypertension (World Health Organization, 2013a; Idung, Abasiubong, Udoh, and Ekanem, 2014; Alkerwi, Vernier, Crichton, Sauvageot, Shivappa, and Hébert, 2015; Mogre, Nyaba, Aleyira, and Sam, 2015; Sotos-Prieto et al., 2017; Bivoltsis, Trapp, Knuiman, Hooper, and Ambrosini, 2018; Munyogwa and Mtumwa, 2018; Panizza, Shvetsov, Harmon, Wilkens, Le Marchand, Haiman, Reedy, and Boushey, 2018; Pestoni, Krieger, Sych, Faeh, and Rohrmann, 2019). Furthermore, hypertension constitutes the commonest predicting factor for most of the vascular diseases and as important cause of death worldwide (World Health Organization, 2016b). Besides, the proportion of individuals affected by hypertension has risen substantially over the past recent decades (World Health Organization, 2016b), with significantly high proportions being affected both in the American and African regions (World Health Organization, 2019).

Worse still, about two-thirds of those affected live in low- and middle-income countries (LMICs) (WHO, 2019), most especially in Africa (Zhou *et al.,* 2017), where awareness, treatment and control of the disease are poor (World Health Organization, 2019a), a scenario blamed primarily on the weak health systems, low literacy levels, non-frequent medical check-ups, and prevailing poverty in low and middle-income countries ( Bosu, Aheto, Zucchelli, and Reilly, 2019).

Additionally, faulty diet, physical inactivity, excess body weight, and hypertension all increase the risk of other NCDs including cancers, diabetes, HIV/AIDS, and chronic respiratory diseases in addition to cardiovascular diseases (CVDs) (World Health Organization, 2018a). Non-communicable disorders account for the leading causes of deaths, especially in economically less advantaged settings. It is also feared that over seventy five percent of deaths accruing from NCDs globally occur in the less developed countries (World Health Organization, 2018a).

While the Sub-Saharan Africa is already facing the scourge of under-nutrition, there is an upsurge in chronic disease risk factors in the same settings (World Health Organization, 2020). Besides, the region is hardly equipped to handle these disease burdens. Already, increased risk of NCDs, resulting from obesity and hypertension have been reported among adults in the African region, including Nigeria ( Murthy, Fox, Sivasubramaniam, Gilbert, Mahdi, Imam, and Entekume, 2013; Idung *et al.*, 2014; Akpan, Ekrikpo, Udo, and Bassey, 2015; Bosu, 2015; Olawuyi and Adeoye, 2018). Within Nigeria, there are some indications that the South South region may harbour more obese individuals than some other parts of the country (National Population Commission and ICF, 2019). The increasing prevalence of obesity in the African region implies that more individuals are predisposed to the risk of higher prevalence of NCDs.

### 1.3 Justification of the Study

Information on dietary intakes in Nigeria is mostly derived from studies investigating nutrient adequacy, dietary patterns (often measured by food frequency), and dietary diversity. Only few of these studies are ever population-based studies, and where there were so, such studies were conducted in pockets of locations that could rarely give inference to a larger population (Sanusi, 2010; Agada and Igbokwe, 2015; Oladoyinbo, Ugwunna, and Ekerette, 2017; Raaijmakers, Snoek, Maziya-Dixon, and Achterbosch, 2018; Obayelu and Osho, 2020). Dietary intakes in Nigeria is rarely assessed by measures that capture different aspects of diet quality (Onyeji and Sanusi, 2018). Moreover, studies on dietary intakes among adults in South South Nigeria, especially those in AK and CR States scarce. Assessing the overall quality of diets in the region is is important can serve as the impetus to implement nutrition intervention programmes that will promote appropriate dietary intakes to reduce the burden of diet-related disorders and under-nutrition.

Although physical activity has been studied extensively in Nigeria, information available is limited to those reporting only physical activity levels (Samson-Akpan, Eyo, Olamoyegun and Joshua, 2013; Iwuala, Sekoni, , Akanbi, Sabir, and Ayankogbe, 2015; Akinroye and Adeniyi, 2018; Oyeyemi, Adewale, Oyeyemi, Omotara, Lawan, Akinroye, Adedoyin, and Ramírez, 2018). Physical activity is rarely reported in the context of its association with health outcomes among individuals in Nigeria (Ogwumike, Adeniyi, Dosa, Sanya, and Awolola, 2014; Sokunbi and Tersoo-Ivase, 2015; Kayode and Alabi, 2020). Most information on physical activity is available from institutional-based studies and do not describe the physical activity of individuals in the general population ( Samson-Akpan *et al.*, 2013; Iwuala *et al.*, 2015; Owoeye *et al.*, 2016; Kayode and Alabi, 2020). Moreover, physical activity profiles of individuals vary in different domains; as well, individual PA domains relate differently with health and disease risks (Diaz *et al.*, 2017; Medina, Janssen, Barquera, Bautista-Arredondo, González, and González, 2018; Byambasukh, Snieder, and Corpeleijn, 2020). Information on PA profiles of Nigerians based on individual domains is rarely reported. Evaluating the quality of dietary intakes and PA concurrently in populations can yield greater insights into factors that are important in health outcomes in such settings and provide direction on appropriate policy recommendations for improved health-related quality of life.

Prevalence and comorbidities of diet-related diseases, including obesity and hypertension, have been studied extensively across the globe. Most studies in Nigeria also incorporate considerations for obesity and hypertension as part of risk factors for other non-communicable disorders (Bello-Ovosi *et al.*, 2018; Olawuyi and Adeoye, 2018). Population-based studies assessing the prevalence and comorbidities of obesity in Nigeria are scanty, representing few locations within States and the country as a whole ( Ekanem, Opara and Akwaowo, 2013; Samson-Akpan *et al.*, 2013; Idung *et al.*, 2014; Akpan *et al.*, 2015; Ajayi, Adebamowo, Adami, Dalal, Diamond, Bajunirwe, Guwatudde, Njelekela, Nankya-Mutyoba, Chiwanga, Volmink, Kalyesubula, Laurence, Reid, Dockery, Hemenway, Spiegelman and Holmes, 2016). Adequate information on the prevalence of obesity and hypertension in South South Nigeria, especially in AK and CR States can justify the formulation and or strengthening of health and nutrition policies that will enhance the control of obesity and its complications and improve the general quality of life among individuals.

## 1.4 Research Objectives

The general objective of this study was to assess associations between diet quality, physical activity, obesity and hypertension among adults in Akwa Ibom and Cross River States, Nigeria.

The specific objectives include to:

1. assess nutrient intake adequacy of adults in Akwa Ibom and Cross River States, Nigeria.
2. assess the quality of diets among adults in Akwa Ibom and Cross River States, Nigeria.
3. determine physical activity of adults in Akwa Ibom and Cross River States, Nigeria.
4. assess the prevalence of obesity and its associations with diet quality and physical activity among adults in Akwa Ibom and Cross River States, Nigeria.
5. determine the prevalence of hypertension and its associations with diet quality and physical activity among adults in Akwa Ibom and Cross River States, Nigeria.

## 1.5 Research Questions

1. What is the quality of dietary intakes of adults in Akwa Ibom and Cross River States, Nigeria?

2. What are the physical activity patterns of adults in Akwa Ibom and Cross River States, Nigeria?

3. To what extent is obesity prevalent among adults in Akwa Ibom and Cross River States, Nigeria?

4. To what extent is high blood pressure prevalent among adults in Akwa Ibom and Cross River States, Nigeria?

5. Does diet quality relate with the prevalence of obesity and hypertension among adults in Akwa Ibom and Cross River States, Nigeria?

6. Does physical activity relate with the prevalence of obesity and hypertension among adults in Akwa Ibom and Cross River States, Nigeria?

## 1.6 Research Hypotheses

The null hypotheses state that:

1. **Ho1**: Nutrient intakes among adults in Akwa Ibom and Cross River States, Nigeria, are inadequate.

2. **Ho2:** Dietary intakes among adults in Akwa Ibom and Cross River States, Nigeria, are of low quality

3. **Ho3:** Physical activity patterns among Adults in Akwa Ibom and Cross River States, Nigeria are low.

4. **Ho4:** The quality of diets does not relate significantly with the prevalence of obesity among adults in Akwa Ibom and Cross River States, Nigeria.

5. **Ho5**: There is no significant relationship between physical activity and obesity among adults in Akwa Ibom and Cross River States, Nigeria.

6. **Ho6**: There is no significant relationship between diet quality and hypertension among adults in Akwa Ibom and Cross River States, Nigeria.

7. **Ho7:** There is no significant relationship between physical activity and hypertension among adults in Akwa Ibom and Cross River States, Nigeria

# CHAPTER TWO
# LITERATURE REVIEW

### 2.1.1 Importance of Diet in Health and Diseases

The major function of food is to furnish the body with vital nutrients that aid growth, development and maintenance of sound health. However, certain dietary elements, when consistently consumed in excess over time, usually result in adverse health conditions (Conklin, Monsivais, Khaw, Wareham, and Forouhi, 2016; Lee, Kim, Choi, Kim, Cho, and Sohn, 2016; Koksal, Seyda, Ermumcu, and Mortas, 2017; Bivoltsis *et al.,* 2018). Diet-related chronic diseases now constitute major health concerns across the globe, increasing the disease and related economic burdens among more people than ever before. Adopting a dietary intake pattern that provides adequate supply of essential nutrients while preventing excessive energy consumption is crucial for ensuring desirable health outcomes (Chiuve, Fung, Rimm, Hu, Mccullough, Wang, Stampfer, and Willett, 2012). In other words, following a dietary pattern that provides all nutritional elements in desirable quantities, proportions and frequency, will most likely protect against the development of chronic diseases. For instance, the Mediterranean Dietary pattern had inverse relationships with most chronic disease risk biomarkers among adults in Luxembourg (Alkerwi *et al.,* 2015).

Healthy dietary patterns support optimum growth and development processes right from childhood through adolescence and mitigate challenging health conditions usually associated with advanced age in adulthood; thus the emphasis on appropriate food selections. Food selections that are based primarily on food groups capable of furnishing the diet with more number of essential nutrients in sufficient amounts, constitute one of the viable means of attaining consumption patterns that support good health (Shin, Kim, Kim, Kim, and Kim, 2015). As a result, dietary patterns based primarily on sub-optimal intakes are important controllable threats that increase incidence and morbidity linked to several non-communicable conditions (Conklin *et al.,* 2016; Bivoltsis *et al.,* 2018).

Low quality diet is implicated in development of obesity, which in turn predisposes to the risk of other non-communicable diseases (Chiuve *et al.*, 2012; Koksal *et al.*, 2017; Cheung, Chan, Ko, Lau, Chow, and Kong, 2018). When the diet is primarily based on increased total energy consumption, as well as proportions derived from energy yielding food materials which fail to meet the AMDRs, the outcome is more often the development of obesity (Cheung *et al.,* 2018). Since the overall quality of the diet is indicated by a number of attributes, a diet that falls short in any of such characteristics will more than not increase the likelihood of adverse health outcome depending on the attribute concerned. For instance, Cheung *et al.* (2018) noted that, individuals who fail to consume varied diet and those consuming excess of those items that need to be consumed in moderation will most likely have obesity.

Increasing consumption of dark-green and orange coloured vegetables, whole fruit, whole and total grains, nuts, milk, vegetable oils but considerate moderation in consumption of dietary elements that require restrictions, related negatively with the risk of chronic diseases (Chiuve *et al.*, 2012). Within-group diversity in dairy, fruits and vegetables were all associated with about 30% reductions in the likelihood of suffering from diabetes among Korean women (Shin *et al.,* 2015). Poor quality diets predisposes to the development of CVDs. Low diet quality was responsible for 3.9% of incident CVDs and 12.5 % mortality among adults (Tong, Wareham, Khaw, Imamura, and Forouhi, 2016). The risk of mortality is increased under conditions of poor quality diets. A decrease in the quality of dietary intakes over years was shown to increase the risk of mortality among adults (Sotos-Prieto *et al.,* 2017; Panizza *et al.,* 2018).

### 2.1.2 Dimensions of Diet Quality

The dimensions of diet quality often considered in overall diet quality consist of food variety, adequacy in consumption of foods and nutrients, moderation in consumption of dietary elements needed in limited amounts for optimum health conditions and overall balance in macronutrients distribution in the diet (Kim, Haines, Siega-Riz, and Popkin, 2003).

#### 2.1.2.1 Food Variety

Dietary diversity or variety refers to the number of foods or food groups consumed over a reference period (Steyn and Ochse, 2013). Dietary variety is defined as the inclusion of a wide range of foods and beverages from various food groups in the diet ( USDA, 2015; de Oliveira *et al*., 2018). In other words, variety in dietary intake is attained when and if daily consumptions are based primarily on assorted food items chosen from across and within nutrients dense food groups. Variety in dietary intake can be measured by identifying each food item or individual food groups that contribute to the overall intakes over a predetermined time frame. While the Dietary Diversity Score (DDS) indicates variety across all major food groups, Food Variety Score (FVS) indicates variety attained when oneor several items selected within a particular food group contributes to overall intakes withina specified period (Rukundo, Oshaug, Andreassen, Kikafunda, Rukooko, and Iversen, 2016).

Since each food group consists of foods that provide similar number and amounts of nutritional components, planning meals to draw foods from major food groups rather than individual food items guarantees the possibility of obtaining a wider range of nutrients in the diet. This is because, the probability of selecting foods that provide the same types of nutrients, while limiting the chances of including others in the diet is higher when and if the diet draws items from individual foods rather than across major food groups. Dietary diversity, the concept which describes the representation of each food group in the totality of a meal is a viable means of meeting the daily needs of essential nutrients and other essential dietary elements. Steyn and Ochse (2013) opined that, measuring dietary diversity is a better marker of food variety than indicators based on individual food items, and most especially when used for predicting nutrients adequacy.

No one food contains all the essential nutrients needed to meet all dietary needs (Steyn and Ochse, 2013; Gil, Victoria, and Olza, 2015), therefore choosing a wide variety of foods from diverse sources guarantees consumption of requisite dietary elements (de Oliveira Otto *et al.,* 2018). Food variety also ensures a diet that meets and provides essential dietary needs while protecting against incidence and development of chronic disease conditions often associated with over-nutrition. Danquah, Galbete, Meeks, Nicolaou, Klipstein, Addo, Graft, Stephen, Peter, Baffour, Boateng, Bedu, Joachim, Liam, Ellis, Dabo, and Agyemang, (2018) evaluated the association between food variety and type 2 diabetes (T2D) among adult Ghanaian migrants in a cross-sectional study. Food variety was measured using DDS (0 – 7 points), FVS (0 -20 points), and the DQI-I variety component (0–20 points). After adjustment for confounders, there was an inverse relationship between FVS and T2D.

Conklin *et al.* (2016) examined the association between food variety and T2D in United Kingdom. At baseline, dietary intake was measured using FFQ 1993–1997, after which there was a ten-year follow-up. Food variety was measured using diversity between and within major food groups. After adjustments for confounders, results revealed an inverse relationship between food variety and nutrients intake inadequacies. The risk of T2D was 30% lower among adults who drew their total consumption from more food groups when compared to others. As well, the contribution of varied diet selected from items within nutrient dense groups was evident among participants in this study. Diets containing assorted items chosen within dairy products, fruits and vegetables all had weaker connections with incidence of the disease as against those consisting of fewer items (Conklin *et al.*, 2016).

Obesity is both a disease and a significant determinant of most other NCDs. However, the present body of literature does not indicate any distinct beneficial effects of food variety on body weight. Findings are inconsistent, with most studies reporting no significant associations between food variety and obesity, while there are more reports on direct associations than inverse relationships (de Oliveira Otto *et al.*, 2018). Food variety enhances the maintenance of healthy body weight if and only variety in food selections is limited to low energy-dense foods in long term durations, rather than high energy-dense foods (de Oliveira Otto *et al.*, 2018). Karimbeiki *et al.*, (2018) adopted a case-control approach to compare DDS among 100 overweight, 200 obese, and 300 normal-weight adults. Dietary intake data was collected using FFQ and the extents to which overall consumptions were drawn from each of the grains, vegetables, protein, dairy, and fats groups were also evaluated. Mean DDS decreased with BMI, such that adults with normal body weight had the lowest score. Furthermore, more obese participants had higher DDS. However, the reverse was the case among Filipino women. In the study, women whose diets consisted of several food items as well as those whose consumptions were particularly based on selection of items from other vegetables, were less likely to have obesity (Abris, Provido, Hong, Yu, Lee, Eun, and Id, 2018). Since increased food variety associates with increased body weight considerably, individuals, therefore, need to take into account the energy density of food items when selecting foods from different food groups for consumption. It is advisable to select more foods of low energy density from within and between major food groups, increase consumption of healthy traditional and modern, as well as functional foods as a way of attaining dietary diversity while maintaining a healthy body weight (Steyn and Ochse, 2013).

#### 2.1.2.2 Dietary Adequacy

Adequacy in dietary intake evaluates how nutrient intakes meet the daily recommended levels, whereas the quantities or number of food servings indicate how consumption of such items meets the food-based dietary guidelines. Increased consumption of components is desirable to confer higher diet quality. Nutrients of interest in most diet quality indices include protein; carbohydrates (complex, mono- and disaccharides); iron; calcium, and vitamin C, whereas food and food groups whose intakes are desirable often include fruits; vegetables; cereals; legumes, nuts, and seeds; milk and dairy products; olive oil and fish (Gil *et al.,* 2015).

A continuous supply of quality protein in the diet is needed to furnish the body with essential amino acids for optimal protein functions, including the synthesis of structural and functional components in the body. Although animal-sourced proteins are the best sources of high biological value proteins, plant proteins can provide daily protein requirements if consumed with complementary proteins (combination of legumes with cereal foods or with animal foods). When evaluating the adequacy of protein intake, the Diet Quality Index (DQI), which adopts reverse scoring, awards 0 for intakes exceeding 100% recommended daily allowance (RDA), 1 for 50 to 100%, and 2 for less than 50% RDA, lower scores representing higher diet quality (Gil *et al.,* 2015). Protein intakes providing up to and over 10% of daily energy intakes make the highest contribution to the overall diet quality in Diet Quality Index-International (Kim, *et al.,* 2003). Healthy diet index (HDI) scores 1(high quality) point for intakes providing 10 to 15% energy intake (Lucini, Zanuso, Blair, and Pagani, 2015).

Carbohydrates sources, when consumed in appropriate amounts and frequencies can guarantee a healthy body weight and micronutrient density while protecting against various NCDs associated with excess intakes. The type and quality of carbohydrates thus become important when considering their contribution to the overall diet quality. While an overall high carbohydrate consumption can lead to weight gain, overweight, and obesity, a relatively low energy-dense diet that guarantees satiety can be achieved by consuming one that is based on whole-grain cereals, vegetables, legumes, and fruits. Carbohydrate based meals, especially those that provide ample amounts of dietary fibre and are selected from grains have the potentials to furnish the body with adequate quantities of micronutrients while maintaining healthy body weight. The DQI indicates a higher diet quality with increased carbohydrate servings. The HDI awards 1 (high quality) to intakes that provide between 50 – 70% energy intakes (Lucini *et al.,* 2015).

Problems of insufficient iron intake affects more people worldwide than any other nutrient deficiency disease, usually causing impaired growth and development and reduced cognitive function in children, adverse pregnancy outcomes, and low immunity in all age groups etc. Even mild deficiency that does not produce any physical symptom can lead to marked reductions in capacity for physical and mental productivity, as patients often experience chronic fatigue (Diaz, Iii, Seals, Abdalla, Dubbert, Sims, Ladapo, Redmond, Muntner, and Shimbo, 2018). Consuming foods that contain heme iron (commonly found in animal source foods) rather than those with non-heme iron (plant-based foods) is a better way of ensuring adequate iron intake through bioavailable sources. Both Diet Quality Index-revised (DQIr) and Diet Quality Index-International (DQI-I) indicate higher diet quality with increasing iron consumption (Kim *et al.,* 2003; Gil *et al.,* 2015).

Fruits and vegetables are nutrient dense materials, which when consumed adequately make significant contributions to micronutrients intakes and increase the possibility of meeting daily nutrients requirements. They also enhance adequate supplies of dietary fibre and phytochemicals in the diet, which in turn protect against development of malignant disorders, especially cancers. Fruits and vegetables (particularly non-starchy vegetables) when consumed in amounts up to 400mg per day constitute a powerful strategy to mitigate against the global chronic disease burdens (Nour *et al.,* 2018). The importance of adequate fruits and vegetables consumption in health and diseases is evident in the extent to which sup-optimal intakes predispose to chronic and malignant diseases. Sup-optimal consumptions of fruits and vegetables were implicated in over four million deaths worldwide in the year 2017 (World Health Organization, 2019a).

Assigning a significant proportion of a diet that is low in fat, sugar and sodium to fruits and non-starchy vegetables can protect against excessive weight gain and reduce the possibility of contracting common ailments. It is important to reduce the consumption of fats and other energy dense foods while fruit and vegetable should be increased. One advantage of incorporating sufficient amounts of fruits and vegetables in daily intakes is that, they can be consumed in large quantities without necessarily taking in excess energy. This is due to the high water content, micronutrients and dietary fibre in the food materials. This way, consuming fruits and vegetables in large amounts can quickly confer satiety and displace the chances of consuming more energy dense foods, thereby, limiting the chances of excess energy intake and weight gain (Nour, Lutze, Grech, and Allman-Farinelli, 2018).

Fruits and vegetable intakes constitute important adequacy components in most diet quality indices. Some indices assess fruits and vegetable intake as a single quality component, whereas others consider fruit intakes separately from those of vegetables. The HDI gives the highest score for consumption up to 400g/day; the Mediterranean Dietary Quality Index (Med-DQI) considers daily consumption of ≥700g/day of fruits and vegetables combined, whereas, Mediterranean Diet Score (MDS) considers daily consumption above median values for maximum scores. The DQI gives the highest score for daily intake of ≥5 servings of fruits and vegetables (combined). All DQIr, Healthy Eating Index (HEI), and Alternate Healthy Eating Index (AHEI) have maximum scores for consuming 3-5 servings of vegetables and 2-4 servings of fruits per day. Both Mediterranean diet adherence screener (2 or more servings of vegetables per day and three or more pieces of fruit per day) and Mediterranean lifestyle index (3–6 servings per day for fruits and two or more servings per day of vegetable consumption) demand for a higher consumption of fruits than that of vegetables (Gil *et al.,* 2015).

Cereals constitute good sources of carbohydrates, dietary fibre, some B-vitamins and selected minerals. Adequate intakes are necessary for attaining daily requirements for certain nutrients as well as maintenance of good health. Incorporating whole grains into the diet can improve the overall quality of the diet through its high nutrient density. Since grains are regarded as good sources of micronutrients, especially the B-vitamins and vitamin E, increasing the consumption of grains in recommended levels could serve as a viable means of attaining adequate intakes of most essential micronutrients. Legumes are of two groups- the oilseeds (those containing high amounts of oils) and the pulses. Soybeans, peanuts, peas, all beans, and lentils constitute common food legumes (Maphosa and Jideani, 2016). Legumes provide ample supplies of both macro- and micronutrients, especially high quality proteins, complex carbohydrates, healthy fats and dietary fibre in the human diet across the world. Leguminous proteins are high in essential amino acids, though, except for soy protein, they are low in methionine, cysteine and tryptophan and are therefore considered incomplete protein (Kouris-Blazos and Belski, 2016; Maphosa and Jideani, 2016). Cereals are low in lysine however, individuals can take advantage of the complementary potentials of combining cereal products and legumes to derive maximum nutritional benefits from these food items in respect to essential amino acids. Legumes contain high amount of carbohydrates, though they are of low glycemic index.

Another class of nutrient dense food materials consists of milk and dairy products. They make the highest contributions of bioavailable and relatively low-cost dietary calcium, protein and selected minerals- magnesium, potassium, zinc, and phosphorus per calorie in the human diet than any other typical food item (Rozenberg *et al*., 2016). Dairy products also contain considerable amounts of fats, hence, consuming them in large quantities over time can lead to obesity. Fish is an important dietary component that furnishes the diet with essential nutrients (Skåre, Brantsæter, Frøyland, Hemre, Knutsen, Lillegaard, and Torstensen, 2015). Some fish are lean, medium-fat or fatty, depending on the amount of fat in their body tissue (Skåre *et al.*, 2015; Tørris, Småstuen, and Molin, 2018). Lean and fatty fish are both considered good sources of protein, iodine, vitamins and minerals, though fatty fish contain n-3 fatty acids and vitamin D in higher amount (Skåre *et al.*, 2015; Tørris *et al.*, 2018). Current dietary guidelines recommend consuming fish at least once to thrice a week (USDA, 2015; Tørris *et al.*, 2018).

#### 2.1.2.3 Food Moderation

Moderation in dietary intake entails bringing the consumption of foods or nutrients that easily predispose to over-nutrition to barest minimum. Dietary items often included in this dimension include fats, particularly total and saturated fats as they contribute to overall energy intake. Others include amounts of cholesterol consumed per day, sodium, sugars, and other empty-calorie foods. The acceptable macronutrient distribution range (AMDR) of 20–35% for total fat supports a diet that provides adequate supply of essential nutrients. This also guarantees that, the right type and sufficient quantities of fats, with special emphasis on unsaturated fats is consumed. Besides, consuming excessive amounts of food energy is curtailed when a diet is planned to reflect these requirements. Increasing the amounts of fats in the diet leads to increased consumption of total fats which is also linked to consumption of saturated fats, cholesterol, and energy over recommendations (Gil *et al.*, 2015).

Saturated fats and cholesterol, when consumed in excess are related to increased development and progression of several chronic sicknesses. While higher consumption of monounsaturated fats (MUFAs) and polyunsaturated fats (PUFAs) seems to associate with reduced risks of CVDs, increased consumption of saturated fats constitutes the single most important item under consideration in most diet quality indices (Food and Agriculture Organization, 2010). Including more of unsaturated fats in the diet, and keeping the consumption of total fats within AMDRs is recommended. The 2010 DGA recommended maximum intake of cholesterol to 300 mg per day (USDA, 2010). In the same vein, the 2015-2020 DGA recommends that cholesterol be consumed in amounts as little as possible with limited sodium intake of 2,300 mg/day while maintaining a healthy eating pattern that provides less than 10% energy intake from each added sugar and saturated fats (USDA, 2015).

Individuals can make up for their daily energy needs above the amount derived from nutrient-dense meals by consuming additional calories from other food sources. Discretionary calories represent the amount of energy consumed above total energy requirements aimed at meeting daily intake recommendations (Dietary Guidelines Advisory Committee, 2004). Such guidelines usually indicate that individuals can meet recommended nutrient intake at a particular energy level through nutrient-dense foods without necessarily meeting their recommended energy needs at such level. Discretionary calories allow individuals to consume some additional energy to meet their daily recommended energy levels. Individuals can consume nutrient-dense foods above recommendations or consume foods containing solid fats, added sugar or alcohol to provide discretionary calories (Guenther *et al.,* 2007). However, empty-calorie foods can displace the consumption of adequate amounts of nutrient-dense foods and oils in the diet. This informs the decision in most diet quality indices to ascertain amounts of calories from Solid Fats, Alcohol and Added Sugars (SoFAAS), usually expressed as a percentage of total energy consumed (Kim *et al.*, 2003; Guenther *et al.*, 2007).

#### 2.1.2.4 Overall Balance

This component gives consideration to the contributions of individual food energy sources. It evaluates that aspect of quality in the diet that reflects adherence to the principles of AMDRs. In the DQI-I, it is constructed to measure the ratios of energy intake from all carbohydrates, proteins and total fats to the overall energy intake. As well, the ratio of each fatty acid to the total fat intake is also examined (Kim *et al.*, 2003). Diets tailored to provide energy outside the requirements of the AMDRs has been shown to predispose to increased risk of diet related disorders. Lee *et al.* (2015) reported a direct association between inappropriate AMDRs in consumptions among Korean adults with increased risk of hypertension.

When the proportion of energy derived from carbohydrate was examined with respect to the diet quality among Korean adults, it was shown that, carbohydrate consumption outside the recommendations of the AMDRs (<50% or >65%) resulted in a significantly lower quality diet, when compared to diets that followed appropriate proportion of energy intake from carbohydrate (Soh, Chung, and Yoon, 2020). Moreover, carbohydrate intakes that didn't meet AMDRs recommendations were associated with prevalence of hypertension and low HDL-cholesterolemia in the population (Soh *et al.*, 2020). Increased risk of metabolic syndrome, specifically reduced HDL cholesterol and elevated triglyceride levels was observed among both US and Korean adults (Ha *et al.*, 2018). Gebremedhin and Bekele (2021) assessed how the present food environment in Africa influences the consumption of energy, macronutrients and selected food materials. The analysis revealed that, although the energy supply had increased over few years, consumption of macronutrients remained constant and was almost within the limits of the AMDRs. It was also noted that, sugar consumption exceeded limits especially in the middle and high income regions, whereas fruits and vegetables intakes remained below recommendations (Gebremedhin and Bekele, 2021).

### 2.1.3 Diet Quality Indices

**Posteriori Approach Indices:** Gil *et al.* (2015) defined diet quality indices (DQIs) as a set of algorithms aimed at evaluating the overall diet and categorize individuals according to the extent to which their eating behaviour is healthy. The overall quality of the diet can be evaluated using any of the two fundamental approaches: posteriori and priori approaches. Posteriori approach employs statistical methods to aggregate intake variables into factors that reveal predominant dietary patterns in the population under study (Asghari, Mirmiran, Hosseni-esfahani, Nazeri, Mehran, and Azizi, 2013; Burggraf, Teuber, Brosig, and Meier, 2018). The disadvantage of this approach lies in the fact that, current knowledge in nutrition as well as the evidence-based diet–health relationships are usually not applied in food consumption studies adopting the methods.

Moreover, the methods do not usually define dietary intake patterns with the healthiest trends and cannot be adapted across different populations (Burggraf *et al.*, 2018). One example of the posteriori approach consists of the use of nutrient-based indices in assessing food intakes. Assessing dietary intakes in populations is important for identifying the relevance of various dietary habits and or patterns to the risk of chronic ailments (Bivoltsis *et al.*, 2018). Different approaches, including single nutrients, individual food items, and food groups have been adopted in evaluating the correlation between food intake and health (Koksal *et al.*, 2017). One way of measuring the quality of diet at individual or population levels is to evaluate individual nutrient intake. Information collected on food intakes are translated to food weights, and the food weights are further used to derive the actual nutrient intake values using relevant information from food composition tables or databases. In order to judge the individual dietary intake, nutrient intake values are compared with established recommended nutrient values.

Gil *et al.* (2015) in a review on indicators for evaluating diet quality, identified three categories of diet quality indices. The first category consists of the nutrient-based indicators developed to assess the adequacy of nutrients intakes. Examples include the Nutrient Adequacy Ratio (NAR), Mean Adequacy Ratio (MAR), and Mean Probability Adequacy. Availability of a large body of scientific evidence on recommended nutrient intake values for almost all nutrients confers the robustness and adaptability of nutrient-based diet quality indices for assessing diet quality in different populations and across countries (Verger, Mariotti, Holmes, Paineau, and Huneau, 2012).

Nutrient-based indices fail to account for the upper levels of intakes and are thus limited in their use as indicators of diet quality (Verger *et al.*, 2012). However, they are useful in nutrition research in several ways. First, some indices such as MAR, probability of adequate nutrient intake (PANDiet), total individual macronutrient intake and total individual micronutrient intake capture the adequacy of dietary intakes at both individuals and at population levels. This way, researchers can ascertain the nutritional adequacy of the overall diet rather than focusing on specific nutrients that do not indicate the healthiness of the overall diet. However, such indices do not reveal specific nutrient deficiencies in the diets (Verger *et al.,* 2012; INDDEX Project, 2018). An additional usefulness is that, information derived from nutrient based indices can be used in combination with some other data to estimate sub-optimal intakes; besides, they can be adapted to meet specific research priorities in instances where there are needs to either include or exclude certain nutrients of particular interest to meet specific research objectives (INDDEX Project, 2018). Some of these indices can serve as useful tools in validation studies for more complex diet quality indicators.

The direct positive association between micronutrient intakes and dietary diversity has been documented in some studies (Acham, Oldewage-theron, and Egal, 2012; Steyn and Ochse, 2013). The second set of examples of the posteriori approach in dietary intake assessments consists of food based indicators. Although, there are insufficient scientific evidences for the development of these indices, which in turn limit their applications for specific populations. Secondly, since dietary patterns differ from population to population, it therefore, becomes difficult to adopt a food-based diet quality index developed for a particular population in evaluating the quality of dietary intakes in other population settings, except such indices are adapted to account for identified differences (Verger *et al.*, 2012).

**Priori Approach Indices:** Diets exhibit a characteristic of complexity in their constituents and subsequent effects on health. Posteriori approaches usually fail to establish the possible synergistic or antagonistic effects of different food constituents on the overall health outcome since individuals do not consume nutrients and foods in isolation (Pestoni *et al.*, 2019). Priori approach considers cogent scientific evidence in constructing comprehensive quality indices that can capture major quality aspects of the diet and categorize it (Asghari *et al.*, 2013; Burggraf *et al.*, 2018). Priori approach often adopt pre-defined indices derived from current nutrition knowledge to assess food intake patterns in settings (Gil *et al.*, 2015).

Diet-related disorders consist of both single nutrient deficiency diseases and those resulting from complex interactions from numerous dietary components. Even single nutrient disorders do not occur from the absence of a single food in the diet, but from inadequate consumption of a range of food items that furnish the diet with the specific nutrient involved. Besides, consuming sufficient amounts of food items that furnish the system with a specific nutrient does not guarantee the absence of its deficiency, being able to consume all dietary elements needed in all processes to ensure the ultimate metabolism and utilization of such nutrients is paramount. This is because, nutrients interact with each other and non-nutrient elements in the diet to either enhance or limit their bioavailability. Therefore, because diet-related disorders develop from complex interactions of various dietary components, adopting the combination of food and nutrients based approach in ensuring adequate food consumption patterns offers the gateway to success against diet-related disorders. The use of single pre-defined indices in evaluating the diet quality becomes increasingly popular (Bivoltsis *et al.*, 2018); proving the effectiveness of complying with dietary guidelines and recommendations in protecting against most diet-related chronic diseases (Chiuve *et al.*, 2012; Asghari *et al.*, 2013; Alkerwi *et al.*, 2015; Shin *et al.*, 2015; Conklin *et al.*, 2016; Tong *et al.*, 2016; Sotos-Prieto *et al.*, 2017; Cheung *et al.*, 2018; Panizza *et al.*, 2018).

Since dietary guidelines employ scientific nutrition knowledge in recommending ways of attaining levels of food intake compatible with sound health, these indicators are often designed to rely on the basic elements of such recommendations to judge the quality of intakes. And because established recommendations rely mostly on food-based approaches to attain optimum nutrition, most indicators of diet quality demand adequate consumption of selected foods with few nutrients as parameters to capture the overall quality of intakes.

The third group of diet quality indices consists of those that combine nutrient intake values, selected foods and or food groups (including fruits, vegetables etc.) to estimate the quality of the diet as consumed by individuals and groups. This approach consists of the most popular applications in examining the potential link between diets and diseases (Gil *et al.,* 2015). The overall sequence usually include an estimate of food variety, (that is to say, analysing the extent to which foods are selected from major food groups to make up the overall diet) particularly when and if food selection is drawn from within major food groups as well as those derived across nutrient dense groups. Other important components in such indices also include measures that estimate adequate intakes. Adequacy include standards for assessing how consumption meets daily requirements for both nutrients and selected food items regarded as good sources of nutrients that must be supplied in sufficient quantities in the diet.

Several number of dietary elements have been identified as significant predictors of chronic diseases when consumed in amounts in excess of recommendations. Sodium, solid fats, total fats, sugars and other food sources that increase the energy contents of meals without necessarily making any meaningful contributions to essential nutrients are recommended in limited amounts. Diet quality indices also contain measures that evaluate compliance to these recommendations. The fourth dimension consists of methods that evaluate how well a diet complies with the recommended AMDRs. This component consists of the overall balance, which measures the proportions of individual macronutrients to the overall energy intake. Based on priori approach, the HEI, DQI, HDI and the MDS comprise the original diet quality indices that have been adapted and or modified into various other indices based on specific research objectives (Gil *et al.,* 2015).

Healthy Eating Index: This indicator was developed by the USDA in 1995 to estimate compliance of the American diets to recommendations (Burggraf *et al.,* 2018). It measures the intake of ten dietary components - grains, vegetables, fruits, milk, and meat groups servings (as recommended in the USDA Food guide pyramid); percentage of total energy intake derived from each total and saturated fats; total amounts of cholesterol and sodium intakes as well as food variety in a three-day food intake. Each dietary component receives the highest score of ten and a minimum score of zero, depending on the attainment for the recommendation. Thus, the overall diet quality measured by HEI has a score range of 0 to 100 (Kennedy, Ohls, Carlson, and Fleming, 1995). A modification of the index, Alternate Healthy Eating Index (AHEI) was introduced in 2002 as a tool to measure the disease risk in response to food intakes (Chiuve *et al.*, 2012). However, the HEI has evolved over time to reflect specific adjustments in the USDA dietary guidelines for America. Hence, it has been adapted to reflect key messages in 2005, 2010 and 2015 dietary guidelines for Americans (Asghari *et al.,* 2013; Guenther *et al.*, 2013; Panizza *et al.,* 2018).

The Mediterranean diet describes the general traditional dietary patterns of the people around the Mediterranean regions (Tong *et al.,* 2016), and gives preference to higher intakes of olive oil, vegetables, grains including legumes and cereals and fruits. Wine, fermented dairy products, poultry and fish are consumed in moderation while limiting red meat consumption to barest minimum (Tong *et al.,* 2016; Papadaki, Johnson, Toumpakari, England, Rai, Toms, Id, Zazpe, Mart, and Feder, 2018). The Mediterranean dietary pattern draws its popularity from its association with a lower incidence of chronic disease conditions (Tong *et al.,* 2016; Papadaki *et al.*, 2018). As such scientists, in attempt to evaluate adherence to and promote dietary intake patterns that reflect the diet, have taken advantage of the predominant features of the diet in developing single composite diet quality indices. Diet quality indices have been designed to reflect key principles in the Mediterranean diet. Mediterranean Diet Score (MDS) was constructed by Trichopoulou *et al.* (1995), and consists of nine dietary components as prescribed by the traditional Mediterranean diet pattern (Alkerwi *et al.,* 2015).

Diet Quality Index-International (DQI-I) was developed based on the North American dietary guidelines by Kim *et al.* (2003) to enhance comparison of diet quality across different settings. The DQI-I can be used to derive relevant information about issues relating to a particular nutrition transition period within and across locations. It is used to evaluate the quality of diets across cultures, traditions, and countries at any point in time. It constitutes a single measure of the healthfulness of diets that examines different aspects of diet quality and addresses issues relating to under-nutrition and over-nutrition (Kim *et al.,* 2003). The index evaluates selected aspects of the diet - food variety, adequacy, moderation and overall balance.

### 2.1.4 Contributions of Individual Dietary Components to Overall Diet Quality

The contributions of energy, nutrients, food groups and specific food quality characteristics to the overall diet quality have been documented in food consumption studies. Dietary consumption patterns tailored towards high energy intakes are less likely to meet the requirements for healthy living through food intake. Verger *et al.* (2012) developed the PANDiet (probability of adequate nutrient intake) as a tool for ascertaining the extent to which adults in France and United States of America consume diets that guarantee adequate intakes of most essential nutrients. High energy consumptions related positively with lower quality diets (Verger *et al.,* 2012).

Dietary intakes, when measured quantitatively from food frequency among 215,000 adults from Hawaii and California revealed dietary intake patterns (as measured with the HEI-2015) that related negatively with energy density of the diet (Panizza *et al.,* 2018). Alkerwi *et al.* (2015) tested the effectiveness of different diet quality measures in identifying the risk of chronic disease conditions among 1,352 adults in Luxembourg. The FFQ was used to assess dietary intakes, while selected diet quality measures were used to assess overall diet quality. Findings revealed that diet quality scores increased with decreasing total energy intakes for all diet quality indices except MDS. Remarkably, the observed inverse association between energy density of the diet and diet quality was especially true among adults who consumed diets that provided a higher proportion of energy from fats rather than other energy sources (Alkerwi *et al.,* 2015).

Individuals can meet the needs for essential dietary elements if they select their diets to include sufficient quantities of grains and other food groups that provide ample quantities of essential nutrients. Verger *et al.* (2012) discovered that, diets that guarantee consumptions of essential nutrients in sufficient quantities are characterized by adequate intakes of milk, other dairy products, fish, fruits and vegetables. In the RESIDential Environments (RESIDE) project, conducted between 2004–2011, data were collected from 555 Australian adults ≥ 25 years old using a 24-item questionnaire. An indicator for evaluating the quality of intakes, RESIDE dietary guideline index (RDGI) was developed to assess how the dietary intakes of Australian adults complied with the established dietary guidelines in the country. Two other sub-sets of diet quality scores (S-RDGI1 and S-RDGI2) were derived from the original RDGI. Findings revealed increased consumptions of fruits and vegetables contributed significantly to higher diet quality scores, while increased intakes of discretionary foods had significantly negative correlations with all diet quality scores (Bivoltsis *et al.*, 2018).

Sotos-Prieto *et al.* (2017) reported that consuming whole grains, vegetables, and n-3 fatty acids in higher quantities while lowering the consumptions of sodium over a 12 years period led to significant improvements in the overall diet quality in US (Sotos-Prieto *et al.*, 2017). Asghari *et al.* (2013) evaluated the effects of food intakes on changes in lipid profiles over a follow-up duration of 6.7 years among 469 adults in Tehran. Dietary intake data obtained by conducting a 24-hour dietary recall on two occasions was used to derive scores for three indicators of diet quality - the MDS, HEI-2005 and DQI-I. Intakes characterized by higher consumptions of fibre and whole grains but lower intake of fats and discretionary foods had a direct positive association with diet quality (Asghari *et al.*, 2013).

When diet quality (measured using DQI-I and MDS) was assessed among apparently healthy 797 Chinese adults in Hong Kong between 2008 and 2010, diets that were predominantly based on increased consumptions of seafood, cereals and legumes (especially soy based products), fruits; vegetables, dietary fibre, as well as those contributing minimally to energy intakes from fat, met the criteria for better diet quality (Chan, Wong, Chu, Lai-, Wong, Li, Leung, Chim, and Yeung, 2015). Most priori diet quality indices emphasize the need to account for each dimension of diet quality identified to enhance a healthy diet - food variety, dietary adequacy, food moderation and overall balance in the distribution of energy sources. Several studies have identified how these dimensions contribute to the overall quality of dietary intakes in populations. This is important to identify the possible causes and execute interventions that will effectively correct inappropriate intakes to meet specific diet quality dimensions. In the study to evaluate the validity of the PANDiet in French and American populations, dietary adequacy and moderation were taken into account. To achieve this, the authors evaluated the probability of meeting the requirements for dietary intake components that should be consumed in amounts beyond the established reference values as well as those that should not be taken in amounts beyond the permissible intake levels. Findings indicated that participants in both populations scored better in moderation components than in the adequacy component (Verger *et al.*, 2012).

However, among Korean women, Shin *et al.* (2015) evaluated how food intakes related with gestational diabetes mellitus. A three-day food record, conducted between 2008 and 2012 was used to derive dietary intake data from 166 women; DQI-I was adopted to describe diet quality. Results showed that dietary variety, followed by adequate intakes of selected food groups and nutrients constituted more important considerations in food intakes. The observation that moderation constituted the most important dimension in diet quality among French and US adults is in tandem with the school of thought that nutrition transition is presently at a stage where individuals are conscious of the diets-disease relationship and therefore tailor their diets towards consuming healthy components while limiting intakes of those believed to increase risks of chronic diseases.

### 2.1.5 Diet Quality and Diseases/mortality

The major function of food is to furnish the body with vital nutrients that aid growth, development and maintenance of sound health. However, certain dietary elements, when consistently consumed in excess over time, usually result in adverse health conditions. Following the MDS dietary pattern was accompanied by significant inverse associations with most chronic disease risk biomarkers among 1352 adults in Luxembourg (Alkerwi *et al.*, 2015). Chiuve *et al.* (2012) reported low incidence of selected NCDs among men whose consumptions were patterned to follow recommendations. Participants in the highest quintile of diet quality (measured by various versions of the HEI) had less likelihood of suffering from non-infectious ailments (total CVD, CHD, stroke, diabetes, and cancer) unlike participants with poorer intakes over a 24 years follow up period in age-adjusted models. Also, increased consumption of dark-green and orange vegetables, whole fruit, whole and total grains, nuts, milk, vegetable oils but considerate moderation in consumption of dietary elements that require restrictions, related negatively with the risk of chronic diseases.

Shin *et al.* (2015) in their study to examine the associations between dietary pattern and diet quality (measured by DQI-I) among 166 women with gestational diabetes mellitus in Korea reported that plasma fasting glucose levels and HbA1c concentrations were significantly lower among women in the highest quintile of DQI-I group, whereas a higher level of the biomarkers were reported among participants with lower quality intakes. Within-group diversity in dairy, fruits and vegetables were all associated with about 30% reductions in the likelihood of suffering from diabetes in the same population.

Tong *et al.* (2016) evaluated the associations between habitual diets (assessed using MDS) and the risk of CVDs and mortality. Primary dietary intake data was obtained using FFQ between 1993–1997 and 1998–2000 among 23,902 adults. The authors documented significant inverse associations between diet quality and incidence of cardiovascular outcomes. Low diet quality was responsible for 3.9% of incident CVD and 12.5 % mortality in the population. Findings from a study examining the risk of mortality from inappropriate dietary intakes revealed significant inverse associations across quintiles of change over 12 years between diet-quality scores (measured by AHEI-2010, AMDS and DASH) and total mortality (Sotos-Prieto *et al.,* 2017). A decrease in diet quality, as compared with no change, was associated with an increase in total mortality (Sotos-Prieto *et al.,* 2017). Findings from a study involving multi-ethnic cohorts resident in Hawaii and Latin America revealed that, although, most adults with the highest diet quality scores (measured by HEI-2015) had diabetes; high diet quality scores were linked to lower death rates from CVD, and cancer when compared to participants in the lower quintile (Panizza *et al.,* 2018).

Food impacts directly on physical body dimensions, including body weight, height in children and young adults who are still undergoing the processes of growth and development. The evidence of eating, particularly when following nutritional principles is usually obvious in healthy body weight. Although some other dietary elements may have indirect impact on body weight through metabolic roles, body weight often changes over time to reflect the extent of energy intakes. Hence, in order to assist individuals attain and sustain healthy body weight, dietary recommendations advice food intake patterns that support moderate energy intakes for respective physiological states and conditions. A good quality diet will supply all nutrients in sufficient quantities within each energy intake level. A poor quality diet furnishes the body with excess energy over essential nutrients, leading to overweight and obesity.

The existing relationships between the quality of diets and overweight/obesity have been studied extensively. Diet quality had inverse associations with BMI among US adults (Chiuve *et al.,* 2012). When association between alterations in nutritional intake patterns and death rates was examined in the same cluster, results revealed that, participants with healthy dietary intakes over long term periods were more likely to have favourable BMI values (Sotos-Prieto *et al.*, 2017). Panizza *et al.* (2018) reported that, the highest diet quality scores were obtained from adults whose intakes were characterized by low energy density that translated to lower BMI in a multi-ethnic cohort from Hawaii and California. Declercq, Cui, Forbes, Grandy, Keats, Parker, Sweeney, Yu, and Id, (2017) in their study to evaluate diet quality and its association with adiposity among 23,768 adult in Atlantic Canadian provinces, indicated that, participants' BMI reduced with increasing quality of intake patterns in the study population.

Diet quality measured in terms of diversity in intakes among Fillipino women, revealed that, low diet quality had independent inverse effects on anthropometric measures of obesity in the population (Abris *et al.,* 2018). The authors in this study reported that residence status of up to ten years or more, absence of alcohol intake and consistency in the dietary pattern were important for mediating the inverse relationship between diet quality and obesity. These intervening effects indicate that intervention strategies and policy planning need consider the roles of other factors in yielding health benefits of adequate diet. The relationship between within-group diversity for specific food groups and obesity is indicative of those food groups that are important in contributing to desirable body weight. The authors in this study documented an inverse relationship between within-group diversity in vegetable intake and general and abdominal obesity (Abris *et al.,* 2018).

In a cross-sectional study investigating how body weight varies in response to dietary intakes among 211 Chinese T2D adults, obesity was assessed by BMI while diet quality was measured using three indices - AHEI-2010, DQI-I and DASH. Obese T2D patients had significantly lower mean scores for all diet quality indices when compared to non-obese counterparts. Total caloric intakes and those derived from protein, as well as increased consumption of meat, poultry, and organ meat all related positively with obesity. When specific components of the DQI-I were considered, obese participants had lower mean scores for both variety and moderation scores, indicating an inverse association between obesity and food variety and moderation (Cheung *et al.,* 2018). In a cross-sectional study to describe diet quality among 494 Turkish adults, Koksal *et al.* (2017) collected dietary intake data using 24-h dietary recall and measured diet quality by HEI-2005 and HEI-2010 while assessing obesity by BMI. Findings showed positive correlations between diet quality scores (for HEI-2005 and HEI-2010) and BMI. Overweight individuals had the highest mean scores for diet quality indices (Koksal *et al.,* 2017).

### 2.1.6 Diet Quality and Socio-demographic Variables

There are consistent evidence that the quality of dietary intakes differs with age. Older people seem to adopt healthier dietary intake patterns. Among French adults, Verger *et al.,* (2012) in their findings reported a significant direct relationship between the PANDiet score and higher age. In South Africa, women 56 years and above had higher mean intakes for different food groups when compared to those aged 19 to 25 years in a study to evaluate diet quality using DDS, NAR and MAR (Acham *et al.,* 2012). There were direct positive relationships between all diet quality scores (measured by RCI, DQI-I, DASH MDS and DII) and age among adults in Luxembourg (Alkerwi *et al.,* 2015).

Findings from the study by (Koksal *et al.,* 2017) indicated that adults 51 years and above had the highest diet quality scores; moreover, there were positive correlations between diet quality scores and increasing age. A twelve years longitudinal study on changes in diet with total and cause-specific mortality among US health professionals reported that adults with consistently high diet quality at baseline and 12 years later were older, although younger participants showed the greatest increase in diet quality scores (Sotos-Prieto *et al.,* 2017). Findings obtained from the RESIDE study in Australia revealed that, although not statistically significant, diet quality scores seemed to increase with increasing age (Bivoltsis *et al.*, 2018). Compared to those in the lowest quintile of HEI-2015 scores, participants in the highest diet quality quintile were likely to be older adults in a multi-ethnic cohort from Hawaii and California (Panizza *et al.*, 2018).

Winpenny, Greenslade, Corder, and van Sluijs, (2018) observed that vegetables intakes, as well as low-fat dairy and legumes intakes were greater among older females in a cross-sectional study investigating associations of the DASH diet with component food groups with age. It is believed that health consciousness increases with advancing age (Yoshida, Scribner, Chen, Broyles, Phillippi, and Tseng, 2017), which could explain some differences in diet quality among people of different age groups. Those of older age groups may be more mindful in their choices of foods and tend to select food items and consume a diet that meets dietary guideline recommendations including, adequate intake of those items whose consumption must meet recommended levels, increase fruits and vegetable intakes while decreasing intakes of saturated fats and sodium than those of younger age (de Andrade, Previdelli, Cesar, Marchioni, and Fisberg, 2016).

Urbanization is linked to changing food patterns. Indigenous people, once in urban areas begin to consume less traditional staple foods while increasing intakes of highly processed and sugar-sweetened foods and beverages (Cockx, Colen, De Weerdt, and Gomez Paloma, 2019). The urban setting because of industrialization may present the consumers with more options and availability of novel, highly processed energy-dense foods as well as commercially cultivated animal foods. Thus, urban residents may have more access to varieties of foods and consume highly processed and energy-dense foods than their rural counterparts (Rothman, Ranneileng, Nel, and Walsh, 2019), although the global shift in lifestyles, including dietary intakes accompanying industrialization is not limited to urban settings.

Cockx *et al.* (2019) argued that the urban-rural differences often observed in dietary patterns can be attributed to changing incomes and living conditions usually seen in rural-urban migration, rather than the urban location itself. Rural people may also tend their food consumption to conform to the western diets as their socioeconomic status improve. Increased consumption of protein, fat, saturated fat, monounsaturated fat, cholesterol has been reported among rural women of reproductive age, compared to their urban counterparts (Martin, Moran, Teede, Ranasinha, Lombard, and Harrison, 2017). The common scenario now is a situation where both indigenous food systems and dietary patterns associated with nutrition transition coexist in the same settings.

Food consumption is also influenced by cultural factors, leading to cultural influences in the overall diet quality. Food culture entails the kinds of food cultivated and eaten, belief systems about foods as well as food preparation and services common among indigenous people of a discrete geographical location. The type of food allowed for each category of persons, either within family settings or in the entire society is also determined by cultural norms and practices. Food culture also determines the kinds of foods served in respective traditional functions within the culture. The use of foods for particular connotations over specific occasions or circumstances cuts across most cultures. With the advent of globalization, almost every civilized society now harbours an array of food values, ostensibly imported by people from respective geographical locations.

Culture dictates that people eat differently based on their origin, hence differences in diet quality. Differences in dietary patterns across locations and culture may be seen in types of food items or food groups consumed in each culture including the most important sources of specific nutrient and energy. Declercq *et al.* (2017) in the Atlantic PATH Cohort, observed significant differences in consumption of major food groups (fruit and vegetable, grains, milk and dairy, and meat and alternatives) in different provinces. While dietary intakes among Ghanaian migrants in Europe was characterized by protein and fat intake as primary sources of food energy, carbohydrate supplied most energy intake among those in Ghana, especially rural people (Danquah *et al.*, 2018).

Pestoni *et al.* (2019) recorded a higher diet quality score for residents of the French- and Italian-speaking regions of Switzerland compared to residents of the German-speaking region. Location is a well-known factor that influences food intake, probably due to differences in climatic conditions of each geographical location, which predicts to an extent the type of foods cultivated and available. Availability of specific food items in a setting constitutes one of the significant determinants of indigenous food culture, which in turn predicts the prevalent dietary pattern(s) in any given locality.

Food intake patterns, hence overall diet quality differ between men and women, often leading to gender differences observed mostly in studies. Both have ardent inclinations towards consuming different kinds of foods, different food preferences. For instance, women though consume more confectionaries than men, have preferences for healthier foods (Koksal *et al.,* 2017). Women will naturally choose to go for vegetable based dishes, such as salad as refreshment during relaxation, while men will typically go for drinks. Men on the other hand, have preferences for consuming more protein, derived mostly from animal products, which are in turn rich in fat. Hence, men will naturally fill their plates with more pieces of meats or fish while eating than women. It is also said that women exhibit yearnings to comply with dietary recommendations, which again may be driven by their health seeking behaviours (Arganini, Saba, Comitato, Virgili, and Turrini, 2012).

Health seeking behaviours expressed by women could be as a result of the quest for perfect body size and shape or resulting from increased awareness of the nutritional benefits of eating well that is common among women (Arganini *et al.,* 2012). Also, the disposition to eating well among women may not be independent of the social roles which makes women the nutritional gatekeepers of their families. Consistent findings from studies indicate that more females than males are likely to follow dietary patterns consistent with good health. Females usually follow dietary patterns that confer higher diet quality scores than males. Adopting the PANDiet to assess the quality of dietary intakes among French and US adults, Verger *et al.* (2012) observed significantly higher diet quality scores among females. Tehranian females scored significantly higher than the male counterparts in HEI-2005 (Asghari *et al.,* 2013). American women also had better diet quality measured by DQI-I and DASH patterns than men (Alkerwi *et al.,* 2015). A cross-sectional study among Turkish adults revealed higher mean total scores for both HEI-2005 and HEI-2010 among females than males (Koksal *et al.,* 2017). Among Australian adults, Bivoltsis *et al.* (2018), reported higher diet quality among females. The female sex was a predictor of higher diet quality in Switzerland (Pestoni *et al.,* 2019).

Consistent with a higher total mean scores of individual diet quality index, is the observation that females also score higher in consumption of individual components believed to contribute positively to diet quality. For instance, Turkish females had higher scores for complying with dietary patterns that followed adequate consumption of individual dietary components in HEI-2005 and HEI-2010 diet quality indices (Koksal *et al.*, 2017). However, Lee *et al.* (2016) had contrary findings from these trends among Korean adults. In their study to evaluate dietary patterns in the population, four distinct dietary patterns were uncovered in the population. Results showed that, women engaged more in overeating/binge and dietary impulse than men. Women had lower scores for food variety but scored higher in adequacy components (especially vegetables, iron, cereal, and dietary fibre, but not in fruits).

### 2.2.0 Physical Activity

### 2.2.1 Definition of Physical Activity

Physical activity occurs when individuals undertake specific tasks that engage the contraction of skeletal muscles to produce bodily movements while energy is expended. This involves several undertakings including activities performed while carrying out occupational duties, household chores, transportation, and even recreational engagements and could span from walking, sweeping, mopping of floors, scrubbing, laundry, pounding, grinding, lifting heavy objects, stirring of mixtures, pushing, operating certain machines to running, jumping, swimming, skating etc. It has been reiterated that, for any task to be classified as physical activity, the energy requirements for their executions must substantially exceed that of resting energy expenditure for the individuals engaged in the pursuits (Abdool-Gaffar *et al*., 2011; Pfeifer *et al.*, 2017).

Physical activity can be described as those subsets of multidimensional human behaviours whose physiological outcomes are not limited to energy expenditure, but can also confer greater health benefits including improved physical fitness (Center for Disease Control and Prevention, 2011). Health-enhancing physical activity includes only those activities that produce health benefits and improve functional capacity without undue harm and risks (Abdool-Gaffar *et al.*, 2011). However, when physical activity is intentionally planned and executed with a goal to confer identified or general health benefits, then, such programme becomes physical exercise. Physical exercise offers the most beneficial health impacts of all physical activities, especially when performed consistently in a well-structured plan.

Physical inactivity is a term that refers to condition where ordinary activity is performed without attaining any moderate or vigorous-intensity physical activity (Pfeifer *et al.*, 2017) and extends to include activities with levels below those that impact positively on health. Basic physical activity is that amounting to 2.9 METs and is above low-intensity PA (1.5 to 2.9 METs) but below amounts needed to engage in moderate-intensity activities (Pfeifer *et al.,* 2017). Sedentary lifestyle is on the increase resulting from changing economic trends that favour using energy-saving devices in accomplishing most tasks that initially entailed human physical efforts, as such incident health problems emerging from sub-optimal physical activity are on the increase worldwide. Specifically, sedentary behaviour is physical inactivity that is mostly characterized by long periods of sitting and or prolonged engagements in activities that require energy expenditure less than 1.5 METs.

### 2.2.2 Recommendations for Physical Activity

For individuals to attain and maintain health sustainably, the WHO and national authorities have compiled minimum sets of recommendations on physical activity to be followed. Recommendations depend on specific health benefits of physical activity to each age group. For instance, adequate physical activity is critical for the development of healthy skeletal muscles, cardiovascular system, guarantees maximum nervous and muscular health, and many psychological benefits in children. Adults 18 to 64 years old who meet recommended physical activity levels for their age stand the chances of enjoying improved cardiovascular health and reduced high blood pressure, stroke as well as other metabolic disorders that usually manifest as type 2 diabetes, metabolic syndrome, various forms of cancers. Adopting a healthy lifestyle that includes sufficient physical activity also ensures emotional health and strong skeletal system. Physical activity does not only increases the capacity to maintain healthy body weight across all age groups, it also ensures the development and maintenance of healthy body composition among adults (World Health Organization, 2010).

Children, five to seventeen years old are expected to attain a minimum combination of moderate and vigorous intensity physical activity that amounts to 60 minutes of aerobic activities per day. There is also an emphasis that, those within this age group should engage in vigorous intensity physical activity aimed at improving bone health as well as muscle strengthening activity not less than thrice a week. A life style that includes consistent engagements in physical activity, where individuals spend not less than 150 minutes per week in performing activities of moderate intensity is crucial for impacting the health benefits of PA among adults eighteen to sixty-fours years of age. An alternative to this entails participating in aerobic activities with vigorous intensity that accumulates to at least 75 minutes spread across the week; as well, individuals could attain an equivalent combination of moderate- and vigorous-intensity activity (World Health Organization, 2010).

Adults, aged 65 years and above very often suffer from degenerative conditions that result in progressive declines in cardiovascular, respiratory and muscular functions. Very importantly, they also stand a greater chance of experiencing various forms of NCDs, emotional abnormalities and psychological imbalances than those in other age groups. Whereas these conditions can be effectively mitigated when adequate level of physical activity is attained and maintained over sufficient period. Physical activity recommendations for this age group is not different from those for adults 18 to 64 years old. That is to say, a minimum of 150 minutes invested into aerobic activities of moderate intensity that spans across the week is important for conferring identified benefits of physical activity for those in this group.

Alternatively, the older adults can also attain recommended level of physical activity when and if they participate in activities of vigorous intensity that eventually amount to a minimum of 75 minutes in a week and or attain an equivalent combination of moderate- and vigorous-intensity activity (WHO, 2010). These recommendations could be attained easily by increasing involvements in normal daily activities that include recreational and job related activities as well as household chores. In addition to the general recommendations, it is important that, adults who are prone to falls pay attention to and apportion at least three days in each week to exercises that promote balance and prevent falls. Maximum level of physical activity attainable should be maintained in an occasion where ill health poses constraint to adequate PA (World Health Organization, 2010).

It is important that, PA be performed in durations beyond 10 minutes for each occasion (bouts) by individual of all ages (World Health Organization, 2014) if the health benefits of

PA is to be achieved. Increasing the duration of weekly participation in physical activity beyond those recommended for adults eighteen years and above is desirable to achieve added health benefits. It is advisable that, adults accumulate up to 300 minutes per week, spent in performing physical activity of moderate intensity or they make additional efforts to increase participation in activities of vigorous intensity amounting to 150 minutes per week. A good alternative, where possible is to attain PA patterns that meets the requirements for a combination of both moderate and vigorous-intensity PA patterns. Intentionally increasing the participation in lifting weight, climbing stairs, walking up the hills, cycling, sit–ups, squats etc could help strengthen major muscles groups. The WHO recommends that such activities be done on not less than two days a week while avoiding long and uninterrupted sitting times (World Health Organization, 2010; Pfeifer *et al.*, 2017).

### 2.2.3 Measurement of Physical Activity

Though it is difficult to measure physical activity objectively, there are two broad ways of estimating the amount of physical activity performed by individuals or groups. The first set of methodologies involve direct measurements using various appliances. Examples of such include pedometers, accelerometers, heart rate monitors etc. The second set of methods include using indirect ways (especially self-reported questionnaires) to estimate physical activity.

### 2.2.4 Regulation of Physical Activity

A number of human and animal based studies have disclosed strong evidences of genetic influences on daily physical activity level. Numerous researches have led to the discovery and identification of some quantitative trait loci (i.e. chromosomal locations) that explain variations in physical activity level and that the influence of genetic make-up activity level varies particularly by age (Lightfoot, De Geus, Booth, Bray, den Hoed, Kaprio, Scott, Pomp, Saul, Thomis, Theodore, and Bouchard, 2018).

### 2.2.5 Physical Activity and Health

Frequent participation in physical activity, especially those incorporating activities of moderate to vigorous intensity is of immense health benefits for people of all age groups; besides, these benefits outweigh any potential harm or accident that may occur in the course of the exercise (World Health Organization, 2014). However, frequency, duration, intensity and the type of PA (Rhodes *et al.,* 2017), constitute important determining factors for the final benefits of PA in individuals. Since the effects of PA are dose-dependent, individuals with PA levels below recommendations can still attain some kind of health benefits when participating in lesser PA levels (Alricsson, 2013).

Physical activity impacts positively on health through several enticing characteristics that make it attractive for participation. Beginners stand the chances of benefitting most from participation (Pfeifer *et al.,* 2017). That is to say that, the highest form of positive influence accruing from participation in physical activity is usually experienced by those who never adopted physical activity as part of their lifestyles, but decide to engage in active lifestyle at some point in time. Furthermore, PA also has the distinct benefit of impacting on several body organs and systems simultaneously, validating the justification for participation (Alricsson, 2013). Moreover, attaining the recommended PA levels only requires that individuals increase activity levels by engaging more in simple and routine daily endeavours (World Health Organization, 2014).

Advantages of physical activity have been enumerated severally, both by independents researchers and health related institutions across the globe. Consistent reports indicate that increasing physical activity level to meet recommendations is essential for attaining and sustaining good health. All cardiovascular, muscular and skeletal systems as well as metabolic profiles are impacted positively in the occasion where and when individuals engage in sufficient physical activity. Individuals who report higher participation in physical activity can have greater health benefits in physiological and skeletal outcomes and at the same time attain healthy levels of disease biomarkers (World Health Organization, 2014; World Health Organisation, 2018b). Kanagasabai *et al.* (2015) evaluated participations in PA domains and body weight history among 2,753 obese US adults, 20 years and above. Metabolic syndrome (MetS) was defined based on the harmonized criteria. Physical activity was classified into three levels: participants with no reported PA; PA greater than zero but less than 500 METs-minutes/week and PA greater than 500 METs-minutes/week and were classified as inactive, somewhat active and active respectively based on each PA domain.

Results revealed that higher PA had significant positive associations with metabolically healthy phenotype in obese adults.

Individual contributions of each PA domains on health-related quality of life (HRQoL) in older age was evaluated in Brazil (Scarabottolo, Cyrino, Nakamura, Tebar, Canhin, Gobbo, Giulliano, and Christofaro, 2019). A short-form health survey questionnaire was adopted to evaluate the HRQoL among study participants. Overall physical activity in the population was derived from information collected mostly on questions that boarder on occupation, participation in sports and gym as well as leisure time activity. Results indicated slight differences in associations between individual PA domains and HRQoL. Older adults with higher PA scores in each domain were more likely to experience higher functional capacity, less body pains and better mental health, indicating direct positive effects of PA on quality of life through functional capacity.

Physical activity, (measured to account for the contributions of all domains using the International Physical Activity Questionnaire – IPAQ long form) was evaluated in relation to physical fitness among 192 Turkish adults (Özköslü, Daşkapan, Karataş, and Tekindal, 2017). Various measurements were taken to assess physical fitness using appropriate devices and techniques. There were two groups of participants- apparently healthy adults and patients with fibromyalgia syndrome (FMS). The authors reported higher PA among healthy adults compared to patients of FMS. Healthy adults performed significantly better in some of the physical fitness tests, particularly the Sit-up test and the Left lateral flexion test. A longitudinal study conducted to evaluate physical activity, diet quality and adiposity in South Carolina involved 658 children (Dowda, Ross, Mciver, Dishman, and Pate, 2017). Physical activity was measured using accelerometer and categorized into levels using age-specific prediction equations. Obesity was measured by Fat mass index (FMI), per cent body fat (PBF), and BMI. Children who reported moderate or vigorous PA patterns all had significantly lower values of all measures of adiposity.

Physical inactivity constitutes one of the most significant health concerns worldwide. The risk of morbidity and subsequently mortality seems to increase in instances where people are less physically active; the impact being in the remarkable proportion of global deaths arising from physical inactivity each year. It is said that, physical inactivity accounts for over three million deaths (about 6% of global deaths) worldwide each year, making it the fourth leading risk factor for global mortality (World Health Organization, 2014). Unfortunately, the situation is rising unabated in most countries and regions, creating a preventable hurdle against the global fight to mitigate the impacts of NCDs and the overall health status (World Health Organization, 2014; 2018). The WHO clearly states that, the likelihood of dying from NCDs increases for over 20% to 30% among individuals with low physical activity patterns when compared to those who engage in at least moderate intensity PA throughout the week (World Health Organization, 2014).

### 2.2.6 Physical Activity Patterns

The roles of physical inactivity in global health and disease rates have made it mandatory for health authorities to proffer ways of improving physical activity among individuals if the present state of global ill-health must be controlled and reversed. Reducing physical inactivity by not less than 10% thus constitutes an essential component in the Global Action Plan for the Prevention and Control of Non-communicable Diseases 2013-2020 (World Health Organization, 2014). Most individuals, including adults, adolescents and children find it challenging to adopt lifestyles that comply with the minimum standards on PA for normal health outcomes. Less than 25% of adults and 85% of adolescents worldwide are affected by physical inactivity (World Health Organisation, 2018b). In 2008, 31% of adults (28% males and 34% females) aged 15 and above had low physical activity patterns (World Health Organization, 2014). A study conducted to estimate the extent to which in-school adolescents in Peru participate in sufficient PA indicated that over 75.0% of adolescents failed to comply with recommended physical activity level for the age group on all days of the week preceding the study, while over 10.0% failed to meet the criteria even for a single day. Adolescents were reported to attain sufficient physical activity only on 3.4 days per week (Sharma, Chavez, and Nam, 2018).

Physical inactivity also constitutes a concern among younger children. A total of 97 children aged ≤ 13 years in the Eastern United States participated in a cross-sectional study assessing how physical activities after school periods related to health-related physical fitness (Yang, Zhu, Haegele, Wilson, and Wu, 2019). School children spent most of the after school periods on sedentary activities with little physical activity of light intensity while minimal or no moments were spent on sufficient active lifestyles. Dowda *et al.* (2017) reported a decline in minutes per hour of MVPA among children in South Carolina while minutes per hour of sedentary behaviour increased over the transition period from elementary to middle school. Participation in PA after school hours was measured using accelerometers for five consecutive days. Results revealed predominant sedentary life while the least duration was used for MVPA among the school children. This view however seems to differ from those observed among young adults, particularly from the African continent. Over fifty percent of students in a Ghanaian university were found to adopt vigorous physical activity patternsin a study that measured PA using the WHO Global Physical Activity Questionnaire (GPAQ) (Mogre *et al.*, 2015).

A systematic review of literature (Loyen, Hecke, Verloigne, Hendriksen, Lakerveld, Steene-johannessen, Vuillemin, Koster, Donnelly, Ekelund, Deforche, Bourdeaudhuij, Brug, and Ploeg, 2016) indicates some dissimilarities in physical activity levels among European adults. While over ninety per cents of both male and female adults from Georgia were unable to attain recommended physical activity levels, about ninety per cents of adults from Ukrain females and Eston were reported to adopt physically active lifestyles. As well, time spent in sufficient physical activity pattern differed between adults in Malta and Netherlands, with the earlier reporting remarkably lower durations involved in MVPA when compared to the latter. According to the report, German adults seemed to score higher in high physical activity patterns when compared to those of Italian adults. While PA scores differed notably between Portuguese adults and those in Latvia, with the latter having significantly higher value. The authors reported variations in the durations used for leisure-time physical activity among adults. Portuguese adults participated in leisure-time activities over longer durations than their Dutch counterparts. The elderly population in Europe also failed to spend sufficient durations in leisure-time PA. A maximum of 20.2 minutes of leisure-time PA in a week was reported among this age group (Loyen *et al.*, 2016)**.**

Özköslü *et al.* (2017) stated that up to 81.7 % of Turkish adults with fibromyalgia syndrome and 58.1% of the healthy counterparts were found with low compliance for recommended level of physical activity. Reports from a study assessing compliance with the WHO recommendations on physical activity in an urban population in Poland reported that, 6.19%, 48.86% and 44.9% of adults scored low, moderate and high physical activity levels respectively (Macek *et al*., 2019). Of all domains of PA, the leisure-time PA seems to make the least contributions to the overall PA in populations. Macek *et al.(*2019) reported that only 4.21% of adults in Poland met physical activity recommendations for leisure-time activities

While a good number of studies recorded low PA in populations, some have equally reported higher PA levels among adults. In Nigeria, the report of the Global Observatory for Physical Activity on the socio-demographic and PA surveillance, national policy and research indicators for Nigeria in 2014 indicated an estimated 78% of sufficient physical activity among Nigerian adults (Oyeyemi *et al.*, 2018). In the study to evaluate physical activity and associated factors among 5,663 Tanzanian residents aged 15 years and above, PA was measured using an adapted WHO GPAQ (John, Todd, Mboya, Mosha, Urassa, and Mtuy, 2017). Results indicated that 97.3% of males and 94.7% of females had sufficient PA.

Another study designed to ascertain patterns of PA in Asia involving 4,750 adults, used locally validated questionnaires to assess PA (Nang, Khoo, Salim, Shyong Tai, Lee, and Van Dam, 2010). Results revealed that over seventy percent of adults met at least one criteria for attaining sufficient PA level in a week. In other words, each adult attained either of the following conditions: up to or above 150 minutes per week of moderate-intensity PA or at least 60 minutes of vigorous-intensity PA or a combination of both. In a sample of 957 Italian adults, PA was measured using the IPAQ long-form to describe the four fundamental domains of PA (Polito, Intorre, Ciarapica, Barnaba, Tagliabue, Ferraris, and Zaccaria, 2016). Findings revealed that most adults attained high PA levels in the population. Specifically, over eighty per cent adults participated in at least 30 minutes of moderate-intensity activity for five days a week. Using secondary data from the 2012 STEPS survey in Tanzania, Mashili, Kagaruki, Mbatia, Nanai, Saguti, Maongezi, Magimba, Mghamba, Kamugisha, Mgina, Mweya, Kaushik, and Mayige, (2018) adopted the WHO GPAQ to measure PA in a study examining the socio-demographic predictors of PA among 5,398 Tanzanian adults. Findings revealed high PA in the region, with at least 96.7% of adults achieving the WHO-recommended level of physical activity.

### 2.2.7 Contributions of Individual PA Domains to Total Physical Activity

Physical activity can be evaluated while accounting for the different contributions of individual domains to the total weekly PA pattern. Four principal domains often considered; these include work/occupation-related PA, transport-related PA, household chores/domestic/garden related PA and leisure-time PA. Findings from several studies reveal that individuals engage more in certain PA domains, especially the work/job/occupation and household chores than in others. Household and occupation-related PA made the highest contributions to the overall physical activity in an adult Asian population, whereas leisure and transportation activity contributed much less (Nang *et al.*, 2010). The authors went further to report that when PA domains were taken into consideration, leisure-time physical activity was the least important PA domain in the population. The Italian adults engaged more in domestic/garden related activities when compared to other PA domains (Polito *et al.,* 2016).

In a cross-sectional survey involving 47, 477 industrial workers in Brazil, it was found that work-related PA, domestic/garden work PA and LTPA (in decreasing order) constituted the most important domains of PA in the population (Santos, Del Duca, Oliveira, Barros, and Nahas, 2016). Cloix *et al.* (2015) investigated the contribution of different domains of PA in daily total activities among 724 French T2D adult population using IPAQ long-form. Findings revealed that domestic-related chores constituted the most popular domain of PA in the study population. Using the baseline data from the CRONICAS (Centre of Excellence in Chronic Diseases) Cohort Study, the researchers adopted the IPAQ to measure leisure time and transport-related PA in a study to examine the dominance of physical inactivity and its possible associated factors among 3,593 adults in resource-poor areas in Peru. Adults in the regions rarely engaged in leisure-time PA- (93.7% physically inactive during LTPA), while transport-related PA was highly prevalent in the settings (Miranda, Carrillo-Larco, Gilman, Avilez, Smeeth, Checkley, Bernabe-Ortiz, Casas, Smith, Ebrahim, García, Huicho, Málaga, Montori, Diette, León-Velarde, Rivera, Wise, and Sacksteder, 2016).

### 2.2.8 Causes and Correlates of Physical Inactivity

The rate at which individuals are physically inactive differs considerably across different regions. The highest rates found in high-income countries (World Health Organization, 2014; World Health Organisation, 2018b). Economic development remains the most important driving force for changing modes of transportation, technology use, urbanization and changing cultural values, which in turn account for increasing sedentary lifestyle and physical inactivity worldwide. The WHO in the year 2014 stated that increase in physical inactivity resulted from lack of leisure time activity, increased sedentary behaviour and increasing dependence on passive modes of transportation. As well, several environmental factors are linked to urbanization which can discourage people from becoming more active (World Health Organization, 2014).

Individuals may prefer to spend more time indoors rather than stepping out to participate in recreational activities in the absence of good air quality, clean environment, or lack of parks, sidewalks and sports/recreation facilities. They may also tend to shy away from adopting the option of active transport to move from place to place if they have the least perception of any possible violence or crime in their immediate environment. Even children who by nature are very active now spend most leisure periods in sedentary activities. Christofoletti *et al.* (2016) in their study to assess the prevalence of sedentary behaviour during leisure time among 1,831 children (mean age = 8.75±1.03) in Florianopolis, recorded that up to 56.1% of children spent time on sedentary activities during their leisure time. Extensive sitting periods in the use of computer, video games, television viewing, and reading have taken over most activities during leisure time and thus assumed the most popular means of sedentary activities during leisure time.

The realization that active transportation rarely plays any vital role in the overall physical activity in populations (Nang *et al.,* 2010; Cloix *et al.,* 2015; Polito *et al.,* 2016; Santos *et al.,* 2016) validates the need to modify transportation systems to encourage and enhance active modes of transportation in populations. Fishman, Böcker, and Helbich, (2015) in their study to investigate the relevance of active transportation to the overall PA from a set of secondary data collected as part of the Dutch National Travel Survey (2010 – 2012) among

74,465 Dutch adults in the Netherlands, noted that some substantial proportion (57.0 %) never adopted any form of active transportation (walking or cycling) during the week.

If participation in PA is to be enhanced and fully attained at individual and population levels, then inter- and intra-personal factors, as well as environmental factors serving as barriers to PA must be looked into. Most persons deliberately opt out from participation in leisure-time activity due to its high cost in facility use. Interference with family norms and routine, time constraint, social networking, complete lack or insufficient availability facilities and some personal issues relating to tiredness, laziness, lack of motivation (Justine, Azizan, Hassan, Salleh, and Manaf, 2013), have been listed as common barriers to PA.

Reports from a qualitative survey evaluating apparent barriers to physical activity among 67 college students aged 18-24 years listed several constraints to PA in this population. Some participants complained of time constraint against sufficient participation in PA; other restraining factors included tiredness, stress, family influence, and lack of safety (Anjali and Sabharwal, 2018). Adults, who had insufficient physical activity from the results of a 7-year follow up of the "German epidemiological trial on ankle-brachial index" study conducted among 1,937 older adults, were subsequently surveyed to identify possible barriers to physical activity. Major barriers to PA identified in the study consisted of poor health status, loneliness, and lack of interest in PA participation. It was discovered that, participant could have had increased participation if there were sufficient opportunities forsports and or recreational activities, as well as safe means of transportation (Moschny, Platen, Klaaßen-Mielke, Trampisch, and Hinrichs, 2011). Ill-health also constitutes important constraint against active participation in PA in most instances where individualswould ordinarily desire to.

A study to evaluating the impact of physical activity on health-related fitness among school-aged children in the Eastern United States reported that afterschool MVPA, energy expenditure, step count all had significant positive relationship with cardiorespiratory endurance, while sedentary time and BMI related negatively with cardiorespiratory endurance (Yang *et al.*, 2019). This finding implies that it takes physical fitness to attain the emotional and psychological benefits derived specifically from vigorous physical activity when compared to those with poor cardiorespiratory fitness. da Silva et al., (2017) examined how built environment influence physical activity among Brazilian adolescents. There were higher tendencies for adolescents to engage in MVPA in instances where street lighting were in place. Street lightings and presence of trees were shown to exert independent influences on self-reported walking among members of the age group. However, paved walk ways or streets did not increase PA among adolescents, rather these constituted a form of barrier to increased physical activity. Adolescents engaged more in moderate-to-vigorous intensity recreational activities in the presence of a beachfront, as well, more street lighting and cycle path/lanes encouraged active transportation.

Physical activity or inactivity differs between males and females in populations. Reports from several studies indicate that the males engage more in the overall PA and perform better in work and leisure time PA while females are more inclined to score higher in household chores related PA. Sharma *et al.* (2018) in their study among adolescents in Peru reported higher PA among males, when compared to females. Insufficient PA was about 30% higher among female adolescents than the male counterparts. The study among Tanzanian adults revealed that males had significantly higher median values for METs-minutes/week for all PA domains except domestic chores (John *et al.*, 2017). Nang *et al.* (2010) reported that, while more males met the minimum recommended level of PA and scored higher in leisure-time and occupational activity, a higher proportion of females engaged in household chores and had higher level of domestic-related physical activity than men. Although there were no sex differences in total physical activity and transport METs-min/week in the cross section of Italian adults, findings indicated significant sex differences in METs-min/week for all work, domestic and leisure-time physical activity among participants. While men had higher METs-min/week for work, leisure time and vigorous-intensity physical activity, women scored higher in domestic/garden and moderate-intensity physical activity (Polito *et al.*, 2016).

The study conducted to evaluate the contributions of PA domains to HRQoL among Brazilian adults, revealed higher overall physical activity patterns among males. Males were also more likely to score higher in PA performed during leisure-time and sports than females, whereas, females had higher preoccupation in physical activities performed during work (Scarabottolo *et al.*, 2019). The observation that males find more satisfaction in leisure-time PA was repeated among adults in Poland. While majority of females attained moderate PA patterns, males had reputation for increased participation in leisure-time activities (Macek *et al.,* 2019). Physical activity when measured by Global Physical Activity Questionnaire among Tanzanian adults, was lower among females (Mashili *et al.,* 2018).

Physical activity participation varies with age, as well findings reveal differences in specific domain PA across age groups. The LTPA was higher among Chinese older adults than those in younger age groups, whereas middle-aged counterparts had the highest contributions to their overall PA from occupational activity; as well, younger adults performed poorly in domestic chores related PA and had lesser chances of meeting the recommended level of PA when compared to older participants (Nang *et al.,* 2010). Physical activity increased with age in an Italian adult population; the youngest age group had the lowest total PA but engaged significantly higher in leisure-time PA than others while those 50 years and above had the highest PA level and had the highest participation in active transportation and domestic/garden related physical activity (Polito *et al.,* 2016). However, findings from the study to evaluate possible factors influencing physical activity patterns among Tanzanian adults revealed similar PA patterns across age groups which reflected in no significant differences in median METs per week by age group for all types of PA (John *et al.,* 2017).

The level at which individuals became active can be influenced by certain socioeconomic factors, including occupation, education, income, etc. In China, higher socioeconomic status was related both to lower total PA and higher leisure time PA; whereas individuals in lower socioeconomic status were reported to have higher participation in occupational PA and household chores Nang *et al.* (2010). Tanzanian adults when categorized into respective occupations performed significantly differently in the physical activity scores derived from work related PA. In other words, the extent to which adults in the population were physically active was determined by the type of work/job/occupation they were involved in (John *et al.,* 2017). For instance, PA scores obtained from farmers significantly exceeded those from adults with some other occupations and had higher chances of meeting PA recommendations (John *et al.,* 2017). Homemakers and retirees specifically did not meet PA recommendations; as well, total PA differed significantly across occupations in the multi-ethnic Asian adult population (Nang *et al.,* 2010). Education did not have any influence on physical activity patterns of Tanzanian male adults (John *et al.*, 2017). However, females with primary and secondary education had significantly lower physical activity patterns that were far below recommendations when compared to females with no education (John *et al.*, 2017).

Fan, Su, Tan, Liu, Ren, Li, and Lv, (2015) used IPAQ long-form to assess PA and sedentary behaviour among 1362 Chinese adults 23 to 59 years old. Higher education exerted a positive influence on PA, causing most adults with higher educational attainments to meet the criteria for moderate physical activity patterns and physical activity recommendations during leisure when compared to others (Macek *et al.*, 2019). Findings indicated that education at younger or middle age was significantly related to physical inactivity. In China, primary and tertiary education had significant relationships with low physical activity among adults (Nang *et al.*, 2010). In the African region, Mashili *et al.* (2018) reported predominant low physical activity patterns among Tanzanian adults with higher educational accomplishments in a study to evaluate socio-demographic correlates of PA.

When evaluating factors that could influence physical activity among Cameroonian adults, the researchers adopted an individually-calibrated combined heart rate and movement sensing over seven continuous days to measure PA (Assah *et al*., 2015). The outcome indicated that PA was significantly higher among rural dwellers than the urban counterparts. Among Tanzanian adults, rural dwellers were observed to have higher physical activity scores when compared to urban dwellers, and being in an urban area was generally associated with low PA (Mashili *et al.*, 2018). Miranda *et al.* (2016) reported lower participation in LTPA in rural compared to urban setting in Peru.

## 2.3.0 Obesity

### 2.3.1 Definitions of Overweight and Obesity

Obesity is a condition where body fat accumulation is sufficient to impair good health, cause diseases and reduce quality of life. For adults, obesity and overweight are defined asBMI $\geq 25$ kgm$^2$ and $\geq 30$ kgm$^2$ accordingly, whereas age consideration is crucial for defining overweight and obesity in children and adolescents (World Health Organization, 2020).

### 2.3.2 Measurements of Obesity

#### 2.3.2.1 Anthropometric Methods

There are two ways of measuring body fat. The first method consists of simple, portable and non-invasive anthropometric methods such as the body mass index (BMI), waist circumference (WC), waist-hip ratio (WHR) and waist-height ratio (WHrt) etc. Anthropometric methods (otherwise called the field methods) are simple to use and most often used in field surveys, hospitals and community settings. The second category of measurements are more sophisticated methods regarded as the gold standards or reference methods and are most often applied in validating the accuracy of the field methods.

Body Mass Index is a simple, inexpensive and accurate method often used in measuring obesity. It is estimated by dividing the body weight (in kilogrammes) by the square of body height (in metres). The WHO cut offs for classifying individual BMI identifies underweight as BMI less than 18.5kg/m$^2$, while values up to 18.5 to 24.99kg/m$^2$, 25.00 to 29.99 kg/m$^2$, and ≥30kg/m$^2$ all indicate healthy body weight, overweight and obesity respectively (World Health Organization, 2000). Since BMI can accurately predict body fat and is again simple to use, it is more often used in community-based and other large scale epidemiological studies to measure obesity. The established evidence that the risk of obesity increases with increasing BMI values makes BMI a useful tool in keeping the prevalence of obesity under surveillance (Lukács *et al.,* 2019) and presents an effective strategy in evaluating the risk of chronic illnesses for both primary and secondary prevention (Hu *et al.,* 2017).

Nevertheless, it is often advised that the index be used with caution since it lacks the capacity to distinguish between fat and lean body masses, neither does it measure body fat at different locations (subcutaneous and visceral fat). Since the degree of abdominal fat is more correlated to the risk of chronic diseases than the total body fat (Brumpton *et al.,* 2013; Lukács *et al.,* 2019), BMI is limited in its use when monitoring the risk of and mortality from chronic non-communicable diseases (Hu *et al.,* 2017). Also, it cannot report body fat accurately among people with different propensity for storing fat. People of various age groups, races, sex and physiological conditions store body fat differently (Min and Stephens, 2015). Despite all limitations, BMI still remains a useful indicator of body fat judging from its remarkable correlation with gold standard methods (Romieu *et al.,* 2017).

Abdominal obesity occurs when there is excessive accumulation of fat in and around the abdominal region. It is often called central adiposity, visceral, android or male-type obesity (Min and Stephens, 2015). Body fat is mostly found in two crucial locations. The subcutaneous fat is fat accumulated under the skin. Visceral fat refers to the fat that is stored around the internal organs in the abdominal region, including fat found within and around the intestines, etc.

Subcutaneous fat is most often located around the hips and lower parts of the body whereas visceral fat deposits occur more often around the waist in the abdominal region. Comparably, disease risk associated with subcutaneous fat is less than that from visceral fats. About 80% of total body fat in males and 90% in females are subcutaneous fat (Min and Stephens, 2015), the remaining being visceral fat. Visceral adiposity is metabolically active, a characteristic linking it to the physiological processes that increase secretion of pro-inflammatory cytokines that are, in part, responsible for the development of insulin resistance and metabolic syndrome (Aktar *et al.*, 2017). Heymsfield and Wadden, (2017) stated that the enormous deleterious health effects arising from metabolic disorders in obesity can be accounted for by some sort of omental and mesenteric fat under visceral adiposity.

Measuring the relative amounts of visceral and subcutaneous fat requires advanced imaging techniques, but, the risk associated with visceral fat deposition can be assessed by waist circumference measurement. Waist circumference is the natural circumference of the abdomen, often measured at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest (WHO, 2011b). Waist circumference is a simple and more accurate field method than BMI in measuring abdominal/visceral fat. It is simple to use, cheap and correlates strongly with body fat and the risk of and mortality from chronic diseases even within normal BMI values. Although the ratio WHR and WHrT can also predict abdominal fat, WC remains a better predictor of visceral and total fat among all anthropometric indices since it’s often indicated in people who store more fat around the abdomen and in situations where there are significant wasting of large muscle groups.

Waist circumference measurements, when taken gives a marked indication of the amounts of both subcutaneous and visceral fat deposits around the abdomen. Since it carries a different metabolic properties from those associated with other body fats, it is therefore assumed that, the disease risks associated with abdominal fat is different from those associated with peripheral fatness measured by BMI (Brumpton *et al.*, 2013). Since WC can clearly identify the amount of visceral fat and has simple measurement and interpretation procedures, it is the most commonly used method in clinical settings to measure abdominal obesity (Kim, Kim, Shin, Han, and Kim, 2019). Obesity-related disorders may develop in situations where Individuals have normal BMI but increased WC.

However, since BMI fails to diagnose abdominal obesity, individuals who are at risk of obesity-related complications without necessarily being obese based on BMI, stand the risk of missing out in routine public health programmes often planned to prevent future cardiovascular or metabolic diseases because they are usually not recognized as being obese in the primary care settings (Aktar *et al.,* 2017; Kim *et al.*, 2019). Despite the advantages of WC, it cannot be used for screening among children due to lack of standardized cut off points for the age group. Waist circumference alone may not accurately predict the risk of diseases in people with extreme body heights and body build since it depends on averages (Lockwood, 2019). It may also not be appropriate for use in extremely obese individuals. Since the risk of morbidity and mortality increases with BMI, even within the context of normal WC, it is advisable to combine both BMI and WC in assessing obesity (Lockwood, 2019).

The WHR is also a very useful anthropometric index used in screening for abdominal adiposity. Based on this index, the WHO cut-offs for defining abdominal obesity identifies WHR greater than 0.90 in males and 0.85 in females (WHO, 2011). Comparably, it is considered that, the WHR is a stronger indicator of abdominal fat deposit than BMI. In other words, it has a greater capacity to screen for chronic disease risk factors than BMI. The effectiveness of WHR as a tool for screening for disease risks is only higher than that of BMI, but not the WC. The inverse relationship between hip circumference and disease risk can be explained by the fact that, hip circumference measurement reflects more of muscle mass rather than fat (Han, Sattar, and Lean, 2006). This is because, the body composition of the hip region comprises more of muscles that fat mass, such that while the WHR increases with abdominal fat, a decrease in lean mass around the hip can also result in higher

WHR. One major limitation of WHR over WC in measuring central adiposity lies in the fact that, WHR is more prone to measurement error. Estimating WHR involves the use of ratio, requiring two different measurements and has a greater possibility of measurement and calculation errors in the data sets. This makes it a weaker indicator of central adiposity when compared to WC, which requires the same measurement and no calculation (Min and Stephens, 2015). The WHR also lacks the capacity to effectively identify lean individuals from those with obesity with the same ratio values.

### 2.3.3 Prevalence of Obesity

The number of individuals affected globally by overweight and obesity is increasing rapidly over time, and has tripled over the last few decades (WHO, 2020). The increasing proportions of people with excess body weight cuts across all age groups, sex and countries at different developmental stages (Ng *et al*., 2014). According to a report from a review of literature, over 36.0% and 38.0% of men and women, respectively, suffered from increased BMI in the year 2013, when compared to about 28.0% and 29.8% of men and women, respectively who had excess BMI in 1980. The WHO decried that, over thirty nine and thirteen per cent of adults eighteen years and above were faced with the burdens of overweight and obesity in the year 2016 (WHO, 2020). The proportion of the younger population affected by these burden is not only high, but is increasing at no slow pace. While obesity and overweight affected a whopping 8.1% and 8.4% of boys and girls in 1980, these rates had increased to 12.9% and 13.4%, respectively in 2013 (Ng *et al.*, 2014). Disturbingly, over forty million children who are just five years and below were trapped in the snare of overweight and obesity (WHO, 2000).

A number of body fat indicators, including BMI, WC, per cent body fat and visceral adipose index revealed that a substantial proportion of the 15,364 adults, 15 years and above in Jiangxi Province of China had at least one form of excess body weight (Hu *et al.*, 2017). About 25.8%, 7.9% and 10.2% of individuals in the population suffered from overweight, general obesity and abdominal obesity, respectively (Hu *et al.*, 2017). Brumpton *et al.* (2013) reported a 12.0% prevalence of obesity in a cross section of 23,245 adults from Nord-Trøndelag, Norway as part of findings from a longitudinal study spanning over a 3 year period to evaluate existing association between obesity and incident asthma. As well, up to

11.6% of the 5,228 Hungarian adults were reported to have central obesity in a study which assessed the possible associations between abdominal obesity and metabolic risk in the population (Lukács *et al.,* 2019).

The Sub-Saharan Africa has its share in the problem and could be predisposed than other areas. This is because larger body size is welcome and celebrated in most cultures in the region as a sign of beauty, wealth and of course respect (Micklesfield *et al*., 2013; Malik *et al.,* 2019). An estimated thirty four per cent of adults in the region were reported to live with obesity (Ajayi *et al.,* 2016). Besides, the proportion of adults in the region with increased BMI – be it overweight or obesity was alarming. Obesity affected over sixty per cents of those from Nigeria, whereas, South Africa had a rate of 85% and about 75% of the population in Tanzania lived with the condition (Ajayi *et al.,* 2016). The lowest rates, though of public health concern were found either the rural areas (46%) or in the peri urban settings (48%) in Uganda (Ajayi *et al.,* 2016). Up to 50% of adults ≥18 years in the Anonkoi region in Ivory Coast had abdominal obesity measured by WHR (Malik *et al.,* 2019). A cross-sectional study assessing the rate and possible predisposing factors of excess central adiposity among 840 adults ≥ 18 years in the Dodoma Region in Central Tanzania reported abdominal obesity to be 24.88% in the area (Munyogwa and Mtumwa, 2018).

According to the WHO report, an estimated 28.9% and 8.9% of the adult population in Nigeria suffered from overweight and obesity in the year 2016 (WHO, 2016a). In a subset of Nigerian University staff, an estimated 72.5% and 67.9% of the total population suffered from increased BMI and WHR, respectively (Joseph-Shehu and Ncama, 2018). Mean body mass index, 21.6 ± 11.3 kg/m$^2$ and waist circumferences for males and females (93.5 ± 10.1cm and 94.6 ± 14.1cm respectively), were reported among 23-87-year-old adults in North-Western Nigeria (Bello-Ovosi *et al.,* 2018). In a cross-sectional study assessing hypertension and diabetes mellitus among adults ≥18 years in five rural communities in South-South Nigeria, the prevalence of overweight and obesity measured by BMI were 21.8% and 10.6% accordingly (Isara and Okundia, 2015). In Uyo, Akwa Ibom State, Nigeria, a cross-sectional study conducted to assess overweight and obesity among 584 adults aged 18–65 years measured obesity by BMI and WHR. Prevalence of overweight was 39.8% and 31.7% among males and females respectively, obesity was 28.0% and 52.0% respectively among males and females (Idung *et al.*, 2014).

#### 2.3.4 Causes of Obesity

##### 2.3.4.1 Energy Imbalance

Obesity can best be considered from the principle of energy balance, which occurs when the body can expend the same amount of energy as consumed. Stable body weight is only achieved under a condition of sustained energy balance, i.e. when the body expends an equal amount of energy consumed over an extended period. Excessive energy intake over expenditure results in positive energy balance and often lead to excess body weight over time, while the reverse is the case in conditions of negative energy balance resulting from higher expenditure over intake. Energy intake is achieved through consumption of energy-giving nutrients and alcohol. The body expends energy through basal metabolism, often measured as resting metabolic rate (amount of energy necessary to sustain the body while at rest), thermic effect of food/diet-induced energy expenditure (energy used for absorbing and metabolizing food consumed); and activity-induced energy expenditure (energy expended through physical activity).

In a day, the three components of energy expenditure including those responsible for basal metabolism, food metabolism and utilization as well as the proportion responsible for physical activity, account for sixty to seventy five per cent, fifteen to thirty per cent and ten per cent, respectively of the total daily energy expenditure (Fonseca, Sala, Ferreira, Reis, Torrinhas, Bendavid, and Waitzberg, 2018). Therefore, obesity results from either excessive energy intake, physical inactivity or both. However, few instances do occur from genetic predispositions, endocrine disorders, medications, and other health conditions.

Energy Expenditure is determined by several factors including body size and composition (Westerterp, 2017). Fat-free mass increases with larger body size and is found in a higher proportion in males than in females who have the same body weight and height (Westerterp, 2017; Fonseca *et al.*, 2018). Therefore, energy expenditure, particularly basal metabolic rate increases with body size through lean body mass, especially in men but decreases in old age through lower fat-free mass. Also, the rate at which individuals can engage in physical activity remains the same for all, except among the morbidly obese. This could be explained by the fact that excess body weight poses hindrances to movement and other physical performances in morbidly obese individuals (Westerterp, 2017).

Although energy is utilized for the metabolism of food components, this may be important only in non-obese individuals (Fonseca *et al.,* 2018); as well, the contribution of food consumption to energy expenditure through increased fat mass in larger body size may be less compared to the effect of larger body size on physical inactivity. If food thermogenesis is linked to energy expenditure and a possible inverse association with positive energy balance; then habitual consumption of high-fat meals is more important in explaining the link between excessive food intake and the development of obesity than the overall food intake (Fonseca *et al.,* 2018). Physical activity, when performed as physical exercise increases energy expenditure to a larger extent, though such energy expenditure may be compensated for in older people and those with negative energy balance through non or decreased participation in non-training physical exercise (Westerterp, 2017). While older people tend to attain energy balance by avoiding non-exercise physical activity after participation in leisure-time physical training, younger ones do this by increasing food intake to compensate for energy spent during exercise (Westerterp, 2017).

While energy balance is the fundamental cause of body weight changes, any genetic or environmental factor affecting body weight does so only through one or more components of energy balance: the amount of energy ingested; amount used either in basal metabolism, food breakdown and utilization and the amount spent on activity; or energy storage. When energy is consumed over and above the amount expended, the result is usually a positive energy balance. Implying the excess of what is consumed is processed and stored as body fat, leading to weight gain. The increase in body weight, of which 60% to 80% is usually body fat (Hill *et al.*, 2012).

Physical inactivity and sedentary life significantly account for the increased global prevalence of obesity across age groups. Prevalent sedentary activities now occupy a significant chunk of time meant for active life. Both children and adults spend much time on internet activities through the use of electronic devices, in addition to traditional television viewing that had already constituted a problem of physical inactivity. Not only do these activities reduce the amount of time spent on active physical endeavours, but they also promote obesogenic lifestyles through advertisement of eating behaviours that increase consumption of fats and related dietary elements not consistent with recommended dietary guidelines. Tabasum *et al.* (2018) in their work on causes, consequences and management of obesity noted that advertised fast foods, snacks and sugary beverages consumed by obese individuals are dependent on the duration spent in television viewing. Traditional modes of transport (walking and cycling) have given way to passive transport systems, where energy is solemnly expended in moving from place to place.

The importance of the built environment in enhancing appropriate level of physical activity among individuals cannot be over emphasized. Physical activity performed either in commuting, occupational and leisure time activity is enhanced where and when people feel safe in the physical environment. Several environmental factors pose constraints against individual efforts in physical activity. The use of active transports has declined over time due to long distances and lack of safe pedestrian route and fear for insecurity, among others (Tabasum *et al.,* 2018). These challenges increase sedentary life and consequently predispose individuals to increased risk of obesity. Increased energy expenditure through physical activity is essential in attaining and maintaining healthy body weight. Epidemiological reports clearly show the inverse associations between physical activity (in terms of all duration, frequency and intensity) and the risk of obesity. Increased physical activity ensures increased expenditure of energy consumed over what is needed and enhances energy balance.

Findings from the study involving Ghanaian university students (Mogre *et al.,* 2015) revealed that, compared to participants with low physical activity, vigorous physical activity related significantly to a lower risk of overweight and obesity. Munyogwa and Mtumwa, (2018) in their study found that the distance covered in walking had significant relations with the risk of abdominal obesity among adults. Compared to adults who covered over a 5 km distance in walking per day, daily walking that covered less than 5 km/day was associated with a higher risk of abdominal obesity. The duration of time spent viewing television had positive associations with the risk of abdominal obesity. Participants who spent up to or over two hours a day watching television had a higher risk of developing abdominal obesity. In Akwa Ibom State, Nigeria, the number of hours spent watching television each day had significant positive relations with the prevalence of obesity among adult out-patients from the University of Uyo Teaching Hospital (Idung *et al.*, 2014).

#### 2.3.4.2 Environmental Factors

Environmental influences have been implicated as the key driving forces, responsible for the upsurge in the number of individuals with excess body weight across the globe. The traditional food patterns have changed over the years, from minimally processed, vegetable based and low energy diets to increased intake of highly processed energy-dense diets. Lifestyles have also changed from those based predominantly on high energy expenditure to standards of living characterized majorly by physical inactivity. These can be seen in modes of transport which are now majorly dependent on passive transport systems rather than the traditional commuting systems of walking and or cycling. Increasing urbanization also implies that more and more people are drawn into the web of physical inactivity and sedentary lifestyle which constitute important predisposing factors to increased bodyweight. It is believed that these environmental issues, to a greater extent are responsible for increasing rates of overweight and obesity rather than biological factors (Munyogwa and Mtumwa, 2018; WHO, 2020).

Dietary intakes, initially based on consumption of whole traditional and minimally processed food items has over time shifted towards increased dependence on processed foods. The traditional practice of eating food cooked at home is gradually being overtaken by eating out, bringing with it increased consumption of edible oils and other unhealthy fats. Increased consumption of beverages sweetened with sugar is also a common place (Popkin, Adair, and Ng, 2012). Sugar-sweetened drinks are less filling when consumed, this makes it easier for people to consume such beverages in excess amounts resulting in excess energy intake and obesity (Tabasum *et al.,* 2018).

The obesogenic effect of sugar-sweetened beverages is more obvious in children from low-income socioeconomic groups and adults from under developed countries (Romieu *et al.,* 2017), though the earlier may not apply for those from African regions. Urbanization brought about by increasing and rapid industrialization across the globe has led to individuals being increasingly exposed to offers of high calorie and palatable but inexpensive foods. Although these changes first began in developed countries long before being observed in less developed countries, there are fears that the health effects of such transitions (including obesity, diabetes mellitus, hypertension etc) are of similar enormity in both settings (Popkin *et al.*, 2012). This shift in dietary patterns is considered a primary underlying factor for the obesity epidemic and the consequent health complications. In a population of university students in Ghana, findings from a study revealed prevalent consumption of animal products, cereal and grains. BMI and WC increased significantly with increased consumption of these products (Mogre *et al.*, 2015).

Portion size (when referred to food quantity) is defined as the quantity of food served for immediate consumption in a single eating occasion (Haynes, Hardman, Makin, Halford, Jebb, and Robinson, 2019). The concept of larger food portion size has increased significantly over the years (Livingstone and Pourshahidi, 2014; Haynes *et al.,* 2019), contributing to increased energy intake and increased prevalence of obesity. Most food service institutions now adopt the concept of presenting the unwary customers with larger quantity of food. This of course is done for several reasons aimed at profit maximization. Consumption of larger portion sizes is linked to increased energy intake. Individuals usually overeat when presented with larger portion sizes, especially when consuming energy-dense meals (Livingstone and Pourshahidi, 2014) and find it difficult to adjust to smaller food portions and energy intake after exposure to larger food portion sizes (Haynes *et al.,* 2019). Sensitizing consumers on the impact of larger food portions in obesity epidemic and finding ways of adopting appropriate food portion consumptions constitutes one effective strategy in curbing the obesity crisis (Haynes *et al.,* 2019).

The concept of increasing human dependence on fast food has come to stay for several reasons. An important factor being that of time constraint in home food preparation, especially that of traditional indigenous dishes that are time and energy consuming. Fast foods are mostly characterized by high energy density, saturated and trans-fatty acids, processed starches and added sugars but low in essential micronutrients (Romieu *et al.*, 2017). Because of the outstanding nutritional features of fast foods, increased consumption which is now prevalent in most settings has been linked to the global rise in obesity. Consumers are often at risk of excessive energy consumption through intake of fats, especially trans- and saturated fats, added sugars but low dietary fibre and other essential nutrients when relying more on consuming fast foods. Unfortunately, such consumers rarely make any effort to compensate for such energy intake by subsequent increase in physical activity.

Genetic factors: Some people develop obesity from the biological susceptibility to store excess body weight due to genetic influences. Genes can interact with developmental processes, behavioural and environmental factors to create specific body weight profiles in people (Thaker, 2017). They influence body weight development by influencing protein productions that play significant roles in food consumption, fat storage and energy expenditure. Specific proteins are responsible for initiating the physiological processes that eventually lead to energy balance. Positive energy balance can occur when genetic defects cause loss of signal in genes involved in the synthesis of these proteins. When it thus happens, the ability for such genes to maintain balance in energy expenditure and food intake is lost. Obesity can occur from defects in single or multiple genes. However, it is rare for a defect in single genes to account for excessive body weight in people. Rather it is speculated that genetically engineered obesity is as result of the combined effects of several gene defects, which in turn act by altering energy balance through basal metabolism, food consumption, adiposity, and physical activity level resulting in larger body size (Thaker, 2017).

Exposure to certain chemicals (including medications) and hormones can predispose individuals to the risk of developing obesity. However, this only happens on rare occasions. Food intake and metabolism are regulated by the actions of many hormones (Insulin, glucagon, ghrelin, cholecystokinin, neurotransmitters and growth factors etc). These hormones all work in synergy to ensure energy balance in normal physiological conditions. However, upon insufficient supply, faulty or complete lack of one or more of these endocrine components, the body loses its natural capacity to attain energy balance, resulting in excess body weight. The presence of obesogenic chemicals (such as tributyltin, triphenyltin, diethylstilbestrol, and bisphenol A) usually cause disruptions in the functions of these hormones (Kelishadi, Poursafa, and Jamshidi, 2013; Heindel and Blumberg, 2019). With the increased use of industrial chemicals, the likelihood of developing obesity increases indicating the probability of substantial effects of obesogenic chemicals in the obesity epidemic (Kelishadi *et al.,* 2013). The actions of obesogenic chemicals on normal endocrine functions on excess body weight can occur at any point in the course of life span, including the prenatal period (Kelishadi *et al.,* 2013; Heindel and Blumberg, 2019).

### 2.3.5 Complications of Obesity

Obesity constitutes added burden to an already existent under-nutrition and infectious diseases in Sub-Saharan Africa and other developing settings. Obesity and associated disease risk factors are increasing at alarming rates, even within the context of under-nutrition and its associated health issues. Thus, it is common to find under-nutrition (both protein energy malnutrition and hidden hunger) and over-nutrition in the form of obesity occurring concomitantly within the same settings (WHO, 2020). Obesity is considered the most predominant global chronic health malaise among adults. Comparatively, obesity is gradually approaching a worse grievous health challenge than under-nutrition (Aktar *et al.,* 2017). Obesity is associated with a chronic low-grade inflammation caused by elevated levels of free fatty acids, soluble pro-inflammatory factors and the activation and infiltration of immune cells into sites of inflammation (Fruh, 2017; Heymsfield and Wadden, 2017). Inflammation and atherogenic dyslipidemia further lead to vascular dysfunction, atherosclerosis formation, impaired fibrinolysis, insulin resistance, and eventually to the development of CVDs, diabetes mellitus and so on (Fruh, 2017).

The study by Lukács *et al.* (2019) in Hungary revealed that the risk of developing major components of metabolic syndrome, including high systolic blood pressure, low HDL cholesterol, and high triglyceride levels were significantly higher among abdominally obese adults with normal BMI. Within the same population, increased waist circumference was identified as a significant risk factor for some disease biomarkers: high blood pressure, fasting blood glucose, total cholesterol and triglyceride. Increased body fat therefore presents as a potent risk factor for several diet related-chronic ailments and consequently poor quality of life, morbidity and mortality. Childhood obesity is gradually becoming overwhelming in most settings especially in developed countries, with worse health consequences in adult years. However, the health hazards of childhood obesity do not manifest only in adults, obese children, just like adults, also risk suffering from most of the health complications resulting from excess body weight.

The risk of CVDs is delicately responsive to any change in body weight. Kinlen *et al.* (2018) reported that, over a 5% increase in the risk of heart failure occurs with every unit increase in BMI. This is observed even among individuals with normal body weight, as well, overweight and obese persons stand a double chance of suffering from stroke. The risk of hypertension is also increased in conditions of overweight and obesity, due to renal compression resulting from pressure on the kidneys from excess adipose tissues around the organ (Heymsfield and Wadden, 2017).

The chronic hyperactivity of the sympathetic nervous system in obesity may be one factor that accounts in part for several disease mechanisms associated with the condition including hypertension. High blood pressure, either independently or sometimes in conjunction with some other biologic parameters including insulin resistance, obesity-associated dyslipidemia, and type 2 diabetes are responsible for most heart diseases and chronic kidney disease (Heymsfield and Wadden, 2017). Idung *et al.* (2014) reported from their study among adult out-patients in University of Uyo Teaching Hospital that hypertension was significantly higher in obese adults. Malik *et al.* (2019) reported in their study in a peri-urban setting in Ivory Coast that abdominally obese adults were over two times more likely to have hypertension.

Diabetes mellitus is gradually assuming a significant public health challenge in Nigeria. Excess body fat, presenting as overweight and obesity constitute major modifiable risk factors for Type 2 diabetes. Furthermore, the timing at which individuals develop overweight or obese is also of importance. Individuals who develop obese early in life, and live with the condition for longer duration, stand greater chances of suffering from diabetes mellitus (Min and Stephens, 2015). A country wide pooled prevalence of diabetes mellitus in Nigeria has been estimated at 5.7%, whereas, 9.8% of the population in South South Nigeria are said to be suffering from the condition (Uloko, Musa, Ramalan, Gezawa, Puepet, Uloko, Borodo, and Sada, 2018). As well, obesity (5.3%), faulty diet (8.0%) and physical inactivity (4.8%) have been identified as major contributors to increased risk of diabetes in Nigeria (Uloko *et al.*, 2018). About 4,828 public service workers in Ondo State, Nigeria (mean age: 40.0±9.7 years) participated in a workplace cross-sectional survey assessing the prevalence of pre-diabetes and diabetes mellitus and their correlates using an adapted WHO STEPwise surveillance questionnaire. Estimated prevalence rates of pre-diabetes and diabetes were reported in 11.7% and 5.3% of the entire working force under study (Isara and Okundia, 2015). As well, it was found that BMI had significant associations with pre-diabetes and diabetes in both univariate and multivariate analyses. (Isara and Okundia, 2015).

Excessive fat accumulation in visceral tissues often leads to circulating adipokines and free fatty acids in the human system. Free fatty acids and adipokines further cause dyslipidemia and consequently adipose tissue dysfunction. Adipose tissue dysfunction is closely related to obesity-induced peripheral- and nervous-tissue dysfunction (Awada, Parimisetty, and Lefebvre dHellencourt, 2013). Neurological health is greatly affected by most metabolic conditions caused by obesity. This is seen in low-grade inflammation, oxidative stress, growth factor loss, loss of hormonal control, all having direct negative effects on neurological health most often observed in obese individuals. Another negative influence of excess body weight on neurological health is through the accelerated ageing processes often observed among obese individuals (Awada *et al.,* 2013; O'Brien *et al.,* 2017). Through neurodegeneration, obesity often leads to gradual cognitive decline and ultimately to brain injury that manifests as mood change, memory loss and movement dysfunction in victims (Awada *et al.,* 2013). Other neurological diseases caused by obesity include sleep apnea, anxiety, manic depressive disorders, and certain ageing-related neurodegenerative conditions such as Parkinson's disease, Alzheimer's disease, and some autoimmune nervous system diseases (Awada *et al.,* 2013).

Obstructive sleep apnea (OSA) characterized mainly by partial or complete lack of airflow and subsequent breathlessness during sleep constitutes a significant predisposing factor for heart-related disorders in victims and constitutes a serious health concern in Nigeria. Few studies conducted in selected formal settings show that more individuals are affected by this disease. In a study, (Awopeju, Fawale, Olowookere, Salami, Adewole, and Erhabor, 2020) assessed the rate at which the risk factors for OSA were prevalent. The study was conducted using the OSA risk Berlin Questionnaire and relevant anthropometric measures among patients attending a family practice clinic in South-western Nigeria. Results indicated a high prevalence of OSA among individuals (23.2%), as well, those with high risk of OSA all had obesity, measured by all BMI, waist circumference, hip circumference, and waist-to-height ratio. Another study involving workers in as tertiary institution in North-central Nigeria (Akanbi, Agaba, Ozoh, Ocheke, Gimba, Ukoli, and Agaba, 2017) included 744 adults, 18 years and above, the risk of having OSA was assessed using the STOP-BANG questionnaire. The prevalence of obesity (27.7%) was high, as well, the rate of OSA was higher among obese adults (58.7%), compared to 34.9% recorded among non-obese counterparts. Adults with grade II obesity in the study had over 15 times higher risk of developing obstructive sleep apnea when compared to those without obesity after adjustment for other lifestyle factors.

Obesity is also related to increased risk of mortality resulting primarily from related disease conditions. The decrease in life expectancy related to obesity is estimated to range between 5 to 10 years (Fruh, 2017). A review of literature on the impact of obesity-related mortality in the US revealed that obesity-related mortality was significantly higher in old age. Between 1986 to 2006, overweight and obesity was responsible for 5.0% and 15.6% of deaths among adult Black and White men, and 26.8% among Black women, while 21.7% of deaths among White women was due to excess body weight (Masters, Reither, Powers, Yang, Burger, and Link, 2013).

### 2.3.6 Prevention and Treatment of Obesity

Lifestyle Modification Interventions: The first line of action in the management of obesity is the adoption of lifestyle modification programmes. In this case, the primary objective usually consist in helping patients lose between 5 to 10% of the initial body weight over the first six months into the treatment program (Aktar *et al.*, 2017; Heymsfield and Wadden, 2017). The program starts with a series of counselling sessions on behavioural change modifications, usually spanning over an average duration of 6 months to assist patients achieve complete adherence to the prescribed treatment regime (Aktar *et al.*, 2017). Dietary modifications constitute one very effective means of weight loss.

Dietary modifications consist of prescribing diets that provide low daily calorie intake. Such diets usually apportion 1200–1500 kcal/day for women and 1500–1800 kcal /day for men.

The possibility of attaining desirable feats in weight loss through dietary interventions lies in planning diets with the patients, in order to capture his or her dietary habits (Aktar *et al.*, 2017; Heymsfield and Wadden, 2017). This approach guarantees some level of compliance to the prescribed diet. The physical activity component of the overall lifestyle intervention regime requires that patients undertake activities that conform to the set standards on global recommendations on physical activity. Hence, the practice is to prescribe at least 150 minutes of aerobic activity for obese patients each week, even though it is desirable to exceed this level. Usually 200 to 300 minutes each week is essential for maintaining healthy weight loss (Heymsfield and Wadden, 2017). Lifestyle modification programmes are usually of short duration, a feature that makes it easy for patients to regain lost weight. However, adopting continued counselling on a periodic basis constitutes an effective strategy in preventing relapse in weight loss (Heymsfield and Wadden, 2017).

### 2.3.7 Obesity and Socio-demographic Factors

Findings from several epidemiological studies indicate that females generally have a higher prevalence of obesity than males. The study to assess the association between general and abdominal obesity and incident asthma in adults living in Nord-Trøndelag, Norway reported a significantly higher prevalence of abdominal obesity among females (17.5% vs. 8.9%) than in males (Brumpton *et al.,* 2013). In Jiangxi Province in China, although there were no statistical differences in prevalence rate between males and females, the prevalence of obesity was higher among males (8.4%) than females (7.6%) while the proportion of females (29.0%) with elevated WC was significantly higher than that of males (24.5%) (Hu *et al.,* 2017). There were similar observations in the African region.

Malik *et al.* (2019) from their study on abdominal obesity in Ivory Coast reported that women constituted 95.5% of those with abdominal obesity and were about 35 times more likely to be abdominally obese when compared to males. Among Ghanaian university students, both obesity/overweight (25.8% in females vs. 5.9% in males) and abdominal obesity (40.9% in females vs.0.8% in males) were significantly higher among females compared to males (Mogre *et al.,* 2015). In Tanzania, females reportedly had higher prevalence (35.14% in females vs. 6.89% in males, $p< 0.0001$) and risk (adjusted OR = 8.21; 95% Cl = 6.44, 19.52; p = <0.0001) of abdominal obesity when compared to males

(Munyogwa and Mtumwa, 2018). Some information from the African region had also indicated a higher propensity for females to have higher body fatness over that of males. In all four selected countries, obesity affected more women than males: rural Uganda (18.9% vs. 2.4%), peri-urban Uganda (23.1% vs. 3.1%) and South Africa (60.5% vs. 38.8%) but not in Tanzania (38.1% vs. 48.3%) and Nigeria (28.0% vs. 35.7%) respectively (Ajayi *et al.*, 2016). Multivariate analyses showed that female gender was a significant predictor of overweight/obesity when compared to normal body weight in both rural (AOR = 1.96; 95% CI = 0.96, 3.97; $p = 0.04$) and urban (AOR = 8.01; 95% CI = 4.02, 15.96; $p < 0.0001$) Uganda.

Joseph-Shehu and Ncama, (2018) reported that, compared to males, the prevalence of overweight or obesity among females was twice that of the value reported for males, whereas, abdominal obesity was higher among males. Findings from a study on cardiovascular risk factors in Abia State, Nigeria, revealed that the prevalence of overweight /obesity was higher among females (37.0% vs 30.1%) than males (Okpechi, Chukwuonye, Tiffin, Madukwe, Onyeonoro, Umeizudike, and Ogah, 2013). A study assessing overweight and obesity among adults attending an out-patient clinic in Uyo, Nigeria, revealed that increased body fatness, measured by BMI was higher among the females, (30.7 $kg/m^2$), against (27.6 $kg/m^2$) among males; as well, WC (95.3 cm and 91.2 cm) and hip circumference (109.4 cm and 103.3 cm) among males and females, respectively (Idung *et al.,* 2014).

Complex physiological processes, coupled with culturally dictated gender roles in the household and society could explain the increased likelihood of obesity in females when compared to males. Urbanization has brought changes in living conditions, impacting physical activity patterns that result in sedentary lifestyles, especially in females (Kanter and Caballero, 2012; Micklesfield *et al.,* 2013). Females again are more susceptible to genetic influences of obesity than males (Link and Reue, 2017; Reue, 2017). Body composition is such that both males and females have different predispositions to store fat differently in respective adipose tissues. The lesser tendency for females to have increased visceral fat only applies in the premenopausal period, after which they begin to store visceral fat in similar amounts as males. In addition, females also have higher amount of subcutaneous fat than males throughout the life span (Link and Reue, 2017; Reue, 2017). The chromosomal make-up in females predisposes them to higher risk of obesity when compared to males (Link and Reue, 2017; Reue, 2017). Females (particularly at and beyond middle age) are more likely to develop diet-induced obesity than males (Salinero *et al.*, 2018). There is consistent documentation that the tendency to develop increased adiposity increases with age, especially between the third and seventh decades of life (Jura and Kozak, 2016).

Malik *et al.* (2019) reported that, abdominal obesity was more likely to be found among older adults in Ivory Coast. When compared to those in lower age groups, obesity increased significantly in those found in all age groups beyond 30 years. Similar observations were obtained in Tanzania, where adults older than 30 years in the Dodoma region were at least two times more likely to have abdominal obesity (Munyogwa and Mtumwa, 2018). As well, some national data have revealed the influence of increasing age on higher risk of obesity among adults in the African region. Data from Nigeria indicated a progressive increase in the risk of obesity with increasing age. When compared to younger adults, the risk of obesity doubled among adults 35 to 44 years old and over 9 times higher in those older than 45 years old (Ajayi *et al.*, 2016). In South Africa, the risk of overweight/obesity was 3 times higher among adults aged 35 to 44 years while the odds increased to 6 times in those aged 45 and above. The influence of increasing age on obesity risk is not limited to older adults only. This was observed among younger adults, 18 to 36 years in Ghana where obesity had weak but significant positive associations with age (Mogre *et al.*, 2015).

The likelihood of developing obese among individuals is also influenced by urban-rural differences, with most observations reporting higher obesity prevalence in urban centres. Because living conditions differ between urban and rural settings, lifestyle factors that impact on body weight, including food intake and physical activity levels also differ between these two settings. The urban setting ordinarily presents conditions that favour higher body weight through food intake and physical inactivity. Globalization, with its attendant industrialization and urbanization exerts greater influence in urban centres and brings with it the problems of nutrition transition that is accompanied by higher energy intakes and sedentary life. Although the problems of nutrition transition are not limited to urban areas, higher income through education and gainful employment in urban settings enhance the adoption of nutrition practices that encourage increased consumption of energy over essential nutrients and physical inactivity to a greater extent than what is obtainable in rural areas.

Both general obesity and abdominal obesity were found to a greater extent in urban areas than that in rural settings in the Jiangxi Province in China (Hu *et al.*, 2017). While the urban areas had prevalence rates of 37.1% and 11.6% of general and abdominal obesity, only 30.2% and 8.7% of those in rural settings had these conditions (Hu *et al.*, 2017). The study to examine the contributions of selected factors to and the overall rates of abdominal obesity among adults in Tanzania revealed in logistic regression that, compared to rural dwellers, urban dwellers were two times more likely to have abdominal obesity (Munyogwa and Mtumwa, 2018). Rothman *et al.*, (2019) recorded 53.5% of general obesity and 62.7% abdominal obesity among urban women in Lesotho; values that were substantially higher than 44.4% and 54.1% rates found among rural counterparts. The prevalence of increased BMI was higher among urban (37.5%) residents compared to rural (30.4%) inhabitants in Abia State, Nigeria (Okpechi *et al.*, 2013).

Prevalence of obesity differs by different socioeconomic conditions. Education, income, occupation and employment status usually predict obesity independently or interact to influence how obesity relates with other factors. Employment affords individuals the opportunity to be preoccupied in various forms of activities, hence increasing the chances of being physically active, which in turn lowers the risk of overweight or obesity. Unemployed individuals on the other hand can afford to take things easy, meet their almost non-existent daily goals in a more relaxed atmosphere, with an undertone of lower physical exertion and consequently lower physical activity. However, this general observation may have some gender influences. For instance, it may be difficult in some cultures for obese females to have gainful employment and earn higher income when compared to their male counterparts (Härkönen, Räsänen, and Näsi, 2011; Some, Rashied, and Ohonba, 2014; Lee, Yeon, Cho, Jo, Chul, Eum, Kim, Lee, Lee, Jung, Jung, Lee, Kim, Han, and Bae, 2019) a development most often attributed to gender discrimination at workplace (Härkönen *et al.*, 2011). This in turn gives the impression that unemployment independently predisposes to obesity.

Obesity is also related to income, although findings differ by studies. At a higher socioeconomic level, individuals with higher income may follow a healthy dietary pattern that promotes and sustains healthy body weight whereas those at low socioeconomic status may tend to over-nutrition when income increases. Templin, Hashiguchi, Thomson, Dieleman, and Eran, (2019) in their review on overweight and obesity transition in low- and middle-income countries reported that obesity had inverse associations with income only at high-income levels. Whereas higher prevalence of obesity is often reported among those with lower income in developed countries (Kim and Knesebeck, 2018; Andoy-galvan, Lugova, Patil, Wong, Chinna, Baloch, Suleiman, and Nordin, 2020). However, a study in China revealed a "U" shaped relationship between BMI and increasing income, implying an initial decrease in obesity with increasing income which eventually rises with income over time (Yao and Asiseh, 2019).

Both income and education interact to predispose individuals to higher risk of obesity in similar ways. This is because individuals with higher level of education stand the chances of gaining employment with better pay, which translates to higher income. Higher income can encourage adopting dietary habits and lifestyles that predispose to obesity, especially in poor income settings. Obesity has often been observed to affect more people who are educationally disadvantaged (Devaux, Sassi, Church, Cecchini, and Borgonovi, 2011), although such observations are subject to some other factors including, economic development (Cohen, Rai, Rehkopf, and Abrams, 2013). Munyogwa and Mtumwa, (2018) reported that increased abdominal fatness was about three times more common and adults with primary and or secondary education when compared to those with no formal education.

One other respondents' characteristic that has a significant relationship with obesity is marital status. Obesity seems to be higher among married individuals when compared to those that are not in any marital relationship. Married adults become obese from several reasons. Teachman, (2016) listed some to include the fact that, married adults overeat in the company of their partners and become overweight eventually. Also, married adults, especially women loose concerns over their body image which they had earlier before marriage and eat with no caution after marriage since they are not seeking to enter into any new relationship.

The risk of obesity differed significantly among adults in different marital relationships in Tanzania. Munyogwa and Mtumwa, (2018) reported that, when compared with adults who never married, the likelihood of being obese was at least two times higher among adults who were either married, divorced or widowed. Ajayi *et al.* (2016) recorded higher BMI values for married adults in all four countries (AOR = 1.70; 95 CI = 1.13, 2.56) as well as among divorced and/or separated individuals. The higher tendency of obesity among married individuals has been attributed to overeating in the presence of a partner as well as less burden of concern over body image so often observed in single females (Teachman, 2016).

## 2.4 Hypertension

### 2.4.1 Definition of Hypertension

Blood pressure is the force generated within the walls of the capillaries, resulting from the flow of blood either from the heart to other organs and systems or vice versa. The circulation of blood to and from all parts of the body is primarily by contraction of the heart. The maximum pressure experienced by the capillary walls when the heart contracts to propel the blood flow is the systolic blood pressure, while DBP is the minimum pressure within the artery walls when the heart is at rest. The force at which the process of heart beat or contraction occurs varies from time to time, resulting from a number of reasons, some of which are preventable. Depending on the prevailing conditions, the pressure at which blood is pumped within the artery walls could be low, moderate, i.e normal or high. Normal blood pressure is essential for healthy body organs and their functions. Extremely high or low pressure within the artery walls is indicative of malfunction of certain segments of the circulatory systems or its accessory organs. Excessively high pressure that persists within the capillary walls for prolonged period constitutes a condition known as hypertension or high blood pressure. The two basic types of blood pressures have ranges that define low, normal or indicate high blood pressure. Hence, hypertension is defined as either any of or a combination of SBP and DBP up to or above 140 mmHg and 90 mmHg, respectively.

### 2.4.2 Symptoms of Hypertension

Hypertension does not have any specific or peculiar symptoms, as such most victims are usually not aware of the condition except when detected in routine medical check-ups. When symptoms occur, patients may experience symptoms ranging from headaches that often occur early in the mornings. Frequent and persistent bouts of nose bleedings as well as irregular and rapid heartbeats are indicative of raised blood pressure. Some other individuals may experience sight problems, which often present as changes in vision. Where the situation is critical, symptoms could range from exhaustion to confusion. Patients may also have increased inclination to vomit and become more and more nervous. Some cases may even cause chest pain, and muscle tremors (WHO, 2019a).

### 2.4.3 Prevalence of Hypertension

Hypertension is implicated in most premature deaths worldwide, especially those linked to vascular diseases. Although hypertension prevalence is high in most locations, the highest burden of raised BP are borne by those in less developed countries. According to the global reports, hypertension affects about one billion people globally. Of this proportion, those in less economically developed nations account for over 75% of the cases and account for 18% of the cases in WHO American Regions and 27% in the WHO African Regions (WHO, 2019b). However, findings from some other report, made earlier contradict the notion that high blood pressure affects more people in less economically developed nations than those in developed countries. Sarki, Nduka, Stranges, Kandala, and Uthman, (2015) discovered from their study that about 32.3% of the world population was affected with hypertension and that, the greatest burdens were born by regions outside the low income settings, including those in the upper middle-income countries.

Hypertension affects more and more people by the day, causing the rates to increase progressively over time. These increases are however not limited by location or region, though could be higher in some situations than the others depending on the prevailing conditions. (Bosu, 2015) reported that about 34.4% of those in West African region were affected by high blood pressure in the year 2014, a proportion that almost tripled the 12.9% estimated in the 1980s. In Nigeria, nationwide estimates approximated that about 44.9% of individuals in the whole population as being victims to the scourge of high blood pressure

(Murthy *et al.,* 2013). Within Nigeria, (Olamoyegun *et al.,* 2016) discovered that over one-half of adults in a semi-urban area in South West Nigeria were hypertensive. Prevalence of hypertension is equally high across other regions within the country, with 31.4% of adults in a community in south eastern Nigeria being affected (Okpechi *et al.,* 2013). In a North West community in Nigeria, it was found that, the overall mean values for both SBP and DBP exceeded ranges that are considered normal for a healthy population- an indication of high burden of the disease in the setting (Bello-Ovosi *et al.,* 2018). Moreover, final estimates indicated that about fifty five per cent of adults in the same setting suffered from hypertension, worst still a greater percentage 28.5% were affected by the most severe form of the disease, though a significant proportion also suffered from stage I of the disease (Bello-Ovosi *et al.,* 2018). Hypertension constitutes a high disease burden in the South South region in Nigeria as well. The disease condition has been observed to affect some 28.0% in a location within the region (Akpan *et al.,* 2015), at some other location, about 47.0% of adults were diagnosed of the condition (Ekanem *et al.,* 2013). Among office workers, two studies, one from each Niger Delta and South western regions in Nigeria reported prevalence rates of 25.9% (Ofori and Obosi, 2019) and 37.1% (Olawuyi and Adeoye, 2018a) respectively.

### 2.4.4 Causes of Hypertension

Causes of hypertension varies, depending on whether it is primary or secondary hypertension. Most cases are usually primary or essential hypertension. However, the disease can develop when individuals are exposed continually over time to certain risk factors. Overweight and obesity constitute the foundation on which many more diseases stem from and are implicated in the development of both primary and secondary health problems associated with increased body fatness. Hypertension, by some biological mechanisms affects more individuals who are overweight and or obese, and in turn cause several other vascular diseases in patients.

Physical activity, performed with sufficient intensity over considerable period and frequency, especially when adopted as a lifestyle is intended to confer a healthy body composition and enhance development of healthy metabolic biomarkers. When this fails to happen, the consequences usually comprise of several physiological conditions that form synergy to precipitate chronic disease conditions. Sedentary life, low PA or an outright physical inactivity constitute well known conditions that increase to a far extent, the likelihood of suffering from unhealthy blood pressures. The significance of risky lifestyles, with reference to tobacco smoking and excessive alcoholism cannot be over emphasized.

There has been aggressive publicity on the health implications of these practices over time across the globe. The decision to avoid the menaces often yield the benefit of being excluded from common health problems that consistently associate with them. Chronic alcohol usage and tobacco smoking constitute potential risk factors that predispose users quickly to excessive high blood pressure and some other diseases. The essence in adopting a healthy pattern of food intake consists in attaining and subsequent maintenance of good health. Faulty diet predisposes to unhealthy body compositions, which in turn increase the risk of hypertension. Besides, there are specific dietary elements (especially those that are high in sodium), when consumed in amounts over normal levels and the ultimate utilisation increases the risk of hypertension. Some other items, for instance, fruits and vegetables need to be consumed in higher quantities to prevent hypertension from occurring, and when they eventually occur, these practices helps to cushion the adverse health effects and prevent further complications.

Managing stress is essential for attaining and maintaining healthy blood pressure ranges. Stress constitutes a very important predisposing factor to increased blood pressure and when allowed or ignored over time can lead to hypertension. The risk of hypertension can also increase as a result of certain conditions that occur beyond the direct control of individuals. The WHO list these factors to include older age, race and family history (World Health Organization, 2013a, 2019b). It is believed that, the blood vessels become hardened with increasing age, causing substantial constriction against normal blood flow along the capillary walls. As well, the number or proportion of people who suffer from high blood pressure and selected risk factors differ by race. Hypertension affects more blacks than the whites.

**Genetic Predisposition:** Genetic factors play significant roles in the development of primary hypertension and are often indicated by family history of hypertension in hypertensive patients ( Whelton *et al*., 2018; WHO, 2019b). However, the contribution of genetic influence on the eventual development of hypertension in most people is negligible (Whelton *et al.,* 2018), leaving such roles to factors that are highly preventable or controllable. It takes some sort of synergy with other factors or conditions before genetic variations can be implicated in the development of hypertension.

**Environmental Risk Factors:** The global outbreak of hypertension and its complications has been blamed primarily on sub-optimal diet, especially those containing high amount of sodium and fats (other than unsaturated fats, especially the poly-unsaturated fats), but low in fibre and phytochemical rich elements including fruits and vegetables (WHO, 2019a). Suboptimal consumption patterns for individual dietary components believed to have either direct or indirect impacts on blood pressure values occupy significant position in the spectrum of factors that interact to precipitate the problem of hypertension. While it is desirable that sodium intake should be in minimal amounts, others- potassium, calcium, magnesium, fibre, and fish need to be increased to support healthy vascular activities. Sub-optimal consumption patterns of these elements have been implicated in differences in blood pressure control across the globe (Whelton *et al.,* 2018). While excessive sodium intake predisposes to higher risk of poor blood pressure control, higher potassium intake may cancel out the effect of high sodium intake in raising blood pressure values. It is often advised that individuals should increase potassium intake over sodium to attain healthy blood pressure status. This may be especially helpful as individuals advance in age, since the effect of sodium consumption on the risk of developing hypertension increases with age.

Sedentary lifestyle and insufficient PA play significant roles in increasing the proportion of individuals affected by hypertension. Since overweight/obesity usually predispose to a higher risk of developing hypertension, physical inactivity increases the risk of hypertension through increased body weight. Irrespective of body weight, physically inactive individuals stand higher chances of suffering from high blood pressure than those who are physically active (Werneck, Oyeyemi, Gerage, Cyrino, Szwarcwald, Sardinha, and Silva, 2018).

Consistent alcohol intake, especially when taken in higher amount constitutes an established risk factor for developing hypertension. Alcohol consumption alone contributes to about 10% of the overall burden in most populations (Whelton *et al.*, 2018). However, this view was contradicted in African region. While the rate of hypertension was not related to alcohol intake in most settings in Africa, those who do not consume alcohol in sub-Saharan Africa had greater chances of suffering from high blood pressure, whereas, low prevalence of high blood pressure was recorded among those who consume alcohol (Sarki *et al.,* 2015). Since consuming alcohol in moderate amounts is desirable to confer healthy metabolic profile and reduce the risk of selected vascular conditions when compared to absolute abstinence (Whelton, et al. 2018), it could imply that intakes in these settings are not sufficiently high to confer the negative effects of alcohol on blood pressure.

Tobacco use comprises one of the lifestyle factors responsible for the global hypertension epidemic which is equally applicable in Nigeria. When compared to non-smokers, a higher proportion of smokers suffered from abnormal blood pressures in a setting in Eastern Nigeria (Okpechi *et al.*, 2013). However, reports from a larger body of literature revealed some variations in the proportions of smokers affected by hypertension. When compared to smokers, hypertension was common to a larger extent among non-smokers in selected regions across major continents; whereas, the reverse was the case in some other countries, selected randomly across most continents (Sarki *et al.*, 2015). The attributable risk of tobacco use on blood pressure control could be mediated by cultural elements in specific regions, which subsequently explains the observed variations in associations between smoking and the risk of hypertension in different settings.

**Metabolic Disorders:** Excess body fat, usually reflected in increasing values of anthropometric indices constitutes important predicting indicator of high blood pressure in all age groups. Epidemiological findings consistently indicate existent positive association between higher prevalence of hypertension and increased anthropometric indices. Up to forty per cent variation in hypertension cases is explained by abnormal metabolic profile that can be explained by obesity (Whelton *et al.*, 2018). Murthy *et al.* (2013) reported a steady increase in BMI with increasing severity of high blood pressure. In line with this, the prevalence of hypertension was higher among the obese (59.8%) when compared with those who were underweight. Diastolic hypertension had positive and significant relationships with increasing values of anthropometric indices, including BMI and WC among adults in North-west Nigeria (Bello-Ovosi *et al.,* 2018).

Although, the risk of both hypertension and obesity increase in advanced age, yet hypertension was more prevalent in a population of older obese adults than in the non- obese group in rural communities in southern Nigeria (Isara and Okundia, 2015). Akpan *etal.* (2015) reported a 7% increased risk of hypertension for every one unit increase in BMI among adults in Akwa Ibom State. Another study in Akwa Ibom also indicated a 9% increased risk of hypertension for each unit increase in BMI in univariate analysis and remained a significant independent predictor after adjusting for relevant confounders (Ekanem *et al.*, 2013). Obesity was associated with over a double increase in the risk of being hypertensive when compared to the non-obese among adults in rural Cameroon (Arrey, Dimala, Atashili, Mbuagbaw, and Monekosso, 2016).

Selected underlying medical conditions usually cause sudden and severe hypertension (secondary hypertension), which often dissolves completely or results in less severe controlled hypertension after proper diagnosis and subsequent treatment. Secondary hypertension occur as a result of complications arising from some other chronic disease condition. The cases are often resistant to routine drugs and are often associated with worse diastolic conditions and severe organ damage (Whelton *et al.,* 2018). Kidney diseases are most commonly implicated in the aetiology of secondary hypertension than some other disease conditions. Less common conditions that often predispose to increased risk of hypertension include diseases of the adrenal and thyroid glands, inherited diseases of the blood vessels and OSA. Secondary hypertension can also develop as a result of using certain chemical substances including non-steroidal anti-inflammatory drugs, birth control pills, decongestants, cocaine, amphetamines, corticosteroids, and high sodium content foods stand the risk of developing high blood pressure (Whelton *et al.,* 2018). Some cases can develop from chronic alcohol abuse (Whelton *et al.,* 2018).

### 2.4.5 Social Determinants of Hypertension

The social determinants of health, which also applies for hypertension include educational status, occupation, income, sometimes residence etc, constitute common elements of SES often analysed in studies. Most of these factors are themselves determined by education, since educational status, to some extent can determine the type and status of employment. Employment then indicates the nature of income, which again determines possibility of other lifestyle decisions. Higher income, resulting from better employment opportunities through education, can push more people from the traditional dietary patterns into nutrition transition and associated physical inactivity. Better living conditions may translate into physical inactivity and sedentary life through excessive use of labour-saving devices for most home chores besides increased passive transport systems. Globalization and the resulting modernization in initially primitive settings have brought about the influx of risky lifestyles that were alien to these localities, hence the rampant tobacco use and alcohol abuse. Social determinants of health all predispose to increased risk of hypertension, either independently or in combination with other factors through the development of metabolic disorders.

The influence of age on increased risk of hypertension is not controllable; risk of hypertension rises with increasing age, and stems from gradual stiffening of the blood vessels, which increases with age (World Health Organization, 2013a). As individuals age, they become more prone to developing hypertensive. Ageing is usually accompanied by impairments in the structure and functions of most respiratory organs, resulting in loss of endothelial functions and inflammations. Consequently, the blood vessels may be damaged, resulting in impairments in the normal blood flow and increased stiffness in the arteries. Under these conditions, the blood pressure is increased and in turn lead to vascular injury which may be associated with cardiovascular complications of hypertension. At middle age, both blood pressures continue to increase with age. However, while there is a continual increase in the systolic blood pressure, the DBP begins to decline after age sixty. This explains the higher incidence of systolic hypertension over increased DBP often observed among adults, especially in the elderly.

Findings from a national survey in Nigeria revealed a progressive rise in the prevalence of hypertension with advancing age (Murthy *et al.,* 2013). Among adults in North-west Nigeria, systolic hypertension had positive and significant associations with age (Bello-Ovosi *et al.,* 2018). The proportion of adults in rural communities in southern Nigeria who had hypertension increased with increasing age and was particularly evident among the older adults as they were predisposed to a remarkably higher risk of developing hypertension than the younger ones (Isara and Okundia, 2015). Akpan *et al.* (2015) reported that, members of a selected community in Akwa Ibom State, Nigeria stand the risk of experiencing up to 6% increased risk of hypertension as they age by every one year. In the same region, an 8% increased risk of hypertension was associated with every one year increase in age (Ekanem *et al.,* 2013). The risk of hypertension increased steadily after age forty among Cameroonian adults in a rural community (Arrey *et al.,* 2016).

Hypertension affects males and females differently, with more males often affected than females. It is believed that both biological and behavioural factors play vital roles in creating differences in hypertension risk between sexes. Biologically, females are believed to have some kind of protective effects against the development of hypertension, arising from the activities of sex hormones (especially oestrogen), influence of chromosomes and some other biological mechanisms that may not be well understood (Link and Reue, 2017; Reue, 2017).

However, these protective effects against hypertension in females are active at younger age and persist until menopause, after which the risk of hypertension in females approaches that in men and sometimes exceed the levels affecting males (Bell *et al.*, 2015; Everett and Zajacova, 2015; Ghosh, Mukhopadhyay, and Barik, 2016; Bosu *et al.* 2019). This is because, oestrogen levels falls abruptly following menopause, and hence the protective effect against cardiovascular conditions is lost. It is also possible for some behavioural risk factors to account for gender differences in hypertension. The males usually have greater exposures to some of these practices, especially alcohol use and tobacco smoking (Arrey *et al.,* 2016). Since alcohol usage and smoking more often predispose to hypertension, more males than females would normally suffer from high blood pressure provided they engage in such practices.

The WHO report corroborates the fact that hypertension is higher in males than in females. It was reported that, hypertension affected one out of every four among males, whereas, one out of every five females were affected by high blood pressure in the year 2015 (World Health Organization, 2019a). The notion that hypertension is higher in males may hold only for adults younger than forty years, beyond which the risk increases equally among both sexes or higher among females aged 65 years and above (Bell *et al.*, 2015). Bosu *et al.* (2019) in their findings from a systemic review of literature on determinants of systemic hypertension reported that older females (>50 years) in the African region had about 80% higher chances of developing hypertension than males.

In a study to assess hypertension and diabetes mellitus in rural communities in southern Nigeria, a higher proportion of the male participants were hypertensive when compared to their female counterparts (Isara and Okundia, 2015). Prevalence of hypertension was significantly higher among male adults (30.1%) than females (16.8%) in a semi-urban community in South-South Nigeria (Ekanem *et al.,* 2013). In a finding from a study on cardiovascular risk factors in Abia State, Okpechi *et al.* (2013) recorded a significantly higher prevalence of hypertension among males (34.9%) than females (28.1%). However, in a national survey in Nigeria, it was revealed that females had higher odd ratios for all grades of hypertension in both univariate and multivariate analyses (Murthy *et al.*, 2013).

Hypertension relates differently with SES in different locations and settings. While higher SES predisposes individuals in less economically developed settings to increased risk of hypertension, the reverse is the case in high income settings, where those in higher SES have lower risk of hypertension (Antignac, Diop, De Terline, Kramoh, Balde, Dzudie, Ferreira, Houenassi, Hounsou, Ikama, Kane, Kimbally-Kaki, Kingue, Kouam, Limbole, Kuate, Mipinda, N'Guetta, Nhavoto, Sesso, Ali, Toure, Plouin, Perier, Narayanan, Empana, and Jouven, 2018). The nature of interactions between SES and hypertension risk is not independent of common lifestyle factors that easily predispose to obesity in respective settings. Since obesity predisposes to hypertension, the prevalent lifestyles within respective socioeconomic strata in each income setting will influence the association between SES and hypertension. It is well known that obesity is more prevalent among individuals in the lower SES in high income settings. Low PA, excessive energy consumption, smoking and alcohol intake are common in lower socioeconomic class in developed setting (Rana, Ahmmad, Sen, Bista, and Islam, 2020). These probably explains the inverse relationship between hypertension and SES in developed settings, whereas, a direct relationship is often observed between hypertension and SES in poor settings (Rana *et al.*, 2020). In less developed countries, higher income through education and occupation translates to better food choices, predominantly characterised by dietary patterns associated with high energy intakes.

Also, with higher income, sedentary life and physical inactivity come into play resulting from increased use of energy saving devices. These and some other factors interact to give higher prevalence of obesity and other chronic diseases including hypertension among those in higher SES in low income countries. Consistent reports indicate higher hypertension prevalence among individuals in lower socioeconomic status, especially in the higher income settings (Antignac *et al.,* 2018). However, findings from a recent review of literature revealed an inverse relationship between educational attainment and the rate of hypertension in several regions, irrespective of the level of economic development (Sarki *et al.,* 2015). There was a gradual decrease in the prevalence of hypertension with increasing educational level, such that, those with tertiary education had the lowest prevalence of hypertension. Even in a rural setting, hypertension was found to affect a greater proportion of adults with no education, when compared to those with higher education in Cameroon (Arrey *et al.,* 2016). In Nigeria, nationally representative data revealed that compared to educated and wealthy individuals, hypertension was more prevalent among the illiterate (47.2%) and the least affluent (51.2%) (Murthy *et al.,* 2013).

Hypertension prevalence differs based on race/ethnicity probably as a result of some biological parameters, including genetic predisposition. It is also possible that, some social determinants of hypertension and its control that have ethnic inclinations could interact to cause racial differences in the disease rates. However, it is said that hypertension affects more blacks than whites.

There are also urban-rural differentials in the rate of hypertension, which could probably result from differences in lifestyles between the settings. The globalization driven nutrition transition in less economically developed nations is most evident in urban areas when compared to rural settings. Nutrition transition has brought with it dietary patterns that mimic the highly processed energy dense, nutrient poor food patterns into settings that were originally dependent on unprocessed and vegetables based meals. Moreover, changes in lifestyles has led to increased physical activity in most regions. The impacts of these developments are felt more in urban areas. However, differences in prevalence or risk of hypertension between the urban or rural settings differ in directions from study to study. Hypertension was found to affect more urban residents in the African continent, such that, the rate was 15% higher than that reported in the rural settings (Bosu *et al.,* 2019). In Nigeria, a report indicated a progressive increase in the rate of hypertension along the rural to urban gradient (Raji, Abiona, and Gureje, 2017).

A nationally representative data on hypertension in Nigeria revealed a much higher prevalence and risk of hypertension in urban settings over what was obtained in the rural setting. (Murthy *et al.,* 2013). Information from literature indicated consistent higher prevalence of hypertension in urban settings in less economically developed settings in the world, and a 32.7% was recorded for the urban against 25.2% among rural dwellers (Sarki *et al.,* 2015). In Akwa Ibom State, Nigeria, reports indicated higher prevalence of hypertension in a rural area (44.3%) than that of the urban area, 27.5%; as well, the odds of hypertension were two times higher in the rural setting than in the urban (Akpan *et al.,* 2015). In Abia State, Nigeria, the prevalence of hypertension was similar among urban and rural dwellers (Okpechi *et al.,* 2013).

### 2.4.6 Complications of Hypertension

Chronic hypertension usually lead to a condition called hypertensive heart disease. Hypertensive heart disease consists of a group of CVDs resulting from uncontrolled elevated blood pressure over a long period of time. These complications include systolic or diastolic heart failure, conduction arrhythmias, ischemic heart disease and increased risk of coronary artery disease. Among major modifiable risk factors (hypertension, cigarette smoking, diabetes mellitus, and abnormal lipid profiles) that predisposes to cardiovascular disorders, hypertension is associated with the strongest evidence for causation and has a high prevalence of exposure (Fuchs and Whelton, 2020). Hypertensive individuals are almost 3 times more likely to develop cardiovascular conditions when compared to those with normal blood pressure (Oh and Cho, 2020).

There is a linear increase in the risk of CVDs with increased blood pressure. Reports indicate that the risk of death from most CVDs doubles with every 20 mmHg increase in SBP and or every 10 mmHg increase in DBP, starting from 115 mmHg SBP and or 75 mmHg DBP, respectively (Whelton *et al.,* 2018; Ripley and Barbato, 2019), and increases with all blood pressure components, SBP being the most important (Ripley and Barbato, 2019). Cardiovascular consequences of hypertension stem from tissue damage (blood vessels), which again restricts blood flow between blood vessels and the heart. It can also cause kidney failure, blindness, rupture of blood vessels, cognitive impairment and others (World Health Organization, 2019b). The Global Burden of Disease (GBD) 2013 Mortality and Causes of Death Collaborators study indicated that, the hypertensive heart disease was implicated in 1.07 million global deaths in 2013 against 630,000 deaths reported in 1990 (GBD 2013 Mortality and Causes of Death Collaborators, 2015).

Hypertensive heart disease can occur with or without heart failure. Long standing hypertension is strongly linked to the development of heart failure. Conversely, individuals who are free from hypertension, obesity, and diabetes at middle age have about 86% lower risk of developing heart failure in advanced age (Messerli, Rimoldi, and Bangalore, 2017) It accounts for almost 25% of all heart failure cases (Tackling and Borhade, 2019). Hypertension is two times more likely to cause heart failure in men and 3 times more in women (Messerli *et al.*, 2017; Tackling and Borhade, 2019). Other studies have indicated that about 28% to 91% of patients with heart failure cases had an earlier history of hypertension and that intensive treatment of hypertension may prevent and or reverse myocardial changes in patients at risk heart failure (Oh and Cho, 2020).

The development of coronary heart disease, (a condition characterised by narrowing of the blood vessels supplying blood to the heart) is most often preceeded by hypertension in most individuals. Blood vessel narrowing can be caused by any of blood clot, constricting blood vessel or by atherosclerosis. Complete lack of blood flow to the heart results is a condition called myocardial infarction or heart attack, characterized mostly by the death of cells in the heart muscles. Lack of sufficient blood flow to the heart can prevent oxegen from being supplied to the heart, resulting in angina pectoris. Angina pectoris is characterized by discomfort in the chest, jaw, shoulder, back, or arms that is typically aggravated by exertion or emotional stress and relieved promptly with rest or by taking nitroglycerin (Institute of Medicine (US) Committee on Social Security Cardiovascular Disability Criteria., 2010). Hypertension is the single most important independent predictor of coronary heart disease. However, the risk of CAD in respect to hypertension varies with age. While DBP accurate predicts IHD among individuals below 50 years old, systolic blood pressure constitutes the major risk factor for those 60 years old and above (Rosendorff *et al*., 2015). It has been reported that, the risk of fatal CHD doubles with every 20 mmHg increase in SBP and or each 10 mmHg increase in DBP (Rosendorff *et al.*, 2015).

### 2.4.7 Awareness, Treatment, and Control

Assessing how individuals are aware of their blood pressure status is often based on self-reported assessments. Treatment of hypertension involves administering blood pressure-lowering medications to prevent blood pressures from rising beyond acceptable limits. Hypertensive individuals can attain blood pressure control when treatment using blood pressure-lowering leads to satisfactory blood pressure levels, indicated by SBP/DBP less than 140/90 mm Hg on treatment. Awareness of hypertension, treatment and control has been reported to have improved over the years in developed countries (National Center for Health Statistics, 2013; Whelton *et al.*, 2018), especially among females, whites and older adults: except for adults older than 75 years, as well as those with higher socioeconomic status (National Center for Health Statistics, 2013; Whelton *et al.*, 2018). In developing countries, consistent reports indicate low awareness and treatment that eventually lead to poor control. In Nigeria, Murthy *et al.*, (2013) reported that only 14.1% of those diagnosed as having any hypertension ever had previous knowledge that they were hypertensive.

In Ghana, a systemic review on the epidemic of hypertension revealed that, of the total number of persons identified to have raised blood pressure, only 22%-54% were aware of their condition, 7%-31% were on treatment, and 0%-13% had their blood pressures controlled (Bosu, 2010). Very few individuals ever had pre-knowledge about their blood pressure status in a rural community in Akwa Ibom State, Nigeria ( Akpan *et al.*, 2015). Olamoyegun *et al.*, (2016) reported that only 26.0% of persons discovered to have hypertension in semi-urban communities in Southwest Nigeria were previously diagnosed with hypertension prior to the study and that only 10.9% were on treatment. Furthermore, only 22.9% of those on treatment ever had their blood pressure under control of ≤ 140/90 mmHg. Findings from a study in rural Cameroon showed that only 28.9% of individuals diagnosed with hypertension knew their status before the study, 47% of those who previously knew their status were on antihypertensive treatment, while only 21.2% had their blood pressures well-controlled (Arrey *et al.*, 2016).

Non-pharmacological approaches, in other words, lifestyle modifications (with respect to diet, physical activity and alcohol consumption), have proven effective in preventing and or managing high blood pressure. They are fundamentally potent in preventing and managing raised BP either as sole therapy or in combination with drug therapy (Whelton *et al.,* 2018). The most common of such approaches consist of weight loss, achieved through a long term dietary modification. The DASH diet has the potential of correcting any faulty dietary pattern, while ensuring adequate compliance with intake patterns that prevent further rise in blood pressure as well as a mitigating effect on the condition. Sodium restriction, while increasing potassium can impact directly on the vascular system to reduce blood pressure and bring them to normal ranges in hypertensive. Recommending increased physical activity for the hypertensive ensures healthy muscular and vascular structures and functions, improve desirable body compositions and reduce unhealthy metabolic profiles that increase the risk of hypertension. It is also recommended that alcohol consumption be reduced for the alcoholics.

# CHAPTER THREE
# METHODOLOGY

## 3.1.0 Study Design

This study adopted a descriptive cross-sectional design to assess the quality of diets, physical activity, obesity and hypertension among adults in Akwa Ibom and Cross River States in Nigeria.

## 3.2.0 Study Population

This study involved adult males and females aged 20 to 64 years old who were resident in the study communities. The age range, twenty to sixty-four years, was chosen to exclude adolescents. Adolescents are classified as people 10 to 19 years by WHO (World Health Organization, 2013b).

## 3.3.0 Study Locations

The study was conducted in Akwa Ibom and Cross River States, Nigeria. Both Akwa Ibom and Cross River States are located in the southern part of Nigeria, constituting two States in the South-South geo-political zone in Nigeria. Akwa Ibom State is situated between latitudes 4°32′N and 5°33′N, and longitudes 7°25′E and 8°25′E. It shares boundaries with Cross River and Rivers/Abia States all within Nigeria on the east and west, respectively. On the south, it is surrounded by the Atlantic Ocean and the most southern part of Cross River State. The State occupies 7,081 square kilometre and has a population of about 5,450,758 million people. Indigenous languages spoken in the State include Ibibio, Annang, Eket and Oron.

Cross River State occupies 20,156 square kilometres, with about 3,737,517 million people. Cross River State is surrounded by Benue, Ebonyi/Abia States to the north and west, respectively. On the east, it shares boundary with Cameroon Republic and on the south with Akwa-Ibom and the Atlantic Ocean. Apart from English language, several indigenous languages are spoken within the State, including Efik, Ejagham and Bekwarra.

### 3.4.0 Duration of the Study

A total of sixteen months were used to obtain information for this study; five months for data collection (September 2018 to January 2019) and eleven months for data analysis. (February to December 2019).

### 3.5.0 Sampling Techniques

This study adopted a three (3) steps multistage sampling technique. The two States used for this study were selected using purposive sampling because of their similarity in food culture and other lifestyle factors. Within each of the three Senatorial Districts (SDs) in each State, two Local Government Areas (LGAs) were selected using simple random sampling to give six LGAs in each State, and a total of twelve (12) LGAs in all. Within each selected LGA, electoral wards were identified in their urban and rural clusters. Then, one ward was randomly selected from all urban wards, while two wards were selected from the list of all rural wards within a LGA using simple random sampling. A total of three wards (one urban and two rural) were selected. One community was selected from each electoral ward using simple random sampling technique. Thus, study locations consisted of twelve (12) urban communities and twenty-four (24) rural communities in all. The choice of one urban and two rural areas within the same LGA was to reflect the urban-rural population density differences in the region (Akwa Ibom State Government, 2007; National Population Commission and ICF Macro, 2009).

Within each community, household listing was conducted to identify eligible households. To identify eligible households, interviewers listed all houses serially, collecting information on each family unit within a building. Once a household was identified in a particular building, information on the number, ages and sex of household members were obtained. From the list of all the eligible households (those with adults twenty years and above), households were selected using systematic random sampling technique. Participants (adults 20 to 64 years old) were selected within each eligible household in the community.

### 3.6.0 Sample Size Determination

The minimum sample size in this study was computed using the statistical formula developed by Cochran (1963) for calculating the sample size, especially for large populations. Sample size calculation adopted a desired precision level of 2.75% (0.0275) and 95% confidence interval. Sample size was calculated using all four variables (diet quality, physical activity, obesity and hypertension) used in this study, (appendix V). The proportions of the whole sample with key attribute under measurement for respective variables were as follows:

1. diet quality: the 5.7% of under nutrition in South South Nigeria from the findings of the National Demographic and Health Survey in Nigeria (NPC and ICF, 2019).
2. physical activity: the 22.0% of physical inactivity, indicated in the findings on the study to assess physical activity profiles of adults Nigerians (Oyeyemi *et al.,* 2018).
3. obesity: a 22.2% prevalence of obesity from the findings of a systematic review of obesity among adult Nigerians (Chukwuonye *et al*., 2013).
4. hypertension: a 44.9% prevalence of hypertension among adult Nigerians (Murthy *et al.,* 2013).

The largest sample size, calculated from the four variables was chosen for this study. Therefore, the minimum sample size used in this study was based on the 44.9% prevalence of hypertension among adult Nigerians (Murthy *et al.,* 2013).

Using the formula:

$$n = \frac{z^2 \text{ x } pq}{d^2}$$

where;

**n** represents the minimum sample size;

**$z^2$** the normal deviate corresponding to the desired confidence interval = 1.96

**p** the proportion of elements in the study population with the key attribute being measured = 44.9% (0.449)

**q** unaffected population = 55.1% (0.551)

**d** the desired degree of accuracy = 2.75% (0.0275)

Minimum sample size was therefore calculated to be;

$$\frac{1.96^2 \text{ x } 0.449 \text{ x } 0.551}{0.0275^2}$$

$$= 1257$$

The minimum sample size calculated was 1257.

Adjusting to account for a 10% attrition rate, it was calculated to be 126 + 1257 = 1383. The minimum sample size calculated for the study was 1383. However, the total sample size used for the study was 1320. However, 63 questionnaires were lost due to incomplete responses.

### 3.7.0 Inclusion Criteria

The study included all subjects who:

1. gave informed consent to participate in the study.
2. were between the ages of 20 to 64 years old.
3. have been resident in the study communities for at least the past two years.
4. were non-pregnant women or lactating mothers and
5. did not alter their usual food intakes because of ill-health, fasting, national holidays, and festive celebrations.

### 3.8.0 Data Collection

### 3.8.1 Tools for Data Collection

Data was collected using a semi-structured questionnaire. Questionnaire consisted of a separate section to record information on questionnaire identification consisting of respondent's identity (ID), community, LGA, Senatorial District and State. For study information, the questionnaire consisted of five (5) separate sections, sections A to E. Section A was designated to obtain information collected on socio-demographic variables. Section B obtained information on dietary intake assessment using twenty-four hour dietary recall. Section C was used to report information collected on physical activity of respondents using IPAQ long form. Section D was used to record information collected on anthropometric measurements of respondents' body weight, height, waist and hip circumferences, body mass index (BMI) and waist/hip ratio. Section E recorded information collected on blood pressure measurements.

### 3.8.2 Socio-demographic Information

Socio-demographic and economic information consisted of information on socio-demographic characteristics. Socioeconomic information on respondents included sex, age, State of origin, ethnicity, religion, marital status, highest educational attainment, primary occupation and household estimated monthly income.

### 3.8.3 Dietary Intake Assessment

Dietary intake assessment was conducted using a four step multi-pass 24-hour dietary recall questionnaire (Gibson and Ferguson, 1999), administered by trained interviewers. Interviews to obtain information on dietary intakes were conducted by trained interviewers. Each pass provides respondents with a different approach to recall foods consumed over the reference period. Prior to the interview, each respondent was informed of the information he/she would be required to provide and the appropriate way to respond to each question during the interview- recalling all foods consumed during the immediate past 24 hour period, the place, time, occasion, descriptions and quantities consumed.

**First Pass (quick list):** This step consisted listing of foods, mixed dishes and beverages consumed during the immediate past 24 hours period (from midnight to midnight) by the respondent. The time and eating occasions for each food listed were thereafter recorded. Information on time and eating occasion was considered memory cues to help respondents recall details about foods in the subsequent interview steps. At the end of the food listing, interviewers probed to identify and record any omitted items during the initial listing.

**Second Pass (detailed description):** Second pass required respondents to provide adetailed description of each food and drink listed during the first pass - brand name where available; recipes for mixed dishes. Once respondents provided complete information on food descriptions of the primary food consumed, interviewers probed to identify any foods probably omitted during the first pass. The interviews also adopted probing questions to collect information on possible food addition(s) at this stage. "An addition" is any food added to the primary food, for example, whether respondents added salt or sugar when drinking gari; adding sugar in tea or cereal gruels; margarine or butter on bread. Information on "food additions" were collected after the descriptive probes for the primary foods. Thus respondents could visualise the food as eaten, including foods added.

**Third Pass (Quantity Estimation):** Quantities of foods listed and described in the earlier passes were estimated and recorded using simple household measures (such as teaspoon, tablespoon, serving spoon, measuring cup, plates, sales measures and selected replica of food models. For each food listed, respondents identified the specific measures used in quantifying each meal consumed. Where respondents reported consuming commercially manufactured foods, they were asked to provide information on the quantity, the proportion of the whole consumed, detailed description of the food and or the food cost. Subsequently, descriptions and price of commercially manufactured foods collected were used to estimate quantities consumed for respective foods from market survey records (obtained from each survey location) or bought to extract needed information where such was missing in the market survey compilations. For all listed and described foods recorded, interviewers collected data on portions consumed, the proportions of leftover and additional helpings where applicable.

**Fourth Pass (final probe):** This stage entailed a review of all foods and drinks taken in chronological order, prompting for any foods and drinks consumed that the respondent may have omitted in previous steps. Clarifications were obtained on any ambiguities regarding the type of food, drink and portion sizes of food consumed. Finally, respondents were asked to indicate if recalled intakes were typical of their usual food intake or if it was unusual or restricted in any way.

### 3.8.4 Assessment of Physical Activity

The study adopted the IPAQ to assess PA of respondents (Appendix I). The IPAQ was developed and subjected to reliability and validity studies in 12 countries in 2002 by (Craig *et al*., 2003). The instrument is used as a global standard to quantify habitual PA in people from various nations and socio-cultural settings, with a focus on young and middle-aged adults aged 15 to 69.There are two forms of IPAQ. The long and short IPAQ forms are both used to assess physical activity patterns over a period of 7 days in populations. The IPAQ long form was employed to assess PA in this study. The IPAQ long form measures PA to provide information on four different domains that include activities performed at work, PA undertaken by reason of transportation from place to place, PA performed during household chores and PA estimated from leisure-time or recreational activities. The questionnaire consists questions that provide information on three distinct activity types, including walking, moderate-intensity activities and vigorous-intensity activities within each PA domain. Within each PA domain, the IPAQ provides information on the number of days and the activity duration for each activity type performed within the seven day period prior to the survey.

### 3.8.5 Anthropometric Measurements

Anthropometric measurements taken in this study included weight, height, waist and hip circumferences

**Measurement of Weight:** Respondents' body weights were measured using a sensitive bathroom scale- CAMRY Personal Electronic Scale, EB1002 model. For accuracy, the following procedures were adopted in taking body weight measurements of the subjects in chronological order.

1. The scale reading was set at zero before the measurement was taken for each participant.
2. Participants were asked to take off every heavy accessories including shoes, jackets, sweaters or head gears. Where they had any item in their pockets or anywhere else on them, such items were brought out and kept aside until measurements were completed.
3. They were then instructed to step on the scale with both feet placed properly on the scale platform while placing their arms at their sides, staring front and maintaining still.
4. The interviewer then read out the values and recorded them to the nearest 0.1 kilogramme.
5. Procedures were repeated for each participant after the first reading.
6. For confidentiality, values were read out quietly while weight measurement values recorded immediately.

To ensure accurate readings, the scale was placed on a hard flat surface for all measurements. The scale was calibrated daily using a 5kg object, before being used for weight measurements each day. Measurement of the 5kg object was taken twice to ensure the effectiveness of the process. In instances where the scale failed to give accurate measurement of the object, any of the appropriate actions was taken.

i. The scale battery was replaced with a new one,
ii. The scale was sent for servicing or
iii. The scale was replaced with a new one where other efforts failed.

**Measurement of Height:** This was performed using a locally fabricated Stadiometer, following the procedures stated below. For accurate measurements, respondents were asked to do the following in chronological order:

1. take off all necessary accessories, especially shoes, hair extensions and gears to the extent possible.
2. stand in such a position that their back touched the stadiometer, legs straight and brought together (in contact at some point), arms at sides, and shoulders relaxed.
3. stand erect with the head positioned in the Frankfort plane.

Thereafter, a flat headpiece on the stadiometer was lowered and placed firmly on the crown of the head. While handling the headpiece, the interviewer stood such that the eyes remained parallel to the headpiece before taking the corresponding reading on the stadiometer in the nearest 0.1 cm. The whole procedure was repeated for each participant, and reading recorded immediately.

**Measurement of Waist Circumference:** This was performed using a non-stretchable tape following the procedures stated below.

1. Participants were instructed to undo any constricting clothing - wrappers, belt, and skirt to remove any pressure in the abdomen.
2. They were then instructed to stand straight while placing their arms at the sides and feet brought close to each other.
3. Subjects were instructed to take few deep breaths before measurements. This was to bring the inward pull of the abdomen to its barest minimum.

4. Measurements were made when subjects were in fasted state to reduce the effects of abdominal contents, including water, food or gas on measurement accuracy.
5. Measurements were taken at the end of normal expiration to account for effects of respiration phase on the fullness of lungs, position of the diaphragm and the accuracy of the waist circumference measurements.
6. Respondents with skin folds received measurements on the exterior of the fold.
7. To take the measurement, tape was held parallel to the floor at the midpoint between the lower margin of the last palpable rib and the top of the iliac crest; and snugged slightly around the body.
8. Crouching on the respondent's right side, a cross-handed technique was used to take reading to the nearest 0.5 cm.
9. The procedures were repeated to take a second reading for each participant.

**Measurement of Hip Circumference:** These were taken at the widest perimeter of the buttocks using a non-stretchable measuring tape. First, respondents were requested to remove heavy and tight clothing, loosen belts and empty pockets. They were then instructed to stand with arms comfortably positioned at the sides and feet brought close to each other. Respondents were requested to stand with both feet positioned in a manner to carry the body weight evenly. To take the measurements, measuring tape was snugged loosely around the respondents' buttocks in a position parallel to the floor. Respondents were instructed to take normal breathes and the tape readings corresponding to the circumference of the hip were recorded at the end of gentle exhaling. Measurements were recorded to the nearest 0.5 cm. Procedures were repeated to take a second reading for each participant.

### 3.8.6 Measurement of Blood Pressure

Blood pressure measurements were obtained using a conventional mercury-in-glass sphygmomanometer. Trained qualified nursing officers were employed to take blood pressure measurements for this study. An average of two readings, acquired on two distinct occasions was used to report the blood pressure measurement. Measurements were obtained following the procedures described by (Frese, Fick, and Sadowsky, 2011). Prior to each measurement, respondents were asked to rest for at least 5 minutes in a sitting position with back support and remain silent with feet on the floor (not crossed) during the measurements.

To take blood pressure measurements, the cuff was wrapped around the respondent's upper arm at the level of the right atrium (the midpoint of the sternum). Measurements were taken over bare arms. The cuff used in taking measurements had a width that was wide enough and length sufficiently long to cover a good proportion of subjects' arms circumference. In essence, the width and length of the cuff were about 40% and over 80% of the arm circumference of participants. To rule out the possibility of a systolic auscultatory gap, the cuff was rapidly inflated to 30mmHg above the level at which the radial pulse was silenced. The diaphragm of a stethoscope was placed over the brachial artery while the control valve was opened, causing the cuff to deflate at a rate of about 2mmHg per heartbeat. The manometer value corresponding to the first appearance of a distinct tapping sound was used taken as the systolic blood pressure, while diastolic BP reading was taken when the sound ceased. Measurements were repeated after 1–2 minutes. This time interval between measurements was allowed to avoid venous congestion which usually results in difficulty in hearing the Korotkoff sound. Also, the cuff was completely deflated immediately after each reading. The mean of two measurement readings was recorded in the same arm with the patient in the same position. The two arms were used for taking blood pressure measurements. Blood pressure readings from the arms with consistent higher values were subsequently recorded and interpreted for both visits.

## 3.9.0 Data Management and Analyses

### 3.9.1 Dietary Intake Analyses

#### 3.9.1.1 Nutrients Intakes Analyses

Total Dietary Assessment (TDA) Software (version 3.0.), produced by Harcourt Incorporation in 2001 was used to estimate energy and nutrient values from information obtained during the dietary intake assessment. The age/sex specific population BMI and mean height values were used to choose daily average energy requirement values as recommended in the Joint FAO/WHO/UNU Expert Consultation compilations (FAO/WHO/UNU, 2004). To derive average daily protein requirements for the study population, the population sex specific mean weight was uased to calculate the 0.83g protein per kilogramme body weight requirements (FAO/WHO/UNU, 2007). Carbohydrate requirements were derived based on the AMDR of 55.0% of total energy requirements (FAO, 1998) for age/sex specific populations. Based on the 15 – 35% AMDR of fat to total energy intake (FAO, 2010), fat requirements were calculated as 20.0% of total energy requirements for respective age/sex populations. The age/sex specific Adequate Intake (AI) dietary reference intake values for dietary fibre (Institute of Medicine, 2005) were adopted to assess adequacy of intakes in this study. Vitamins and mineral intake values were also compared with joint FAO/WHO RNI values (FAO/WHO, 2005). Adequacy of energy and nutrient intake was estimated as percentage of requirements for each group using the formula:

$$\frac{\text{Mean Nutrient intake}}{\text{Requirement}} \times \frac{100}{1}$$

Adequacy was defined as mean intake value ≥ 100.0% of the RNI value.

#### 3.9.1.2 Diet Quality Analyses

The Diet Quality Index-International (DQI-I), created by Kim *et al.* (2003) was used to assess diet quality. The total DQI-I score range from 0 to 100 and is made up of the sum of scores from four distinct components. Diet quality terciles were created from the DQI-I scores. First (T1), second (T2) and third (T3) terciles represented low, average and high diet quality respectively. Variety component of DQI-I assessed variability in food sources across major food groups (overall food group variety) and within (within-group variety for protein sources). Overall food group variety measured variety in food intake as contributions from five major food groups: meat/poultry/fish/eggs; dairy/beans; grain; fruit and vegetable. Consumption amounting to a serving of any food item from each food group received 3 points, giving a total of 15 points for all 5 food groups. Within-group variety for protein sources measured variety in consumption of major protein sources. Major protein sources assessed in this study included meat, poultry, fish, dairy, beans and eggs. Consumption amounting up to a serving from at least 3 protein sources received 5 points, intakes from 2 protein sources received 3 points; while consumption from one source had a score of 1 point. Within-group variety for protein sources had a score range of 0 to 5 points. The variety component of DQI-I had a score range of 0 – 20 points, 0 to 15 points from overall food group variety and 0 -5 points from within-group variety.

Adequacy component of DQI-I assessed the consumption of eight dietary items. Items measured under this component included adequacy in vegetables, fruits, grains, fibre, protein, iron, calcium and vitamin C intakes. The scores for each item in this component ranged from 0 point for minimum intake (0%) to a maximum of 5 points for maximum (100%) intake of adequate level. Intakes of vegetables, fruits and grains were based on the number of servings per day according to the level of energy intake (i.e.1700kcal/day, 2200kcal/day to 2700kcal/day). Intake levels providing between 3 to ≥5 servings of vegetables received a total score of 5 points depending on the energy intake level or 0 points for no consumption; an intake providing between 2 to ≥4 servings of fruits received a maximum score of 5 points depending on the energy intake level or 0 point for no consumption. For grains, an intake containing between 6 to ≥11 servings per day received the highest score of 5 points depending on the energy intake level or 0 points for no consumption. Depending on energy level, fibre intake between 20 to ≥30g per day received 5 points or 0 for 0 g/day. Protein intake up to or greater than 10% of the total energy intake per day received the highest score of 5 points or 0 point for 0% of total daily energy intake. Adequacy in micronutrients intakes, including iron, calcium and vitamin C were based on percentage attainment of the recommended daily intakes, Recommended Daily Allowance (RDA). An intake meeting up to 100% attainment received a maximum of 5 points while 0% attainment was scored 0 point. The adequacy component had a total score range of 0 to 40 points.

Moderation Component of DQI-I component assessed consumption of dietary elements that needs restriction in the diet. Items considered in this group included total fat, saturated fat, cholesterol, sodium and empty calorie foods. Each component had a maximum of 6 points for consumption level compatible with lower risks of diet-related disorders and 0 point for intake levels relating to the development of NCDs. Intake levels providing ≤20% of daily energy from total fat was awarded 6 points; greater than 20 but up to 30% contribution of total fat to energy intake received 3 points; while greater than 30% of total energy intake from total fat received 0 point. A diet containing saturated fat that provides ≤7% of total daily energy intake had 6 points; between 7 to 10% daily energy intake from saturated fat had 3 points; while 0 point was awarded to diets containing saturated fat contributing more than 10% of total daily energy intake. Cholesterol intake up to or less than 300 mg/day received 6 points; consuming between 300 to 400 mg of cholesterol per day was scored 3 points; while intakes greater than 400 mg per day had 0 point. For sodium, intakes up to or less than 2400 mg per day received 6 points; between 2400 to 3400 mg/day received 3 points; while intakes above 3400 mg/day had 0 point. Empty calorie foods assessed the contribution of low nutrient but high energy-dense foods to total daily energy intake. A diet deriving up to or less than 3% total daily energy intake from empty calorie foods was awarded 6 points; between 3 to 10% contribution of total daily energy intake from empty calorie foods received 3 points and energy intake above 10% from empty calorie foods received a score of 0. The moderation component had a total score range of 0 to 30 points.

Overall Balance Component of DQI-I assessed the proportions of energy sources from macronutrients (carbohydrate, protein and fat) and fatty acid (polyunsaturated, monounsaturated and saturated fatty acids) in the overall diet. The individual sun-components of the overall balance in diet quality and the scoring criteria are shown in table 3.1 below.

**Table 3.1: Components of the Overall Balance in the DQI-I**

| Component | Score | Scoring Criteria |
|---|---|---|
| Overall balance | 0–10 points | |
| Macronutrient (carbohydrate:protein:fat) | 0–6 points | 55 - 65:10 - 15:15 - 25 = 6 |
| | | 52 - 68:9 - 16:13 - 27 = 4 |
| | | 50 - 70:8 - 17:12 - 30 = 2 |
| | | Otherwise = 0 |
| Fatty acid ratio (PUFA:MUFA:SFA) | 0–4 points | P/S=1-1.5 and M/S=1-1.5 = 4 |
| | | Else if P/S = 0.8 - 1.7 and M/S = 0.8 -1.7 =2 |
| | | Otherwise = 0 |

### 3.9.2 Physical Activity Analyses

Physical activity was reported in METs-minutes per week, derived as the product of an activity METs score and the duration spent in performing the activity. Information obtained from physical activity assessments were used to compute scores for both domain-specific physical activity and activity-specific sub-scores. Physical activity scores for respective domains were derived by calculating the sum total of all duration (in minutes), multiplied by the frequency (in days) for each activity type within the specific domain. The same procedures were applied for the activity-specific scores across all four domains.

All entries where the sum total of scores from the three specific activity types exceeded 960 minutes, which amounts to 16 hours were removed from the dataset. It is assumed that individuals spend an average of 8 hours per day sleeping and so are not likely to perform any activities during such periods. The health benefits accrued to physical activity is only derived from activity performed over and above 10 minutes. Hence, all reported activities with a duration of less than 10 minutes were recoded to zero in the calculation of METs-minutes scores.

**Physical Activity Scores for Work Domain**

1. The product of the total duration (in minutes) and the number of days spent walking at work was multiplied by the walking METs score (3.3) to derive the physical activity score for walking during occupation or job related activities (Walking METs-minutes/week at work).
2. The product of the total duration (in minutes) and the number of days spent doing moderate-intensity activity at work was multiplied by the METs score (4.0) to derive the Moderate METs-minutes/week at work.
3. The product of the total duration (in minutes) and the number of days spent doing vigorous-intensity activity at work was multiplied by the METs score (8.0) to derive the physical activity score for vigorous-intensity activities (Vigorous METs-minutes/week at work).
4. The sum total of all (walking, moderate and vigorous METs-minutes/week scores at work) was computed to obtain the total activity score for physical activity performed at work (Total Work METs-minutes/week).

**Physical Activity Scores for Active transport Domain**

1. The product of the total duration (in minutes) and the number of days spent walking during transportation was multiplied by the walking METs score (3.3) to derive the physical activity score, walking METs-minutes/week for transport.
2. The product of the total duration (in minutes) and the number of days spent on cycling during transportation was multiplied by the walking METs score (6.0) to derive the physical activity score, cycle METs-minutes/week for transport.
3. The sum total of all (walking and Cycling METs-minutes/week scores for transportation) was computed to obtain the total activity score for physical activity performed during active transport (Total Transport METs-minutes/week).

**Physical Activity Scores for Domestic and Garden Work Domain**

1. The product of the total duration (in minutes) and the number of days spent on vigorous-intensity activities during domestic and garden-related work wasmultiplied by the METs score (5.5) to derive the physical activity score, (Vigorous METs-minutes/week yard chores).
2. The product of the total duration (in minutes) and the number of days spent on moderate-intensity activities during inside chores was multiplied by the METs score (3.0) to derive the physical activity score, (Vigorous METs-minutes/week yard chores).
3. The sum total of all (vigorous yard and moderate inside METs-minutes/week scores) was computed to obtain the total activity score for physical activity performed during domestic and garden-related activities (Total Domestic and Garden METs-minutes/week).

**Physical Activity Scores for the Leisure-time Domain**

1. The product of the total duration (in minutes) and the number of days spent walking during leisure-time activities was multiplied by the walking METs score (3.3) to derive the physical activity score for walking during leisure-time activities (Walking METs-minutes/week leisure).

2. The product of the total duration (in minutes) and the number of days spent doing moderate-intensity activity at leisure was multiplied by the METs score (4.0) to derive the Moderate METs-minutes/week at leisure.
3. The product of the total duration (in minutes) and the number of days spent doing vigorous-intensity activity at leisure was multiplied by the METs score (8.0) to derive the physical activity score for vigorous-intensity activities performed during leisure-time activities (Vigorous METs-minutes/week leisure).
4. The sum total of all (walking, moderate and vigorous METs-minutes/week scores at leisure) was computed to obtain the total activity score for physical activity performed at leisure (Total Leisure-Time METs-minutes/week).

METs-minutes/week were computed for individual type of activity types as follows

**Total Walking METs-minutes/week:** The sum total of all Walking METs-minutes/week computed from walking activities, performed at work, during transportation and at leisure.

**Total Moderate METs-minutes/week**: This consisted of the sum of all activities of moderate intensity, including those performed at work and those performed during house chores as well as activity performed during cycling as means of transportation.

**Total Vigorous METs-minutes/week:** This was computed as the sum of vigorous intensity activity performed during work and at leisure.

**Total Physical Activity METs-minutes/week:** Total PA was estimated as the sum of all activities carried out in all four domains of PA. That is the sum total of individual METs-minutes/week scores computed from work, transport, domestic and garden-related activities as well as those from leisure-time.

Physical activity patterns were determined based on to the procedures in the IPAQ analyses guide.

**High PA level:** This was awarded when:

1. a respondent spent at least three days in a week performing vigorous-intensity PA, provided the total PA score amounted to 1500 MET-minutes/week or more.
2. a respondent spent 7 or more days performing any combination of walking, moderate- or vigorous-intensity activities that amounted to not less than 3000 METs-minutes/week.

**Moderate PA Level:** This was awarded when

1. a respondent spent at least 3 days in a week participating in moderate intensity PA with a duration of not less than 20 minutes in each of those days.
2. a respondent spent not less than 5 days engaging in activities of moderate intensity or spent 30 minutes on walking on each of those days or a combination of both.
3. A respondent achieves up to 600 METs-minutes/week from performing any of the combination of walking, moderate- or vigorous-intensity activities over a 5 days period or more.

**Low PA Level:** Respondent were classified as having low PA patterns when they failed to meet any of the criteria for either high or moderate PA levels.

### 3.9.3 Anthropometric Analyses

Anthropometric measurements were used to derive individual and appropriate anthropometric indices. Indices were compared with reference standard values to ascertain the subject's status. The BMI was computed from weight (kg) and height (m) measurements using the formula below

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height}^2\ \text{(m)}}$$

Individual BMI values were classified based on the WHO classifications. Body Mass Index less than 18.50kg/m$^2$ corresponded to underweight; values between 18.50 to 24.99kg/m$^2$ represented normal body weight; values between 25.00 to 29.99kg/m$^2$ fell among those classified as overweight; and values between 30.00 to 34.99kg/m$^2$, 35.00 to 39.99kg/m$^2$ and ≥40kg/m$^2$ were categorised as Grade I obesity, Grade II obesity and Grade III obesity (World Health Organization, 2000).

Waist circumference measurement served as the basis for classifying participants according to the risk of metabolic complications (World Health Organisation, 2011). Males with waist circumference greater than 94 cm were classified as having increased risk of metabolic complications, those with a waist circumference greater than 102 cm were categorised as being at substantially increased risk of metabolic complications. Females with waist circumferences more than 80 cm and 88 cm were classified as having increased and substantially increased risk of metabolic complications respectively.

Measurements of hip circumference were used to calculate Waist-Hip ratio of respondents according to the WHO guidelines (WHO, 2011). The waist-hip ratio was derived by dividing waist circumference values by hip circumference, as shown below

$$\text{WHR} = \frac{\text{Waist circumference (cm)}}{\text{Hip circumference (cm)}}$$

Males with waist-hip ratios up to and more than 0.90 fell among those classified as having increased risk of metabolic disorders. Females with waist-hip ratios up to and more than 0.85 were classified as having an increased risk of metabolic disorders.

### 3.9.4 Blood Pressure Analyses

Blood pressure measurements of respondents were categorised according to the updated eighth Joint National Committee (JNC-8) guideline recommendations on prevention, detection, evaluation and treatment of Hypertension (James *et al*., 2014). Systolic and diastolic blood pressures less than 120mmHg and 80mmHg were classified as normal; systolic blood pressure between 120 - 139 mmHg and or diastolic blood pressure between 80 - 89 mmHg were classified as prehypertension. Stage I hypertension was considered as SBP between 140-159 mmHg and or DBP between 90 – 99 mmHg. Stage II hypertension referred to as SBP ≥160 mmHg and or DSP ≥100mmHg.

### 3.9.5 Statistical Analyses

All data were analysed using the IBM-SPSS statistical software package, version 20. Data cleaning was performed by running preliminary frequencies and descriptive statistics of all variables to identify values not rightly entered as well as the outliers. Entries with incomplete values were excluded from the data set. Results reported the number and percentages of respondents for categorical variables. Statistical significance was determined at $\alpha_{0.05}$. Findings on nutrients intake adequacy were presented in mean±SD. Independent samples t-test was conducted to examine differences in mean intakes among adults between the two States at significance level $\alpha_{0.05}$. Results on individual components of DQI-I as well as overall diet quality were presented in mean ± standard deviation. Diet quality scores were categorized into terciles: first tercile (T1) represented low diet quality, second tercile (T2) represented average diet quality, and third tercile (T3) represented high diet quality. The proportion of individuals who scored low, average and high categories were reported in number and percentages. Statistical differences in mean diet quality scores between States were determined using the independent samples T-Test. Chi-Square test and multiple logistic regressions were conducted to assess relationships between diet quality and socio-demographic characteristics.

Results on physical activity were presented in median values with interquartile ranges. The proportion of individuals who scared low, moderate and high PA were reported in number and percentages. Differences in PA METs-minutes/week scores between States and sexes were determined at $\alpha_{0.05}$ level using Wilcoxon Mann-Whitney U Test. Chi-Square test and multiple logistic regression were conducted to assess relationships between PA levels and socio-demographic characteristics.

Prevalence of obesity measured by each anthropometric index was presented in number and percentages. Chi-Square test and multiple logistic regressions were conducted to assess relationships between obesity and socio-demographic characteristics. Results on blood pressure measurements were presented in mean (±SD). Prevalence of hypertension was reported in number and percentages. Statistical differences in mean blood pressure measurements between States were determined using the independent samples T-Test, while, Chi-Square test and multiple logistic regressions were conducted to assess relationships between obesity and socio-demographic characteristics.

### 3.10.0 Ethical Considerations

Approval for the study was obtained from the Human Ethics Committee of the University of Ibadan/University College Hospital. Each participant gave informed consent prior to respective interviews.

**Confidentiality of data:** All interviews and measurements were carried out with considerations for the respondent's privacy. Information obtained during interviews and measurements were treated with utmost confidentiality and were used for the purpose of the research only. No information obtained from any respondent during the course of this study was disclosed to any person or groups of persons other than the purpose of the research.

**Translation of protocol to the local language:** All sections of the study instrument were translated into the local language of the respondents (Appendix IV)

**Beneficence to participants:** Information on anthropometric and blood pressure measurements were disclosed to respective participants. Participants with the need for any intervention or treatment were directed to the appropriate institutions for such.

**Non–maleficence to participants:** No procedure of this research was associated with any known risk. Participants were in no condition exposed to non-maleficence.

**Voluntariness:** Interviews and measurements were only conducted after each participant had given an informed consent to take part in the study. Hence participation in the study, from the beginning to the end was voluntary. Each respondent had the right to refuse to take part in the study or to withdraw participation in the course of the study.

# CHAPTER FOUR
# RESULTS

## 4.1 Socio-demographic Characteristics of adults in Akwa Ibom and Cross River States, Nigeria

Findings on socio-demographic characteristics of respondents in the study are presented in Table 4.1. A total of 1,320 adults participated in this study; 55.5% from Akwa Ibom and 44.5% from Cross River States, respectively. Majority, (65.0%) resided in rural communities. A total of 50.4% were females and mean age of adults in the study was 35.4±11.2 years. Participants were predominantly Christians- 99.0%. Mean household size was 5.2±3.0. Majority, (66.1%) were at most forty years. Majority attained either secondary education (52.1%) or tertiary education 21.3%. Major occupations included farming/fishing (27.0%), registered businesses and artisans (15.5%), whereas a good proportion were not currently employed (26.0%). A total of 71.4% came from households with estimated monthly income ≤ N20, 000.00. Married adults constituted 54.0% of the population. A total of 58.5% were Ibibios, 39.24% were either Efik/Ejagham ethnicity, (Table 4.1b).

**Table 4.1a: Socio-demographic Characteristics of Adults in Akwa Ibom and Cross River States, Nigeria**

| Characteristics | n (%) |
|---|---|
| **State** | |
| Akwa Ibom | 733 (55.5) |
| Cross River | 587 (44.5) |
| **Residence** | |
| Rural | 858 (65.0) |
| Urban | 463 (35.0) |
| **Household size** | |
| Mean ±SD | 5.2±3.0 |
| ≤ 5 | 786 (59.6) |
| > 5 | 534 (40.5) |
| **Sex** | |
| Male | 655 (49.6) |
| Female | 665 (50.4) |
| **Age (years)** | |
| Mean ±SD | 35.4±11.1 |
| 20 - 39 | 872 (66.1) |
| ≥ 40 | 448 (33.9) |
| **Formal Education** | |
| None | 65 (4.9) |
| Primary | 286 (21.7) |
| Secondary | 688 (52.1) |
| Tertiary | 281 (21.3) |
| **Employment** | |
| Yes | 1006 (76.2) |
| No | 314 (23.8) |
| **Primary Occupation** | |
| Civil/Public Servant | 40 (3.0) |
| Registered Business/Artisan | 204 (15.5) |
| Farming/Fishing | 357 (27.0) |
| Home Maker | 166 (12.6) |
| Others | 178 (13.5) |
| Not Currently Employed | 343 (26.0) |

*n (%) – Number (Percentage)*

**Table 4.1b: Socio-demographic Characteristics of Adults in Akwa Ibom and Cross River States, Nigeria**

| Characteristics | n (%) |
|---|---|
| **Estimated Household Income** | |
| ≤ ₦20,000.00 | 942 (71.4) |
| > ₦20,000.00 | 378 (28.6) |
| | |
| **Marital Status** | |
| Single | 479 (36.3) |
| Married | 714 (54.1) |
| Divorced | 14 (1.1) |
| Separated | 15 (1.1) |
| Widowed | 98 (7.4) |
| | |
| **Ethnic Origin** | |
| Ibibio | 772 (58.48) |
| Efik/Ejagham | 518 (39.24) |
| Others | 30 (2.27) |
| | |
| **Religion** | |
| Christianity | 1307 (99.1) |
| Islam | 12 (0.9) |

*n (%) – Number (Percentage)*

## 4.2 Specific Objective One: To assess nutrient adequacy of adults in AK and CR States, Nigeria.

1. Dietary intake assessments were conducted using multi-pass (4 steps) 24-hour dietary recall.
2. Information on dietary intakes were used to derive energy and nutrient values using an adapted TDA software, version 3.0.
3. Energy and nutrients intake adequacy were determined by comparing mean intake values with the FAO/WHO/UNU Recommended Nutrient Intakes (RNIs).
4. Results were presented as mean±SD
5. Independent samples t-test was conducted to examine differences in mean intakes among adults between the two States at significance level $\alpha_{0.05}$.

### 4.2.1. Energy and Nutrient Intake Adequacy among Adults in AK and CR States, Nigeria

There were inadequate energy intake among adults in this study, (Table 4.2a). Adequate energy intakes were observed only among females 60 years old and above (115.3%). Energy intake adequacy ranged from 81.2% among males 20 to 29 years old to 95.7% among females aged 30 to 59 years, (Table 4.2a). Results indicate higher mean energy intake values among adults living in Cross River State (CRS) when compared to those in Akwa Ibom State (AKS). Mean energy intake was significantly higher among males, 30 to 59 years (2278.8kcal in CRS vs. 2048.4kcal in AKS, $p = 0.002$), females 20 to 29 years (2380.1kcal in CRS vs. 2059.2kcal in AKS, $p = 0.008$) and females 30 to 59 years (2234.3kcal in CRS vs. 2000.5kcal in AKS) living in Cross River State than those in Akwa Ibom State. Both males and females attained adequate protein intakes, 123.1% and 122.2% respectively. Likewise, mean protein intakes were higher among both males (72.5±43.4g in CRS vs 62.3±36.8g, $p = 0.002$) and females (68.7±41.3g in CRS vs. 60.7±35.1g in AKS, $p = 0.008$) living in CRS, when compared to those in AKS.

There were inadequate carbohydrate intakes among males in this study. Among males, adequacy ranged from 92.3% among those aged 20 to 29 years to 95.1% among males aged 60 years and above. Females attained adequacy in carbohydrate intakes, ranging from 103.3% among those aged 20 to 29 years to 139.1% among females aged 60 years and above. Mean carbohydrate intake values were significantly higher in CRS than those reported in AKS for both males and females across all age groups ($p < 0.05$), except for adults 60 years and above. Males, 20 to 29 years old in CRS had significantly higher carbohydrate intakes (380.0±148.7g vs. 337.7±159.2g in AKS, $p = 0.046$) than those in AKS. Carbohydrate intake was also higher among males 30 to 59 years (355.6±163.3g in CRS vs. 317.7±156.0g in AKS, $p = 0.003$), females, 20 to 29 years (380.5±178.5g in CRS vs. 310.5±133.0g in AKS) and females 30 to 59 years old (355.1±177.0g in CRS vs. 310.3±145.4g in AKS, $p = 0.000$) living in CRS than those in AKS.

Adequacy in fat intake ranged from 103.8% among males 60 years old and above to 146.7% among females 60 years old and above. Fat intake values did not differ significantly among both males and females in any of the age categories between the two States, $p > 0.05$.

There were inadequate intake of dietary fibre across both sex and age groups in this study, (Table 4.2b). Adequacy ranged from 45.5% among males aged 20 - 50 years to 87.1% among females 50 years and above. Dietary fibre intakes did not differ significantly among both males and females in any of the age categories between the two States, $p > 0.05$.

Vitamin A intakes were slightly inadequate (94.2%) among males in this study, whereas females attained adequate vitamin A intakes (117.5%). Overall mean vitamin A intake among males was 565.2±416.0 RAE, whereas, 587.7±501.1RAE was recorded among females. Vitamin A intakes did not differ significantly among both males and females in any of the age categories between the two States, $p > 0.05$. Results indicate adequate intakes of vitamin C (228.7%) among adults in this study. The Overall mean intake value was 102.9±76.4mg. Vitamin C intake was significantly higher among adults in AKS (107.2±82.9mg) than those in CRS (97.5±67.0mg), $p = 0.023$. The Overall mean intake of vitamin B1 in this study was 1.0±0.6mg among males and 1.0±0.5mg among females. Intakes were slightly inadequate among both males (83.3%) and females (90.9%). There were similarity in intake levels among adults in both States, $p > 0.05$. There were inadequate intakes of vitamin B2 among both males (76.9%) and females (90.9%) in this study. While there were no significant differences in mean values among females, $p = 0.207$, the mean intake values among males between AKS (1.0±1.1mg) and CRS (0.8±0.7) were significantly different, $p = 0.002$.

The mean intake value for vitamin B3 was slightly inadequate among males (91.9%) but adequate among females (105.0%). However, intakes did not differ significantly among both males and females in any of the age categories between the two States, $p > 0.05$. There were adequate intakes of vitamin B6 among adults in this study. However, the mean intake value (1.6±1.0mg) among males above 50 years old was slightly inadequate, 94.1%. Males, aged 20 to 50 years had adequate intake level of 123.1%. Among females, adequacy ranged from 126.7% among females 51 years and above to 138.5% among those 20 to 50 years old. The mean intake values for vitamin B6 differed significantly only among females aged 20 to 50 years between the States, $p = 0.031$.

Folate intake (352.5±309.4 µg) was inadequate among adults in this study (88.1%), Table 4.2c. However, adults in AKS had significantly higher intake value (420.2±455.4 µg) than those in CRS (268.0±266.6 µg), $p < 0.001$. The mean intake value (4.0±3.1 µg) for vitamin B12 among adults in this study exceeded the recommended intake value (2.4 µg), giving adequate intake level of 166.7%. This was observed for both States, although, the mean intake value in CRS (4.2±3.1 µg) was significantly higher than that in AKS (3.7±3.0 µg), $p < 0.001$, (Table 4.2c).

The overall mean calcium intake among males was 394.2±279.6mg. Among females, 378.8±264.4mg mean calcium intake was recorded among those aged 20 to 50 years old, whereas, females aged 51 years and above had mean calcium intake of 449.6±327.3mg. Calcium intake adequacy was low among adults, ranging from 34.6% among females aged 51 years and above to 39.4% among males. Also, mean calcium intakes were significantly higher among males (424.5±295.7mg in AKS vs. 356.4±253.4mg in CRS, $p = 0.002$) and females aged 20 to 50 years old (401.1±278.6mg in AKS vs. 350.9±243.1mg in CRS, $p = 0.020$) living in AKS than those in CRS. Magnesium intakes were adequate among adults in this study, 114.4% among males and 140.1% among females. Likewise, there were adequate zinc intakes, 170.0% among males and 230.6% among females. There were no significant differences in mean magnesium and zinc intakes among adults between AKS and CRS, $p > 0.05$. There were adequate intakes of iron among adults, except for females 20 to 50 years of age. Adequacy in iron intake was 153.6% among males and 193.3% among females aged 51 years and above. However, females 20 to 50 years old had 67.9% adequacy in iron intake. Results indicated significantly higher mean intakes among adults in AKS for males (18.3±12.4mg in AKS vs. 15.1±8.3mg in CRS, $p = 0.000$), females, 20 – 50 years old (17.2±12.1mg in AKS vs. 15.2±10.7mg in CRS, $p = 0.030$) and females, 51-65 (20.0±14.7mg in AKS vs. 14.4±6.7mg in CRS, $p = 0.049$) living in AKS than those in CRS.

**Table 4.2a: Energy and Nutrient Intake Adequacy among Adults in Akwa Ibom and Cross River States, Nigeria**

| Components | | | Requirement for age (years) and sex | Akwa Ibom Mean Intake | Akwa Ibom IREQ | Cross River Mean Intake | Cross River IREQ | Total Mean Intake | Total IREQ | p-value |
|---|---|---|---|---|---|---|---|---|---|---|
| Energy (Kcal) | M | 18-29.9 | 2800 | 2180.4±970.0 | 77.9 | 2407.7±884.6 | 86.0 | 2274.6±940.3 | 81.2 | 0.072 |
| | | 30-59.9 | 2600 | 2048.4±937.8 | 78.8 | 2278.8±924.4 | 87.6 | 2150.7±938.2 | 82.7 | 0.002 |
| | | ≥60 | 2150 | 2048.4±937.8 | 95.3 | 1969.3±807.9 | 91.6 | 1813.9±729.2 | 84.4 | 0.085 |
| | F | 18-29.9 | 2400 | 2059.2±805.2 | 85.8 | 2380.1±985.8 | 99.2 | 2198.1±900.1 | 91.6 | 0.008 |
| | | 30-59.9 | 2200 | 2000.5±869.8 | 90.9 | 2234.3±932.1 | 101.6 | 2104.5±904.9 | 95.7 | 0.001 |
| | | ≥60 | 1950 | 2238.6±1137.5 | 114.8 | 2254.6±1103.8 | 115.6 | 2247.4±1098.8 | 115.3 | 0.970 |
| Protein (g) | M | | 49.1 | 62.3±36.8 | 114.8 | 72.5±43.4 | 133.6 | 66.8±40.1 | 123.1 | 0.002 |
| | F | | 47.5 | 60.7±35.1 | 115.5 | 68.7±41.3 | 130.8 | 64.2±38.1 | 122.2 | 0.008 |
| Carbohydrate (g) | M | 19-29.9 | 385.0 | 337.7±159.2 | 87.7 | 380.0±148.7 | 98.7 | 355.3 ±156.0 | 92.3 | 0.046 |
| | | 30-59.9 | 357.5 | 317.7±156.0 | 88.9 | 355.6±163.3 | 99.5 | 334.6±160.3 | 93.6 | 0.003 |
| | | ≥60 | 295.6 | 252.9±103.2 | 85.6 | 296.9±135.2 | 100.4 | 281.2±124.6 | 95.1 | 0.381 |
| | F | 18-29.9 | 330.0 | 310.5±133.0 | 94.1 | 380.5±178.5 | 115.3 | 340.8±157.9 | 103.3 | 0.001 |
| | | 30-59.9 | 302.5 | 310.3±145.4 | 102.6 | 355.1±177.0 | 117.4 | 330.2±161.6 | 109.2 | 0.000 |
| | | ≥60 | 268.1 | 403.9±197.5 | 150.7 | 347.9±191..8 | 129.8 | 373.0±192.9 | 139.1 | 0.447 |
| Fat (g) | M | 19-29.9 | 62.2 | 81.8±49.6 | 131.5 | 70.9±36.1 | 114.0 | 77.2±44.7 | 124.1 | 0.075 |
| | | 30-59.9 | 57.8 | 73.6±46.9 | 127.3 | 67.6±39.9 | 117.0 | 70.9±44.0 | 122.7 | 0.087 |
| | | ≥60 | 47.8 | 44.8±28.6 | 93.7 | 52.2±34.6 | 109.2 | 49.6±32.2 | 103.8 | 0.573 |
| | F | 19-29.9 | 53.3 | 74.9±39.6 | 140.5 | 73.9±37.3 | 138.6 | 74.5±38.6 | 139.8 | 0.848 |
| | | 30-59.9 | 48.9 | 72.3±40.6 | 147.9 | 67.3±38.8 | 137.6 | 70.1±40.0 | 143.4 | 0.108 |
| | | ≥60 | 43.3 | 65.8±33.9 | 152.0 | 61.6±38.0 | 142.3 | 63.5±35.7 | 146.7 | 0.761 |

*IREQ = Intakes as percentage requirement*; *M= Male*; *F = Female*

**Table 4.2b: Energy and Nutrient Intake Adequacy among Adults in Akwa Ibom and Cross River States, Nigeria**

| Components | Requirement for age (years) and sex | | | Akwa Ibom | | Cross River | | Total | | p-value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Mean Intake | IREQ | Mean Intake | IREQ | Mean Intake | IREQ | |
| Fibre (g) | M | 19-50 | 38 | 16.8±11.3 | 44.2 | 18.0±14.4 | 47.4 | 17.3±12.7 | 45.5 | 0.263 |
| | | > 50 | 30 | 15.0±12.3 | 50.0 | 15.1±11.0 | 50.3 | 15.7±11.5 | 52.3 | 0.682 |
| | F | 19-50 | 25 | 17.5±11.3 | 70.0 | 17.2±10.5 | 68.8 | 17.4±11.0 | 69.6 | 0.730 |
| | | > 50 | 21 | 19.0±11.5 | 90.5 | 17.4±13.0 | 82.9 | 18.3±12.2 | 87.1 | 0.562 |
| Vitamin A (RAE) | M | | 600 | 568.1±463..1 | 94.7 | 561.5±349.1 | 93.6 | 565.2±416.0 | 94.2 | 0.842 |
| | F | | 500 | 617.3±531.0 | 123.5 | 550.8±459.3 | 110.2 | 587.7±501.1 | 117.5 | 0.084 |
| Vitamin C (mg) | | | 45 | 107.2±82.9 | 238.2 | 97.5±67.0 | 216.7 | 102.9±76.4 | 228.7 | 0.023 |
| Thiamine (mg) | M | | 1.2 | 1.0±0.6 | 83.3 | 1.0±0.6 | 83.3 | 1.0±0.6 | 83.3 | 0.637 |
| | F | | 1.1 | 1.0±0.6 | 90.9 | 1.0±0.5 | 90.9 | 1.0±0.5 | 90.9 | 0.952 |
| Riboflavin (mg) | M | | 1.3 | 1.0±1.1 | 76.9 | 0.8±0.7 | 61.5 | 1.0±0.9 | 76.9 | 0.002 |
| | F | | 1.1 | 1.0±1.1 | 90.9 | 0.9±0.8 | 81.8 | 1.0±0.9 | 90.9 | 0.207 |
| Niacin (mg) | M | | 16 | 14.9±8.7 | 93.1 | 14.6±8.8 | 91.3 | 14.7±8.7 | 91.9 | 0.777 |
| | F | | 14 | 14.8±8.6 | 105.7 | 14.6±8.5 | 104.3 | 14.7±8.5 | 105.0 | 0.793 |
| Vitamin B6 (mg) | M | 19-50 | 1.3 | 1.6±1.0 | 123.1 | 1.8±1.3 | 138.5 | 1.6±1.2 | 123.1 | 0.06 |
| | | >50 | 1.7 | 1.3±0.5 | 76.5 | 1.7±1.2 | 100.0 | 1.6±1.0 | 94.1 | 0.065 |
| | F | 19-50 | 1.3 | 1.5±1.0 | 115.4 | 1.9±1.4 | 161.5 | 1.8±1.3 | 138.5 | 0.031 |
| | | 51-65 | 1.5 | 1.9±1.1 | 126.7 | 1.9±1.1 | 126.7 | 1.9±1.1 | 126.7 | 0.933 |

*IREQ = Intakes as percentage requirement*; *M= Male*; *F = Female*

**Table 4.2c: Energy and Nutrient Intake Adequacy among Adults in Akwa Ibom and Cross River States, Nigeria**

| Components | Requirement for age (years) and sex | | | Akwa Ibom Mean Intake | IREQ | Cross River Mean Intake | IREQ | Total Mean Intake | IREQ | p-value |
|---|---|---|---|---|---|---|---|---|---|---|
| Folate (µg) | | | 400 | 417.4±449.6 | 105.1 | 268.0±266.6 | 67.0 | 352.5±309.4 | 88.1 | 0.000 |
| Vitamin B12 (µg) | | | 2.4 | 3.7±3.0 | 154.2 | 4.2±3.1 | 175.0 | 4.0±3.1 | 166.7 | 0.000 |
| Calcium (mg) | M | | 1000 | 424.5±295.7 | 42.5 | 356.4±253.4 | 35.6 | 394.2±279.6 | 39.4 | 0.002 |
| | F | 19-50 | 1000 | 401.1±278.6 | 40.1 | 350.9±243.1 | 35.1 | 378.8±264.4 | 37.9 | 0.020 |
| | | 51-65 | 1300 | 488.2±359.1 | 37.6 | 404.1±283.9 | 31.1 | 449.6±327.3 | 34.6 | 0.271 |
| Magnesium (mg) | M | | 260 | 290.9±154.2 | 111.9 | 305.8±149.4 | 117.6 | 297.5±152.1 | 114.4 | 0.210 |
| | F | | 220 | 308.5±163 | 140.2 | 307.7±147.2 | 139.9 | 308.2±156.3 | 140.1 | 0.946 |
| Zinc (mg) | M | | 7.0 | 12.0±7.4 | 171.4 | 11.8±7.2 | 168.6 | 11.9±7.3 | 170.0 | 0.857 |
| | F | | 4.9 | 11.2±6.5 | 228.6 | 11.7±7.8 | 238.8 | 11.3±7.1 | 230.6 | 0.411 |
| Iron (mg) | M | | 11 | 18.3±12.4 | 166.4 | 15.1±8.3 | 137.3 | 16.9±10.9 | 153.6 | 0.000 |
| | F | 19-50 | 24 | 17.2±12.1 | 71.7 | 15.2±10.7 | 63.3 | 16.3±11.5 | 67.9 | 0.030 |
| | | 51-65 | 9 | 20.0±14.7 | 222.2 | 14.4±6.7 | 160.0 | 17.4±12.0 | 193.3 | 0.049 |

*IREQ = Intakes as percentage requirement*; *M= Male*; *F = Female*

### 4.2.2: Energy and Nutrient Intake Values among Adult Males and Females in AK and CR States, Nigeria

Table 4.3 presents findings on mean nutrients intakes among adults in this study. The overall mean energy intake values for adults in different age categories in this study were 2235.0±919.5kcal, 2127.5±921.5kcal and 2034.5±952.8kcal among adults aged 20 - 29 years, 30 - 59 years and those ≥ 60 years, respectively. Mean energy intake values were not different between males and females in all three age categories, $p > 0.05$. Although, protein intake value was higher among males (66.8±40.1g among males vs. 64.2±38.1g among females), the difference in protein intake between males and females was not statistically significant, $p = 0.227$. Overall mean carbohydrate intake value in the study among adults aged 20 - 29 years, 30 - 59 years and ≥ 60 years were 347.8±157.0g, 332.4±160.9g and 327.9±168.0g, respectively. Both males and females under the age of 60 years had similar carbohydrate intakes, $p > 0.05$. However, among adults ≥ 60 years, carbohydrate intake values were significantly higher among females (373.0±192.9g among females vs. 281.2±124.6g among males, $p = 0.037$).

The overall mean intake value for fat ranged from 56.6±34.4g among adults 60 years and above to 75.8±41.6g among those 20 to 29 years. Likewise, the mean intake values for dietary fibre did not differ significantly between males and females in the study, $p > 0.05$. Overall mean intake values for vitamin A, vitamin C. vitamins B1, B2 and B3 were 576.5±460.8 RAE, 102.9±76.4mg, 1.0±0.6mg, 0.9±1.2mg and 14.7±8.6mg, respectively. Results indicated similar mean intake values between males and females for all vitamin A, vitamin C. vitamins B1, B2 and B3, $p > 0.05$. Vitamin B6 intakes were higher among females for both age categories; 1.8±1.3mg and 1.9±1.1mg for females aged 20 to 50 years and ≥51 years, whereas males in both age categories had mean intake values of 1.6±1.2mg and 1.6±1.0mg, respectively for vitamin B6. There were similar mean intake values for vitamin B6 among males and females, $p > 0.05$.

Mean intake values for folate and vitamin B12 were 351.0±286.4 µg and 4.0±3.1 µg, respectively. Overall mean intake values for calcium, magnesium, zinc and iron among adults in this study were 390.4±276.0 mg, 302.9±276.0 mg, 11.6±7.2 mg and 16.7±11.2 mg, respectively. There were no significant differences in mean intake values for all calcium, magnesium, zinc and iron between males and females in the study, $p > 0.05$.

**Table 4.3: Mean Energy and Nutrient Intake Values among Adult Males and Females in Akwa Ibom and Cross River States, Nigeria**

| Components | | Male Mean Intake | Female Mean Intake | Total Mean Intake | p-value |
|---|---|---|---|---|---|
| Energy (Kcal) | 19-29.9 | 2274.6±940.3 | 2198.1±900.1 | 2235.0±919.5 | 0.374 |
| | 30-59.9 | 2150.7±938.2 | 2104.5±904.9 | 2127.5±921.5 | 0.363 |
| | ≥60 | 1813.9±729.2 | 2247.4±1098.8 | 2034.5±952.8 | 0.086 |
| Protein (g) | | 66.8±40.1 | 64.2±38.1 | 65.5±39.1 | 0.227 |
| Carbohydrate(g) | 19-29.9 | 355.3 ±156.0 | 340.8±157.9 | 347.8±157.0 | 0.324 |
| | 30-59.9 | 334.6±160.3 | 330.2±161.6 | 332.4±160.9 | 0.625 |
| | ≥60 | 281.2±124.6 | 373.0±192.9 | 327.9±168.0 | 0.037 |
| Fat (g) | 19-29.9 | 77.2±44.7 | 74.5±38.6 | 75.8±41.6 | 0.468 |
| | 30-59.9 | 70.9±44.0 | 70.1±40.0 | 70.5±42.0 | 0.720 |
| | ≥60 | 49.6±32.2 | 63.5±35.7 | 56.6±34.4 | 0.128 |
| Fibre (g) | 19-50 | 17.3±12.7 | 17.4±10.9 | 17.4±11.9 | 0.927 |
| | > 50 | 15.7±11.5 | 18.3±12.2 | 17.0±11.9 | 0.196 |
| Vitamin A (RAE) | | 565.2±416.0 | 587.7±501.1 | 576.5±460.8 | 0.374 |
| Vitamin C (mg) | | 103.9±75.6 | 101.9±77.2 | 102.9±76.4 | 0.267 |
| Thiamine (mg) | | 1.0±0.6 | 1.0±0.5 | 1.0±0.6 | 0.644 |
| Riboflavin (mg) | | 1.0±0.9 | 1.0±0.9 | 0.9±1.2 | 0.592 |
| Niacin (mg) | | 14.7±8.7 | 14.7±8.5 | 14.7±8.6 | 0.994 |
| Vitamin B6 (mg) | 19-50 | 1.6±1.2 | 1.8±1.3 | 1.7±1.2 | 0.614 |
| | >50 | 1.6±1.0 | 1.9±1.1 | 1.7±1.1 | 0.052 |
| Folate (µg) | | 316.8±320.3 | 350.0±368.1 | 351.0±286.4 | 0.081 |
| Vitamin B12 (µg) | | 4.0±3.0 | 3.9±3.1 | 4.0±3.1 | 0.412 |
| Calcium (mg) | | 394.3±279.6 | 386.5±272.5 | 390.4±276.0 | 0.609 |
| Magnesium (mg) | | 297.5±152.1 | 308.2±156.3 | 302.9±276.0 | 0.209 |
| Zinc (mg) | | 11.9±7.3 | 11.4±7.1 | 11.6±7.2 | 0.220 |
| Iron (mg) | | 16.9±10.9 | 16.5±11.6 | 16.7±11.2 | 0.493 |

### 4.3.0 Objective Two: To assess the quality of diets among Adults in AK and CR States, Nigeria.

1. Diet quality was assessed using the DQI-I.
2. Results on individual components as well as overall diet quality were presented as mean ± standard deviation.
3. Diet quality scores were categorized into terciles: first tercile (T1) represented low diet quality, second tercile (T2) represented average diet quality, and third tercile (T3) represented high diet quality.
4. The proportion of individuals who scored low, average and high categories were reported in number and percentages.
5. Statistical differences in mean diet quality scores between States were determined using the independent samples t-Test. Chi-Square test and multiple logistic regressions were conducted to assess relationships between diet quality and socio-demographic characteristics.

### 4.3.1 Diet Quality Scores among Adults in AK and CR States, Nigeria

The mean diet quality score was 56.4±7.4. The total mean score for food variety was 11.4±3.9 out of a maximum of 20 points. Mean scores for overall food group variety and within-group variety for protein sources were 9.5±2.7 and 1.9±1.5 respectively. The mean score for overall dietary adequacy was 24.8±4.9 out of a maximum of 40 points. Values reported for individual States were 24.9±5.3 for Akwa Ibom and 24.6±4.4 for Cross River State. Adequacy in intakes of protein (4.6±0.8), grains/tuber foods (4.7±0.8), iron (4.3±1.2) and Vitamin C (4.0±1.5) contributed most to the mean adequacy score. Participants performed moderately in fibre intake (3.3±1.4) but poorly in fruits (0.3±1.1), vegetables (1.7±1.2) and calcium (1.9±1.2) intakes. The mean moderation score was 19.6±6.0 out of a maximum of 30 points. Participants scored high in cholesterol (5.8±1.0), sodium (4.1±2.4) and empty calorie foods (5.3±1.7), but poorly in total (2.2±2.4) and saturated (2.1±2.6) fats. Overall balance in energy sources was poor (0.7±1.5), most especially in the fatty acid ratio (0.1±0.4), Table 4.4.

**Table 4.4: Diet Quality Scores among Adults in Akwa Ibom and Cross River States, Nigeria**

| DQI-I Components (Score) | Akwa Ibom Mean±SD | Cross River Mean±SD | Total Mean±SD | p-value |
|---|---|---|---|---|
| **Variety (20)** | 11.9±4.1 | 10.8±3.6 | 11.4±3.91 | 0.000* |
| Overall food group variety (15) | 9.8±2.8 | 9.1±2.4 | 9.5±2.67 | 0.000* |
| Within-group Variety for Protein Source (5) | 2.0±1.6 | 1.6±1.4 | 1.8±1.5 | 0.000* |
| **Adequacy (40)** | 24.9±5.3 | 24.6±4.4 | 24.8±4.9 | 0.199 |
| Vegetable group (5) | 1.6±1.3 | 1.7±1.2 | 1.7±1.2 | 0.101 |
| Fruits group (5) | 0.5±1.3 | 0.2±0.7 | 0.3±1.1 | 0.000* |
| Grains/Tubers group (5) | 4.6±0.9 | 4.8±0.7 | 4.7±0.8 | 0.000* |
| Fiber (5) | 3.3±1.34 | 3.2±1.4 | 3.3±1.4 | 0.606 |
| Protein (5) | 4.6±0.8 | 4.6±0.9 | 4.6±0.8 | 0.992 |
| Iron (5) | 4.3±1.2 | 4.2±1.2 | 4.3±1.2 | 0.393 |
| Calcium (5) | 2.0±1.3 | 1.7±1.1 | 1.9±1.2 | 0.000* |
| Vitamin C (5) | 4.01±1.5 | 4.0±1.4 | 4.0±1.5 | 0.806 |
| **Moderation (30)** | 18.3±5.7 | 21.1±5.9 | 19.6±6.0 | 0.000* |
| Total fat (6) | 1.8±2.3 | 2.7±2.4 | 2.2±2.4 | 0.000* |
| Saturated fat (6) | 1.7±2.4 | 2.7±2.7 | 2.1±2.6 | 0.000* |
| Cholesterol (6) | 5.7±1.1 | 5.8±1.0 | 5.8±1.0 | 0.160 |
| Sodium (6) | 3.9±2.5 | 4.5±2.3 | 4.1±2.4 | 0.000* |
| Empty calorie foods (6) | 5.2±1.8 | 5.4±1.6 | 5.3±1.7 | 0.031* |
| **Overall Balance (10)** | 0.5±1.3 | 0.9±1.6 | 0.7±1.5 | 0.000* |
| Macronutrient ratio (6) | 0.5±1.3 | 0.8±1.5 | 0.6±1.4 | 0.000* |
| Fatty acid ratio (4) | 0.0±.3 | 0.1±0.5 | 0.1±0.4 | 0.024* |
| Total DQI-I Score (100) | 55.6±7.5 | 57.3±7.1 | 56.4±7.4 | 0.000* |

**Differences in DQI-I scores between States are statistically significant at* $\alpha_{0.05}$

*DQI-I – Diet Quality Index-International*

### 4.3.2 Diet Quality Scores between Adult Males and Females in AK and CR States, Nigeria

Males and females performed similarly in food variety, 11.4±3.8 for males and 11.3±4.0 for females. Mean intake values for individual sub-components under variety were also not different between males and females. The mean score for the adequacy component was significantly higher among males (25.1±4.6) than females (24.4±5.1), $p<0.05$. Under this component, males scored significantly higher in iron intakes (4.8±0.7) than females (3.7±1.3), while females had significantly higher mean scores for fruits (0.4±1.3) and vitamin C (4.1±1.5) intakes than males (0.3±1.01) and (3.9±1.5) respectively, $p<0.05$. As well, there were similar intake values for total moderation and most of the moderation sub-components between males and females. However, females (5.5±1.4) scored significantly higher in moderate consumption of empty calorie foods than males (5.1±1.9), $p<0.001$. Both males and females had good performances in moderate intakes of cholesterols, sodium and empty calorie foods. Moderations in total and saturated fats were low for both sexes. Total mean values for overall balance and respective components (macronutrient and fatty acid ratios) were not different between males and females. Likewise, the total DQI-I score was similar among males and females, $p>0.05$, Table 4.5.

**Table 4.5: Diet Quality Scores between Adult Males and Females in Akwa Ibom and Cross River States, Nigeria**

| DQI-I Components (Score) | Male Mean±SD | Female Mean±SD | p-value |
|---|---|---|---|
| **Variety (20)** | 11.4±3.8 | 11.3±4.0 | 0.501 |
| Overall food group variety (15) | 9.6±2.6 | 9.46±2.7 | 0.564 |
| Within-group Variety for Protein Source (5) | 1.9±1.5 | 1.83±1.6 | 0.475 |
| **Adequacy (40)** | 25.1±4.6 | 24.4±5.1 | 0.005* |
| Vegetable group (5) | 1.7±1.2 | 1.7±1.2 | 0.767 |
| Fruits group (5) | 0.3±1.0 | 0.4±1.3 | 0.013* |
| Grains/Tubers group (5) | 4.7±0.8 | 4.7±0.9 | 0.546 |
| Fiber (5) | 3.2±1.4 | 3.3±1.4 | 0.280 |
| Protein (5) | 4.6±0.8 | 4.6±0.8 | 0.559 |
| Iron (5) | 4.8±0.7 | 3.7±1.3 | 0.000* |
| Calcium (5) | 1.9±1.2 | 1.9±1.2 | 0.402 |
| Vitamin C (5) | 3.9±1.5 | 4.1±1.5 | 0.040* |
| **Moderation (30)** | 19.5±6.1 | 19.7±5.9 | 0.528 |
| Total fat (6) | 2.3±2.4 | 2.1±2.4 | 0.251 |
| Saturated fat (6) | 2.2±2.6 | 2.1±2.5 | 0.745 |
| Cholesterol (6) | 5.8±1.1 | 5.9±1.0 | 0.647 |
| Sodium (6) | 4.2±2.4 | 4.1±2.5 | 0.898 |
| Empty calorie foods (6) | 5.1±1.9 | 5.5±1.4 | 0.000* |
| **Overall Balance (10)** | 0.7±1.4 | 0.7±1.5 | 0.862 |
| Macronutrient ratio (6) | 0.6±1.4 | 0.6±1.4 | 0.963 |
| Fatty acid ratio (4) | 0.0±0.4 | 0.1±0.4 | 0.818 |
| Total DQI-I Score (100) | 56.7±7.5 | 56.0±7.2 | 0.090 |

**Differences in DQI-I scores between males and females are statistically significant at* $\alpha_{0.05}$

*DQI-I – Diet Quality Index-International*

#### 4.3.3.1.1 Associations between Socio-demographic Characteristics and Diet Quality among Adults in AK and CR States, Nigeria

Reports on associations of diet quality with socio-demographic characteristics are presented in Table 4.6. A significantly higher proportion of adults from Akwa Ibom State (38.9%), compared to (26.2%) in Cross River State had low diet quality. Higher proportion of adults from the rural residence had low diet quality (36.6%), when compared to those in the urban area (27.1%), $p < 0.001$. Compared to those from Efik/Ejagham ethnicity (25.1%), a significantly higher proportion of adults from the Ibibio ethnicity (38.5%) were found to have low diet quality. Likewise, higher proportions of adults from the Efik/Ejagham ethnicity had high diet quality (40.2%) than adults from the Ibibio ethnic group (28.6%), $p = 0.000$.

There was no association between diet quality and respondents' sex in this study, $p = 0.134$. About 34.6% of adults aged ≤ 40 years and 29.8% of those aged > 40 years scored low in diet quality. No significant associations existed between age and diet quality, $p = 0.219$. No significant association existed between employment status and diet quality, $p = 0.414$, although 30.9% of unemployed adults, compared to 34.0% of those who were employed, had low diet quality. About 34.1% of adults with ≤ N20, 000.00 estimated household monthly income scored low in diet quality, against 31.2% found among those with > N20, 000.00 estimated household monthly income, $p > 0.05$. Compared to married adults(30.8%), a higher proportion (37.6%) of the singles had low diet quality. Diet quality did not differ by marital status, $p = 0.158$.

**Table 4.6a: Associations between Socio-demographic Characteristics and Diet Quality among Adults in Akwa Ibom and Cross River States, Nigeria**

| Characteristics | DQI Low n (%) | Average n (%) | High n (%) | p-value |
|---|---|---|---|---|
| **State** | | | | |
| Akwa Ibom | 285 (38.9) | 231 (31.5) | 217 (29.6) | 0.000* |
| Cross River | 154 (26.2) | 209 (35.6) | 224 (38.1) | |
| **Residence** | | | | |
| Rural | 314 (36.6) | 290 (33.8) | 254 (29.6) | 0.000* |
| Urban | 125 (27.1) | 150 (32.5) | 187 (40.5) | |
| **Household Size** | | | | |
| ≤ 5 | 267 (34.0) | 265 (33.7) | 254 (32.3) | 0.584 |
| > 5 | 172 (32.2) | 175 (32.8) | 187 (35.0) | |
| **Sex** | | | | |
| Male | 202 (30.8) | 232 (35.4) | 221 (33.7) | 0.134 |
| Female | 237 (35.6) | 208 (31.3) | 220 (33.1) | |
| **Age (years)** | | | | |
| 20 - 39 | 301 (34.5) | 285 (32.7) | 286 (32.8) | 0.443 |
| ≥ 40 | 139 (31.0) | 155 (34.6) | 154 (34.4) | |
| **Education** | | | | |
| None | 23 (35.4) | 20 (30.8) | 22 (33.9) | 0.683 |
| Primary | 99 (34.6) | 89 (31.1) | 98 (34.3) | |
| Secondary | 221 (32.1) | 246 (35.8) | 221 (32.1) | |
| Tertiary | 96 (34.2) | 85 (30.3) | 100 (35.6) | |
| **Employment** | | | | |
| Yes | 342 (34.0) | 337 (33.5) | 327 (32.50) | 0.414 |
| No | 97 (30.9) | 103 (32.8) | 114 (36.3) | |
| **Estimated Household Income** | | | | |
| ≤ ₦20,000.0 | 321 (34.1) | 314 (33.3) | 307 (32.6) | 0.516 |
| > ₦20,000.0 | 118 (31.2) | 126 (33.3) | 134 (35.5) | |

**Differences in characteristic across diet quality terciles is significant at* $\alpha_{0.05}$
*n (%) – Number (Percentage)*

**Table 4.6b: Associations between Socio-demographic Characteristics and Diet Quality among Adults in Akwa Ibom and Cross River States, Nigeria**

| Characteristics | DQI<br>Low (T1)<br>n (%) | <br>Average (T2)<br>n (%) | <br>High (T3)<br>n (%) | p-value |
|---|---|---|---|---|
| **Marital Status** | | | | |
| Single | 180 (37.6) | 153 (31.9) | 146 (30.5) | 0.158 |
| Married | 220 (30.8) | 243 (34.0) | 251 (35.2) | |
| Widowed[@] | 39 (30.7) | 44 (34.7) | 44 (34.6) | |
| | | | | |
| **Ethnic Origin** | | | | |
| Ibibio | 297 (38.5) | 254 (32.9) | 221 (28.6) | 0.000* |
| Efik/ Ejagham | 297 (25.1) | 254 (34.8) | 221 (40.2) | |
| Others | 12 (40.0) | 6 (20.0) | 12 (40.0) | |

*@ - includes divorced and separated individuals*

**Differences in characteristic across diet quality terciles is significant at* $\alpha_{0.05}$

*n (%) – Number (Percentage)*

#### 4.3.3.1.2 : Associations of Physical Activity, BMI, WC, WHR and Hypertension with Diet Quality among Adults in AK and CR States, Nigeria

Findings on associations of physical activity, obesity and hypertension with diet quality are presented in Table 4.7. No significant association existed between diet quality and PA among both males and females in the study, $p > 0.05$. There were no significant interactions between diet quality and overweight/obesity (OW/OB) among both males and females in the study, $p > 0.05$. However, prevalence of both overweight and obesity seemed to increase with increasing diet quality among males. A total of 24.8%, 34.2% and 41.0% of overweight males had low, moderate and high diet quality, respectively. Likewise, 34.0%, 34.2% and 41.0% of obese males had low, moderate and high diet quality, respectively. The reverse was the case among females. Though not statistically significant ($p > 0.05$), prevalence of obesity showed an inverse association with diet quality among females in the study. A total of 36.9%, 31.5% and 31.5% of obese females had low, moderate and high diet quality.

There were no significant relationships between diet quality and WC among both males and females, $p > 0.05$. However, there was an indication for a direct association between increased WC and higher diet quality among males, $p > 0.05$. A total of 31.0% of males with increased WC attained low diet quality, when compared to 34.5% of males with moderate diet quality and another 34.5% with high diet quality. Among females, prevalence of increased WC (35.5%) was higher among those with low diet quality, when compared to females with moderate (32.2%) or high (32.3%) diet quality, $p > 0.05$. Also, diet quality did not have any significant interactions with increased WHR in this study, $p > 0.05$. Although the prevalence of hypertension was higher among adults with higher diet quality, this observation was only significant among females, $p = 0.035$. While 28.0% of females with low diet quality had hypertension, up to 36.6% and 35.4% of those with moderate and high diet quality had hypertension, respectively.

**Table 4.7: Associations of Physical Activity, BMI, WC, WHR and Hypertension with Diet Quality among Adults in Akwa Ibom and Cross River States, Nigeria**

| | DQI-I | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Males** | | | | **Females** | | | |
| Components | **Low n (%)** | **Moderate n (%)** | **High n (%)** | **p-value** | **Low n (%)** | **Moderate n (%)** | **High n (%)** | **p-value** |
| **Physical Activity (METs-min/wk)** | | | | 0.950 | | | | 0.508 |
| Low | 18 (28.6) | 21 (33.3) | 24 (38.1) | | 22 (34.4) | 24 (37.5) | 18 (28.1) | |
| Moderate | 57 (31.8) | 63 (35.2) | 59 (33.0) | | 72 (33.8) | 62 (29.1) | 79 (37.1) | |
| High | 127 (30.8) | 149 (36.1) | 137 (33.2) | | 144 (37.1) | 121 (31.2) | 123 (31.7) | |
| **BMI (kg/m$^2$)** | | | | 0.311 | | | | 0.699 |
| Underweight | 14 (28.6) | 14 (28.6) | 21 (42.9) | | 20 (39.2) | 16 (31.4) | 15 (29.4) | |
| Normal weight | 141 (32.3) | 160 (36.7) | 135 (31.0) | | 125 (35.8) | 100 (28.7) | 124 (35.5) | |
| Overweight | 29 (24.8) | 40 (34.2) | 48 (41.0) | | 52 (33.8) | 56 (36.4) | 46 (29.9) | |
| Obese | 18 (34.0) | 19 (34.2) | 48 (41.0) | | 41 (36.9) | 35 (31.5) | 35 (31.5) | |
| **WC (cm)** | | | | 0.971 | | | | 0.707 |
| Normal | 175 (30.8) | 203 (35.7) | 190 (33.5) | | 93 (36.3) | 75 (29.3) | 88 (34.4) | |
| Increased risk | 27 (31.0) | 30 (34.5) | 30 (34.5) | | 145 (35.5) | 132 (32.2) | 132 (32.3) | |
| **WHR** | | | | 0.493 | | | | 0.498 |
| Normal | 135 (32.4) | 147 (35.3) | 135 (32.4) | | 76 (39.2) | 58 (29.9) | 60 (30.9) | |
| Increased risk | 67 (28.2) | 86 (36.1) | 85 (35.7) | | 162 (34.4) | 149 (31.6) | 160 (34.0) | |
| **Hypertension** | | | | 0.114 | | | | 0.035 |
| Hypertensive | 59 (27.6) | 88 (41.1) | 67 (31.3) | | 49 (28.0) | 64 (36.6) | 62 (35.4) | |
| Non Hypertensive | 143 (32.4) | 145 (32.9) | 153 (34.7) | | 189 (38.6) | 143 (29.2) | 158 (32.2) | |

*BMI: Body Mass Index; WC: Waist Circumference; WHR: Waist-Hip Ratio; n (%): Number (percentage)*

#### 4.3.3.2 Predictors of Diet Quality by Sex among Adults in AK and CR States, Nigeria

Results from multivariate analyses (Table 4.8) showed that, the likelihood of attaining moderate or high diet quality was 1.5 times higher in the urban setting (OR = 1.5; CI: 1.2, 2.0; p = 0.001) when compared to those living in rural settings. When stratified into sex, being a male in the urban setting was particularly related to higher diet quality (OR = 1.7; CI: 1.2, 2.5; p = 0.004), not females.

**Table 4.8: Predictors of Diet Quality by Sex among Adults in Akwa Ibom and Cross River States, Nigeria**

| | Combined | | Men | | Women | |
|---|---|---|---|---|---|---|
| | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***p*** |
| State# (Cross River) | 1.3 (0.8, 2.1) | 0.354 | 1.6 (0.8, 3.4) | 0.216 | 1.1 (0.5, 2.1) | 0.865 |
| Residence@ (urban) | 1.5 (1.2, 2.0) | 0.001* | 1.7 (1.2, 2.5) | 0.004* | 1.4 (1.0, 1.9) | 0.083 |
| Ethnic background (Ibibio as reference) | | | | | | |
| Efik/Ejagham | 1.5 (0.9, 2.5) | 0.152 | 1.3 (0.6, 2.8) | 0.530 | 1.6 (0.8, 3.3) | 0.200 |
| Others | 0.8 (0.3, 1.6) | 0.485 | 0.5 (0.2, 1.4) | 0.167 | 1.2 (0.4, 3.9) | 0.721 |

**Differences statistically significant at* $\alpha_{0.05}$

*Diet quality was categorized using respondents with low DQI as reference compared to respondents with moderate/high DQI*

*#Akwa Ibom as reference*

*@ rural as reference*

*Others include; Igbo, Yoruba, Hausa etc.*

#### 4.3.3.3 Predictors of Diet Quality by Age Groups among Adults in AK and CR States, Nigeria

Findings on significant predictors of higher diet quality among adults in age groups are presented in Table 4.9. Multivariate analysis revealed that, when compared to adults in the rural settings, higher diet quality related significantly only among younger adults living in the urban setting (OR = 1.6; CI: 1.2, 2.2; p = 0.001) and not with those in the rural areas.

**Table 4.9: Predictors of Diet Quality by Age among Adults in Akwa Ibom and Cross River States, Nigeria Age groups**

| | Combined | | 20 - 39 years | | ≥40 years | |
|---|---|---|---|---|---|---|
| | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***p*** |
| State# (Cross River) | 1.3 (0.8, 2.1) | 0.354 | 1.3 (0.7, 2.4) | 0.386 | 1.2 (0.5, 2.8) | 0.758 |
| Residence@ (urban) | 1.5 (1.2, 2.0) | 0.001* | 1.6 (1.2, 2.2) | 0.001* | 1.4 (0.9, 2.2) | 0.194 |
| Ethnic background (Ibibio as reference) | | | | | | |
| Efik/Ejagham | 1.5 (0.9, 2.5) | 0.152 | 1.4 (0.8, 2.7) | 0.280 | 1.6 (0.6, 4.1) | 0.308 |
| Others | 0.8(0.3, 1.6) | 0.485 | 1.0 (0.4, 2.5) | 0.981 | 0.4 (0.1,1.7) | 0.194 |

**Differences statistically significant at* $\alpha_{0.05}$

*Diet quality was categorized using respondents with low DQI as reference compared to respondents with moderate/high DQI*

*#Akwa Ibom as reference*

*@ rural as reference*

*Others include; Igbo, Yoruba, Hausa etc.*

### 4.4.0 Objective Three: Determine physical activity of adults in AK and CR States, Nigeria.

1. Physical activity (PA) was assessed using the IPAQ long form.
2. Results were presented in median values with interquartile ranges.
3. Individual PA scores were classified as low, moderate or high PA levels.
4. The proportion of individuals who scored low, moderate and high PA were reported in number and percentages.
5. Differences in PA METs-minutes/week scores between States and sexes were determined at 0.05 level using Wilcoxon Mann-Whitney U Test. Chi-Square test and multiple logistic regression were conducted to assess relationships between PA levels and socio-demographic characteristics.

#### 4.4.1.1 Physical Activity Scores in various PA Domains among Adults in AK and CR States, Nigeria

Results on PA domain scores are presented in Table 4.10. The median (IQR) value for total PA in this study was 4306.0 (5660.0) METs-minutes/week. Based on PA domains, work-related physical activity contributed most to the overall weekly PA, with a median (IQR) value of 1510.0 (4320.0) METs-minutes/week. Domestic and garden-related PA (915.0 (1755.0) METs-minutes/week) and transport-related PA (396.0 (924.0) METs-minutes/week) contributed moderately to total PA in this study in decreasing order.

Physical activity did not differ in States (p = 0.406). Median values indicated that moderate intensity activities performed at work (140.0 METs-minutes/week) contributed most to the work-related physical activity. In both States, over three-quarters of participants did not engage in both vigorous intensity work-related PA (0.0 MET-minutes/week for 75th percentile) and activity requiring walking at work (0.0 MET-minutes/week for 75th percentile). Overall, total work-related physical activity was significantly higher in Akwa Ibom (1554.0 METs-minutes/week) than in Cross River State (1440.0 METs-minutes/week), (p = 0. 033). The median (IQR) of total transport-related PA was 396.0 (924.0) METs-minute/week. Walking (311.9 METs-minutes/weeks) was the most popular form of active transport-related PA. Participants rarely used cycling - 0.0 (0.0) MET-minutes/week as any means of active transportation.

The Median (IQR) value for total domestic and garden (yard chores) was 915.0 (1755.0) MET-minutes/week. Participants rarely engaged in vigorous intensity yard chores, 0.0 (660.0) METs-minutes/week, whereas moderate intensity inside chores contributed most to the total domestic and garden chores, 540.0 (1170.0) METs-minutes/week. Median (IQR) total leisure-time physical activity (LTPA) was 0.0 (414.3) METs-minutes/week. Participants rarely engaged in both vigorous and moderate-intensity LTPA.

**Table 4.10: Physical Activity Scores in various PA Domains among Adults in Akwa Ibom and Cross River States, Nigeria**

| PA Components (METs-minutes/week) | Akwa Ibom Median | IQR | Cross River Median | IQR | Total Median | IQR | p-value |
|---|---|---|---|---|---|---|---|
| **Work Domain** | | | | | | | |
| Vigorous PA at Work | 0.0 | 1440.0 | 0.0 | 1920.0 | 0.0 | 1920.0 | 0.005* |
| Moderate PA at work | 320.0 | 960.0 | 0.0 | 720.0 | 140.0 | 960.0 | 0. 000* |
| Walking PA at Work | 0.0 | 495.0 | 0.0 | 445.5 | 0.0 | 495.0 | 0.205 |
| Total Work PA | 1554.0 | 4205.0 | 1440.0 | 4178.3 | 1510.0 | 4320.0 | 0. 033* |
| **Active Transportation Domain** | | | | | | | |
| Walking PA during Transportation | 346.5 | 693.0 | 297.0 | 717.8 | 311.9 | 693.0 | 0.229 |
| Cycle PA during Transportation | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Transport PA | 420.0 | 706.0 | 396.0 | 1179.0 | 396.0 | 924.0 | 0.509 |
| **Domestic and Garden [Yard Work] Domain** | | | | | | | |
| Vigorous PA during Yard Chores | 0.0 | 330.0 | 330.0 | 990.0 | 0.0 | 660.0 | 0.000* |
| Moderate PA during Inside Chores | 630.0 | 1080.0 | 360.0 | 1080.0 | 540.0 | 1170.0 | 0.000* |
| Total Domestic and Garden PA | 810.0 | 1605.0 | 997.5 | 1928.8 | 915.0 | 1755.0 | 0.242 |
| **Leisure-Time Domain** | | | | | | | |
| Walking PA at Leisure | 0.0 | 198.0 | 0.0 | 198.0 | 0.0 | 198.0 | 0.905 |
| Vigorous PA at Leisure | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Moderate PA at Leisure | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Leisure-Time PA | 0.0 | 396.0 | 0.0 | 396.0 | 0.0 | 414.3 | 0.844 |
| **Total Physical Activity Score** | 2033.5 | 3473.0 | 2070.0 | 3183.5 | 4306.0 | 5660.0 | 0.406 |

**Differences in PA domain scores between States are statistically significant at* $\alpha_{0.05}$
*IQR: Interquartile range*

#### 4.4.1.2 : Physical Activity Scores in various PA Domains between Adult Males and Females in AK and CR States, Nigeria

Total physical activity in this study related significantly with sex, p = 0.005 (Table 4.11). Males had higher PA scores in walking and vigorous activities as well as the total PA at work, p<0.05. There were no differences in the active transport PA domain between males and females, (p>0.05) except that females had higher median (IQR) PA scores for walking, (297.0 (693.0) METs-minutes/week than males 346.5 (660.0) METs-minutes/week p = 0.024. Females scored higher in moderate intensity PA during inside household chores - 630.0 (1410.0) METs-minutes/week versus 315.0 (720.0) METs-minutes/week reported for males. As well, females had higher total domestic and garden-related PA (1260.0 (2088.9) METs-minutes/week) than males (630.0 (1410.0) METs-minutes/week). Males had significantly higher leisure-time PA (792.0 METs-minutes/week) when compared to females (693.0 METs-minutes/week), especially during walking at leisure.

**Table 4.11: Physical Activity Scores in various PA Domains between Adult Males and Females in Akwa Ibom and Cross River States, Nigeria**

| PA Components (METs-minutes/week) | Males Median | Males IQR | Females Median | Females IQR | p-value |
|---|---|---|---|---|---|
| **Work Domain** | | | | | |
| Vigorous PA at Work | 240.0 | 2880.0 | 0.0 | 960.0 | 0.000* |
| Moderate PA at work | 120.0 | 960.0 | 120.0 | 960.0 | 0.618 |
| Walking PA at Work | 0.0 | 495.0 | 0.0 | 408.4 | 0.020* |
| Total Work PA | 1920.0 | 4110.0 | 1015.8 | 3405.0 | 0.000* |
| **Active Transportation Domain** | | | | | |
| Walking PA during Transportation | 297.0 | 693.0 | 346.5 | 660.0 | 0.024* |
| Cycle PA during Transportation | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Transport PA | 396.0 | 924.0 | 436.5 | 834.0 | 0.235 |
| **Domestic and Garden (Yard Work) Domain** | | | | | |
| Vigorous PA during Yard Chores | 0.0 | 660.0 | 0.0 | 660.0 | 0.727 |
| Moderate PA during Inside Chores | 315.0 | 720.0 | 630.0 | 1410.0 | 0.000* |
| Total Domestic and Garden PA | 630.0 | 1410.0 | 1260.0 | 2088.8 | 0.000* |
| **Leisure-Time Domain** | | | | | |
| Walking PA at Leisure | 0.0 | 297.0 | 0.0 | 131.2 | 0.000* |
| Vigorous PA at Leisure | 0.0 | 0.0 | 0.0 | 0.0 | |
| Moderate PA at Leisure | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Leisure-Time PA | 792.0 | 1336.5 | 693.0 | 1221.0 | 0.000* |
| **Total Physical Activity Score** | 4545.0 | 5310.0 | 3991.5 | 4789.5 | 0.005* |

**Differences in PA domain scores between males and females are statistically significant at* $\alpha_{0.05}$

*IQR: Interquartile range*

#### 4.4.2.1 Physical Activity Intensity Scores among Adults in AK and CR States, Nigeria

Findings on PA intensity among adults in this study are presented in Table 4.12. Moderate-intensity PA was the most common PA among adults in this study (1800.0 (2640.0) METs-min/week). Moderate intensity PA performed during inside domestic chores accounted for most moderate-intensity activity (540.0 (1170.0) METs-min/week). Walking was the most common form of physical activity after moderate-intensity PA (726.0 (1287.0) METs-min/week), especially when performed in the form of active transportation (311.9 (693.0) METs-min/week). Participants rarely engaged in vigorous-intensity activities. The Median (IQR) value for total vigorous intensity activity was 240.0 (2160.0) METs-min/week. Vigorous-intensity activity at work (median (IQR) = 0.0 (1920.0) METs-min/week) contributed most to the total vigorous-intensity activity score and was higher in Cross River (median (IQR) = 0.0 (1920.0) METs-min/week) than in Akwa Ibom (median (IQR) = 0.0 (1440.0) METs-min/week), $p = 0.005$.

**Table 4.12: Physical Activity Intensity Scores among Adults in Akwa Ibom and Cross River States, Nigeria**

| PA Components (METs-minutes/week) | Akwa Ibom Median | IQR | Cross River Median | IQR | Total Median | IQR | p-value |
|---|---|---|---|---|---|---|---|
| **Walking Physical Activity** | | | | | | | |
| Walking PA at Work | 0.0 | 495.0 | 0.0 | 445.5 | 0.0 | 495.0 | 0.205 |
| Walking during Transportation | 346.5 | 693.0 | 297.0 | 717.8 | 311.9 | 693.0 | 0.229 |
| Walking PA at Leisure | 0.0 | 198.0 | 0.0 | 198.0 | 0.0 | 198.0 | 0.905 |
| Total Walking PA | 726.0 | 1336.5 | 693.0 | 1369.5 | 726.0 | 1287.0 | 0.155 |
| **Moderate Intensity PA** | | | | | | | |
| Moderate PA at Work | 320.0 | 960.0 | 0.0 | 720.0 | 140.0 | 960.0 | 0. 000* |
| Cycling PA during Transportation | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Vigorous PA during Yard Chores | 0.0 | 330.0 | 330.0 | 990.0 | 0.0 | 660.00 | 0.000* |
| Moderate PA during Inside Chores | 630.0 | 1080.0 | 360.0 | 1080.0 | 540.0 | 1170.0 | 0.000* |
| Moderate PA at Leisure | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Moderate PA | 1845.0 | 2700.0 | 1800.0 | 3225.0 | 1800.0 | 2910.0 | 0.920 |
| **Vigorous Intensity PA** | | | | | | | |
| Vigorous PA at Work | 0.0 | 1440.0 | 0.0 | 1920.0 | 0.0 | 1920.0 | 0.005* |
| Vigorous PA at Leisure | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Vigorous PA | 0.0 | 1920.0 | 480.0 | 2280.0 | 240.0 | 2160.0 | 0.037* |

**Differences in PA intensity scores between States are statistically significant at* $\alpha_{0.05}$

*IQR: Interquartile range*

#### 4.4.2.2 Physical Activity Intensity Scores between Adult Males and females in AK and CR States, Nigeria

Most physical activity intensities differed by sex ($p<0.05$), Table 4.13. Although the total walking intensity for PA was not different between males and females, males scored significantly higher in walking PA intensity performed at work and at leisure, while females performed higher in walking intensity PA performed during active transportation $p<0.05$. Both males and females performed similarly in most components of the moderate intensity PA, except for that performed during inside house chores where females had higher scores, $p<0.05$.

**Table 4.13: Physical Activity Intensity Scores between Adult Males and females in Akwa Ibom and Cross River States, Nigeria**

| PA Components (METs-minutes/week) | Males Median | IQR | Females Median | IQR | p-value |
|---|---|---|---|---|---|
| **Walking Physical Activity** | | | | | |
| Walking PA at Work | 0.0 | 495.0 | 0.0 | 408.4 | 0.020* |
| Walking during Transportation | 297.0 | 693.0 | 346.5 | 660.0 | 0.024* |
| Walking PA at Leisure | 0.0 | 297.0 | 0.0 | 131.2 | 0.000* |
| Total Walking PA | 792.0 | 1336.5 | 693.0 | 1221.0 | 0.151 |
| **Moderate Intensity PA** | | | | | |
| Moderate PA at Work | 120.0 | 960.0 | 120.0 | 960.0 | 0.618 |
| Cycling PA during Transportation | 0.0 | 0.0 | 0.0 | 0.0 | |
| Vigorous PA during Yard Chores | 0.0 | 660.0 | 0.0 | 660.0 | 0.727 |
| Moderate PA during Inside Chores | 315.0 | 720.0 | 630.0 | 1410.0 | 0.000* |
| Moderate PA at Leisure | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Moderate PA | 1530.0 | 2675.0 | 2070.0 | 2910.0 | 0.001 |
| **Vigorous Intensity PA** | | | | | |
| Vigorous PA at Work | 240.00 | 2880.00 | 0.00 | 960.00 | 0.000* |
| Vigorous PA at Leisure | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Vigorous PA | 960.0 | 2880.0 | 0.0 | 1080.0 | 0.000* |

**Differences in PA intensity scores between males and females are statistically significant at* $\alpha_{0.05}$
*IQR: Interquartile range*

#### 4.4.3.1.1 Associations between Socio-demographic Characteristics and Physical Activity Levels among Adults in AK and CR States, Nigeria

Results on associations between socio-demographic characteristics and PA patterns are presented in Table 4.14. Adults in urban residence had significantly higher prevalence of low PA (11.7%), against 8.5% found in rural settings, p = 0.043. There was a significant association between educational level and PA in this study, (p = 0.001). Prevalence of low PA had the highest value among adults with tertiary education (15.7%) when compared to 7.6%, 8.7% and 9.2% among those with secondary, primary and adults with no formal education, respectively. Likewise, prevalence of high PA was least among adults with tertiary education. Prevalence of high PA was 52.7% among adults with tertiary education, when compared with 61.1%, 65.7% and 69.2% among adults with secondary, primary and those with no formal education, respectively. There were significant differences in prevalence of low PA between employed and unemployed adults in this study, p = 0.001. Prevalence of low PA was 16.4% among adults with no employment, against 7.6% found among employed adults. Also, a higher proportion of adults with no employments (48.4%) had moderate PA patterns when compared to 23.9% found among the employed. Whereas, only 35.4% of unemployed adults had high PA patterns, when compared to 68.6% of high PA patterns observed among employed adults.

A total of 61 (8.3%) adults in Akwa Ibom State had low PA pattern, compared to 11.2% in Cross River State, though physical activity pattern did not differ by State, p = 0.195. Physical activity was not related to household size p = 0.436. There were no significant differences in physical activity levels between males and females in the study, p = 0.160. Adults aged forty and above had higher prevalence of low physical activity (10.7%), compared to 9.1% found among those less than forty years, though not statistically significant, p = 0.593. Physical activity was not related to marital status, (p = 0.320), although a higher proportion of married adults had low PA (11.1%) when compared to 8.4% low PA recorded among singles and 6.3% low PA recorded among widowed adults.

**Table 4.14a: Associations between Socio-demographic Characteristics and Physical Activity Levels among Adults in Akwa Ibom and Cross River States, Nigeria**

| Characteristics | Physical Activity<br>Low<br>n (%) | Moderate<br>n (%) | High<br>n (%) | p-value |
|---|---|---|---|---|
| **State** | | | | |
| Akwa Ibom | 61 (8.3) | 223 (30.4) | 449 (61.3) | 0.195 |
| Cross River | 66 (11.2) | 169 (28.8) | 352 (60.0) | |
| **Residence** | | | | |
| Rural | 73 (8.5) | 245 (28.6) | 540 (62.9) | 0.043* |
| Urban | 54 (11.7) | 147 (31.8) | 261 (56.5) | |
| **Household Size** | | | | |
| ≤ 5 | 70 (8.9) | 241 (30.7) | 475 (60.4) | 0.436 |
| > 5 | 57 (10.7) | 151 (28.3) | 326 (61.1) | |
| **Sex** | | | | |
| Male | 63 (9.6) | 179 (27.3) | 413 (63.1) | 0.160 |
| Female | 64 (9.6) | 213 (32.0) | 388 (58.4) | |
| **Age (years)** | | | | |
| 20 - 39 | 79 (9.1) | 258 (29.6) | 535 (61.4) | 0.593 |
| ≥ 40 | 48 (10.7) | 134 (29.9) | 266 (59.4) | |
| **Formal Education** | | | | |
| None | 6 (9.2) | 14 (21.5) | 45 (69.2) | 0.001* |
| Primary | 25 (8.7) | 73 (25.5) | 188 (65.7) | |
| Secondary | 52 (7.6) | 216 (31.4) | 420 (61.1) | |
| Tertiary | 44 (15.7) | 89 (31.7) | 148 (52.7) | |
| **Employment** | | | | |
| Yes | 76 (7.6) | 240 (23.9) | 690 (68.6) | 0.000* |
| No | 51 (16.4) | 152 (48.4) | 111 (35.4) | |
| **Estimated Household Income** | | | | |
| ≤ ₦20,000.00 | 83 (8.8) | 279 (29.6) | 580 (61.6) | 0.262 |
| > ₦20,000.00 | 44 (11.6) | 113 (29.9) | 221 (58.5) | |

*n (%) – Number (percentage)*
**Differences in* socio-demographic *characteristics across PA levels are statistically significant at* $\alpha_{0.05}$

**Table 4.14b: Associations between Socio-demographic Characteristics and Physical Activity Levels among Adults in Akwa Ibom and Cross River States, Nigeria**

| **Characteristics** | **Physical Activity** Low n (%) | Moderate n (%) | High n (%) | **p-value** |
|---|---|---|---|---|
| **Marital Status** | | | | |
| Single | 40 (8.4) | 141 (29.4) | 298 (62.2) | 0.320 |
| Married | 79 (11.1) | 214 (30.0) | 421 (59.0) | |
| Widowed@ | 8 (6.3) | 37 (29.1) | 82 (64.6) | |
| **Ethnic Origin** | | | | |
| Ibibio | 67 (8.7) | 236 (30.6) | 469 (60.8) | 0.178 |
| Efik/Ejagham | 56 (10.8) | 143 (27.6) | 319 (61.6) | |
| Others | 4 (13.3) | 13 (43.3) | 13 (43.3) | |

*@ - includes divorced and separated individuals*
*n (%) – Number (percentage)*
**Differences in* socio-demographic *characteristics across PA levels are statistically significant at* $\alpha_{0.05}$

**4.4.3.1.2 : Associations of Diet Quality, BMI, WC, WHR and Hypertension with Physical Activity among Adults in AK and CR States, Nigeria**

There were no significant associations between diet quality and PA among both males and females in this study ($p > 0.05$), Table 4.15. Physical activity had significant relationships with prevalence of OW and OB among both males ($p = 0.001$) and females ($p = 0.010$). Among males, prevalence of OW/OB had inverse associations with PA levels, and were 18.9/12.8%, 34.0/36.8% and 47.2/50.4% among adults with high, moderate and low PA patterns, respectively. Among females, prevalence of OW/OB were 13.5/13.6%, 40.5/32.5% and 45.9/53.9% among those with high, moderate and low PA patterns, respectively.

Prevalence of increased WC also increased with decreasing levels of PA among both males and females in the study. However, these observations were significant only among males, $p = 0.009$. Prevalence of increased WC increased significantly with decreasing PA patterns among males and were 13.8%, 37.9% and 48.3% among adults with high, moderate and low PA patterns, $p < 0.05$. Physical activity related significantly with increased WHR only among males in the study, $p = 0.009$. Increased WHR was observed among 13.0%, 31.1% and 55.9% of males with high, moderate and low PA, respectively. Although the prevalence of increased WHR increased with decreasing PA levels among females in the study, this observation was not statistically significant, $p = 0.764$. As well, physical activity levels did not have any significant association with prevalence of hypertension.

**Table 4.15: Associations of Diet Quality, BMI, WC, WHR and Hypertension with Physical Activity among Adults in Akwa Ibom and Cross River States, Nigeria**

| | Physical Activity | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Males | | | | Females | | | |
| **Components** | **High n (%)** | **Moderate n (%)** | **Low n (%)** | **p-value** | **High n (%)** | **Moderate n (%)** | **Low n (%)** | **p-value** |
| **DQI-I** | | | | 0.750 | | | | 0.508 |
| Low | 18 (8.9) | 57 (28.2) | 127 (62.9) | | 22 (9.2) | 72 (30.3) | 144 (60.5) | |
| Moderate | 21 (9.0) | 63 (27.0) | 149 (63.9) | | 24 (11.6) | 62 (30.0) | 121 (58.5) | |
| High | 24 (10.9) | 59 (26.8) | 137 (62.3) | | 18 (8.2) | 79 (35.9) | 123 (55.9) | |
| **BMI (kg/m$^2$)** | | | | 0.001 | | | | 0.010 |
| Underweight | 6 (12.2) | 10 (20.4) | 33 (67.3) | | 4 (7.8) | 18 (35.3) | 29 (56.9) | |
| Normal weight | 32 (7.3) | 108 (24.8) | 296 (67.9) | | 24 (6.9) | 100 (28.7) | 225 (64.5) | |
| Overweight | 15 (12.8) | 43 (36.8) | 59 (50.4) | | 21 (13.6) | 50 (32.5) | 83 (53.9) | |
| Obese | 10 (18.9) | 18 (34.0) | 25 (47.2) | | 15 (13.5) | 45 (40.5) | 51 (45.9) | |
| **WC (cm)** | | | | 0.009 | | | | 0.145 |
| Normal | 51 (9.0) | 146 (25.7) | 371 (65.3) | | 20 (7.8) | 75 (29.3) | 161 (62.9) | |
| Increased risk | 12 (13.8) | 33 (37.9) | 42 (48.3) | | 44 (10.8) | 138 (33.7) | 227 (55.5) | |
| **WHR** | | | | 0.009 | | | | 0.764 |
| Normal | 32 (7.7) | 105 (25.2) | 280 (67.1) | | 20 (10.3) | 65 (33.5) | 109 (56.2) | |
| Increased risk | 31 (13.0) | 74 (31.1) | 133 (55.9) | | 44 (9.3) | 148 (31.4) | 279 (59.2) | |
| **Hypertension** | | | | 0.166 | | | | 0.961 |
| Hypertensive | 124 (57.9) | 66 (30.8) | 24 (11.2) | | 102 (58.3) | 57 (32.6) | 16 (9.1) | |
| Non Hypertensive | 289 (65.5) | 113 (25.6) | 39 (8.8) | | 286 (58.4) | 156 (31.8) | 48 (9.8) | |

DQI-I: Diet Quality Index-International; BMI: Body Mass Index; WC: Waist Circumference; WHR: Waist-Hip Ratio
n *(%) – Number (Percentage)*

#### 4.4.3.2 Predictors of Physical Activity by Sex among Adults in AK and CR States, Nigeria

Independent associations of socio-demographic characteristics with PA among males and females is presented in Table 4.16. The multivariate analyses did not reveal education as any significant predictor of higher PA in the whole sample, but when stratified into sex, secondary education was a significant predictor of moderate-high PA pattern only among men (OR = 4.12; CI: 1.36, 12.43; p = 0.012); while tertiary education significantly predicted low PA among females, (OR = 0.12; CI: 0.01, 0.94; p = 0.044).

**Table 4.16: Predictors of Physical Activity by Sex among Adults in Akwa Ibom and Cross River States, Nigeria**

| | Combined | | Men | | Women | |
|---|---|---|---|---|---|---|
| | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***p*** |
| Residence@ (urban) | 1.1 (0.5, 2.2) | 0.855 | 0.7 (0.4, 1.2) | 0.231 | 0.9 (0.5, 1.5) | 0.629 |
| Education (none as reference) | | | | | | |
| Primary | 0.8 (0.2, 4.0) | 0.801 | 2.2 (0.7, 6.9) | 0.193 | 0.3 (0.0, 2.5) | 0.279 |
| Secondary | 0.6 (0.1, 2.9) | 0.567 | 4.1 (1.4, 12.4) | 0.012* | 0.2 (0.0, 1.8) | 0.171 |
| Tertiary | 0.5 (0.1, 2.2) | 0.330 | 1.6 (0.5, 4.7) | 0.424 | 0.1 (0.0, 0.9) | 0.044* |

*Physical activity (PA) was categorized using respondents with low PA as reference compared to respondents with moderate/high PA*

@ *rural as reference*

**Differences statistically significant at* $\alpha_{0.05}$

#### 4.4.3.3 : Predictors of Physical Activity by Age Groups among Adults in AK and CR States, Nigeria

Independent associations of Socio-demographic characteristics with PA patterns in different age groups are presented in Table 4.17. The relationships between physical activity and residence and education were not influence by respondents' age in anyway, $p > 0.05$.

**Table 4.17: Predictors of Physical Activity by Age Groups among Adults in Akwa Ibom and Cross River States, Nigeria**

| | Combined | | 20 – 39 years | | ≥ 40 years | |
|---|---|---|---|---|---|---|
| | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***P*** | **Adjusted OR (95%CI)** | ***p*** |
| Residence@ (urban) | 1.1 (0.5, 2.2) | 0.855 | 0.6 (0.4, 1.0) | 0.065 | 0.9 (0.5, 1.8) | 0.836 |
| Education (none as reference) | | | | | | |
| Primary | 0.8 (0.2, 4.0) | 0.801 | 0.7 (0.2, 3.4) | 0.675 | 1.3 (0.4, 4.5) | 0.648 |
| Secondary | 0.6 (0.1, 2.9) | 0.567 | 1.1 (0.2, 4.8) | 0.922 | 1.1 (0.4, 3.4) | 0.888 |
| Tertiary | 0.5 (0.1, 2.2) | 0.330 | 0.4 (0.1, 1.8) | 0.231 | 0.7 (0.2, 2.4) | 0.596 |

*Physical activity (PA) was categorized using respondents with low PA as reference compared to respondents with moderate/high PA*

@ *rural as reference*

**Differences statistically significant at* $\alpha_{0.05}$

### 4.5.0 Objective Four: Assess the prevalence of obesity and its associations with diet quality and physical activity among adults in AK and CR States, Nigeria.

1. Prevalence of obesity was determined using BMI, while abdominal obesity was determined using WC and WHR.
2. Prevalence of obesity measured by each anthropometric index was presented in number and percentages.
3. Differences in mean anthropometric index scores between States were determined at 0.05 level using independent samples t-Test. Chi-Square test and multiple logistic regressions were conducted to assess relationships between obesity and socio-demographic characteristics.

### 4.5.1 Anthropometric Information among Adults in AK and CR States, Nigeria

Table 4.18 presents findings on anthropometric measurements and indices among adults in the study. The mean ±SD weight/height for men and women were 65.37±13.05 kg/1.67±0.08 m and 63.25±15.21 kg /1.59±0.07 m, respectively. The Mean ±SD BMI among men and women were 23.43±4.65 $kg/m^2$ and 24.94±5.69 $kg/m^2$, respectively, whereas the overall mean ±SD BMI in this study was 24.19±5.26 $kg/m^2$. Mean ±SD waist circumference/hip circumference among men and women were 82.74±11.27 cm/ 92.95±11.47 cm and 96.22±15.84 cm /85.53±15.09 cm respectively, mean ±SD WHR among men and women were 0.90±0.12 and 0.90±0.13 respectively.

**Table 4.18: Mean Anthropometric Measurements and Indices among Adults in Akwa Ibom and Cross River States, Nigeria**

| Anthropometric Index | Akwa Ibom Mean±SD | Cross River Mean±SD | Total Mean±SD | p-value |
|---|---|---|---|---|
| **Men** | | | | |
| Weight (kg) | 64.8 ±11.9 | 66.0±14.4 | 65.4±13.1 | 0.245 |
| Height (m) | 1.7±.1 | 1.7±.1 | 1.7±0.1 | 0.192 |
| Hip Circumference (cm) | 93.9±8.9 | 91.7±14.0 | 93.0±11.5 | 0.014* |
| Body Mass Index ($kg/m^2$) | 23.1±4.1 | 23.8±5.3 | 23.4±4.7 | 0.054 |
| Waist Circumference (cm) | 82.5±9.7 | 83.1±13.0 | 82.7±11.3 | 0.497 |
| Waist-Hip Ratio | 0.9±0.1 | 0.9±0.2 | 0.9±0.1 | 0.000* |
| **Women** | | | | |
| Weight (kg) | 63.1±14.7 | 63.5±15.8 | 63.3±15.2 | 0.708 |
| Height (m) | 1.6±.1 | 1.6±.1 | 1.6±0.1 | 0.000* |
| Hip Circumference (cm) | 98.3±13.4 | 93.6±18.1 | 96.2±15.8 | 0.000* |
| Body Mass Index ($kg/m^2$) | 25.1±5.3 | 24.7±6.1 | 24.9±5.7 | 0.400 |
| Waist Circumference (cm) | 87.1±14.3 | 83.6±15.9 | 85.5±15.1 | 0.003* |
| Waist-Hip Ratio | 0.9±0.1 | 0.9±0.2 | 0.9±0.1 | 0.013* |
| Overall Body Mass Index | 24.12±4.86 | 24.28±5.71 | 24.19±5.26 | 0.583 |

**Differences in anthropometric measures between States are statistically significant at* $\alpha_{0.05}$.

### 4.5.2 Prevalence of Obesity among Adults in AK and CR States, Nigeria

Results on prevalence of obesity are presented in Table 4.19. A total of 100 (7.6%) adults were underweight, 785 (59.5%) had normal body weight, 271 (20.5%) were overweight; 106 (8.0%), 30 (2.3%), 28 (2.2%) had grade I, II and III obesity respectively. Obesity was 12.5%. A total of 824 (62.4%) had normal waist circumference, 213 (16.2%) were classified as being at increased risk of metabolic complications and 283 (21.4%) were classified as being at substantially increased risk of metabolic disorders. Based on increased WC, abdominal obesity was 37.6%. Based on WHR, a total of 709 (53.7%) individuals were classified as being abdominally obese.

**Table 4.19: Prevalence of Obesity among Adults in Akwa Ibom and Cross River States, Nigeria**

| Parameter | Number | Percentage |
|---|---|---|
| **BMI** | | |
| Underweight | 100 | 7.6 |
| Normal | 785 | 59.5 |
| Overweight | 271 | 20.5 |
| Grade I Obesity | 106 | 8.0 |
| Grade II Obesity | 30 | 2.3 |
| Grade III Obesity | 28 | 2.2 |
| Obesity | 164 | 12.5 |
| **Waist Circumference** | | |
| Normal | 824 | 62.4 |
| Men 94- 102cm; Women: 80-88cm | 213 | 16.1 |
| Men >102cm; Women: >88cm | 283 | 21.4 |
| Abdominal Obesity (based on WC) | 496 | 37.6 |
| **Waist-Hip Ratio** | | |
| Men:<0.90; Women: <0.85 | 611 | 46.3 |
| Men ≥ 0.90; Women: ≥0.85 | 709 | 53.7 |
| Abdominal Obesity (based on WHR) | 709 | 53.7 |

#### 4.5.3.1.1 Associations between Socio-demographic Characteristics and Obesity among Adults in AK and CR States, Nigeria

Table 4.20 presents findings on associations between socio-demographic characteristics and obesity. Prevalence of obesity was significantly different between males and females in this study, 0.001; and were 18.2% among females, when compared to 8.7% recorded among males in the study. Respondents' age related significantly with prevalence of obesity in the study, $p < 0.001$. Compared to the prevalence of obesity (10.2%) among adults < 40 years old, 16.7% of adults aged ≥ 40 years had obesity in this study. There were significant associations between estimated household income and prevalence of obesity in the study, $p < 0.001$. Compared to 11.2% prevalence of obesity observed among adults from households with ≤ ₦20,000.00 estimated household income, there was a 19.3% prevalence of obesity among adults from households with > ₦20,000.00 estimated household income. Also, there were significant associations between marital status and obesity among adults in the study, $p < 0.001$. When compared to the 7.4% prevalence of obesity among single adults, an 18.1% prevalence of obesity was observed among married adults, while 11.1% was reported among those classified as widowed (including separated and divorced).

Prevalence of obesity was 12.3% and 15.1% in Akwa Ibom and Cross River States, respectively, though not statistically different. Prevalence of obesity was higher among adults in urban residence (15.9%) than those in rural areas (12.2%), although such differences were not statistically significant, $p = 0.171$. No significant difference existed in mean household sizes across BMI categories, $p = 0.109$. Prevalence of obesity was not related to educational status, ($p = 0.898$) although it was slightly higher among adults with tertiary education (16.6%) compared to those with primary (13.8%) and secondary (13.0%) education, $p = 0.065$.

**Table 4.20a: Associations between Socio-demographic Characteristics and Obesity among Adults in Akwa Ibom and Cross River States, Nigeria**

| Characteristics | Obese n (%) | Obesity Overweight n (%) | Normal n (%) | p-value |
|---|---|---|---|---|
| **State** | | | | |
| Akwa Ibom | 84 (12.3) | 164 (24.0) | 435 (63.7) | 0.115 |
| Cross river | 81 (15.1) | 106 (19.7) | 351 (65.2) | |
| **Residence** | | | | |
| Rural | 97 (12.2) | 182 (23.0) | 514 (64.8) | 0.171 |
| Urban | 68 (15.9) | 88 (20.6) | 272 (63.6) | |
| **Household Size** | | | | |
| ≤ 5 | 88 (11.9) | 169 (22.9) | 480 (65.1) | 0.127 |
| > 5 | 77 (15.9) | 101 (20.9) | 306 (63.2) | |
| **Sex** | | | | |
| Male | 53 (8.7) | 117 (19.3) | 437 (72.0) | 0.000* |
| Female | 112 (18.2) | 153 (24.9) | 349 (56.8) | |
| **Age (years)** | | | | |
| 20 - 39 | 89 (10.2) | 169 (19.4) | 550 (63.1) | 0.001 |
| ≥ 40 | 75 (16.7) | 102 (22.8) | 235 (52.5) | |
| **Formal Education** | | | | |
| None | 2 (3.5) | 12 (21.1) | 43 (75.4) | 0.065 |
| Primary | 36 (13.9) | 48 (18.6) | 176 (68.0) | |
| Secondary | 84 (13.0) | 145 (22.8) | 416 (64.5) | |
| Tertiary | 43 (16.6) | 65 (25.1) | 151 (58.3) | |
| **Employment** | | | | |
| Yes | 127 (13.7) | 203 (21.8) | 600 (64.5) | 0.898 |
| No | 38 (13.1) | 67 (23.0) | 186 (63.9) | |

*n (%) - Number (Percentage)*
**Differences in respondents' characteristic across BMI categories are statistically significant at* $\alpha_{0.05}$

**Table 4.20b: Associations between Socio-demographic Characteristics and Obesity among Adults in Akwa Ibom and Cross River States, Nigeria**

| Characteristics | Obesity<br>Obese<br>N (%) | Overweight<br>N (%) | Normal<br>N (%) | p-value |
|---|---|---|---|---|
| **Estimated Household Income** | | | | |
| ≤ ₦20,000.00 | 97 (11.2) | 190 (21.9) | 581 (66.9) | 0.000* |
| > ₦20,000.00 | 68 (19.3) | 80 (22.7) | 205 (58.1) | |
| **Marital Status** | | | | |
| Single | 33 (7.4) | 76 (17.0) | 339 (75.7) | 0.000* |
| Married | 120 (18.1) | 175 (26.3) | 370 (55.6) | |
| Widowed@ | 12 (11.1) | 19 (17.6) | 77 (71.3) | |
| **Ethnic Origin** | | | | |
| Ibibio | 92 (12.8) | 180 (25.1) | 446 (62.1) | 0.013* |
| Efik/Ejagham | 66 (13.9) | 88 (18.6) | 320 (67.5) | |
| Others | 7 (24.1) | 2 (6.9) | 20 (69.0) | |

*n (%) - Number (Percentage)*
*@ - includes divorced and separated individuals*
**Differences in respondents' characteristic across BMI categories are statistically significant at* $\alpha_{0.05}$

**4.5.3.1.2 : Associations of Physical Activity, Diet Quality, WC, WHR and Hypertension with BMI among Adults in AK and CR States, Nigeria**

There were significant associations between physical activity and obesity among both males and females in the study, (Table 4.21). There were significant associations between PA and obesity among both males and females in the study, p > 0.05. Among males, compared to 6.1% prevalence of obesity among those with high PA pattern, about 10.1% and 15.9% of males with obesity were classified under moderate and low PA levels, p = 0.001. Among females, prevalence of both OW and OB were higher among adults with low PA levels, p = 0.010. Prevalence of OW/OB were observed among 21.4/13.1%, 23.5/21.1% and 32.8/23.4% of females with high, moderate and low PA had overweight/obesity respectively. There were no significant associations between diet quality and obesity among adults in this study, p > 0.05. However, among both males and females, prevalence of obesity was observed to decrease with increasing DQI-I terciles. Among males, prevalence of obesity were 7.3%, 8.2% and 8.9% among those with high, moderate and low diet quality scores, respectively. Likewise, among females, prevalence of obesity were 15.9%, 16.9% and 17.2% among those with high, moderate and low diet quality, respectively.

Up to 11.5% of males and 40.1% of females who had abdominal obesity, measured by increased WC were found to have normal BMI values. Also, substantial proportions of both males (54.6%) and females (49.7%) who had increased WHR were found to have normal BMI values, p < 0.001. There were significant associations between obesity and hypertension among both males and females, p = 0.000. Prevalence of obesity was significantly higher among males and females with hypertension. Compared to 5.4% of obese males without hypertension, 13.6% of obese males had hypertension. Also, compared to 14.3% of obese females without hypertension, up to 23.4% of obese females had hypertension.

**Table 4.21: Associations of Physical Activity, Diet Quality, WC, WHR and Hypertension with BMI among Adults in Akwa Ibom and Cross River States, Nigeria**

| | BMI | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Males | | | | Females | | | |
| Components | **Obese n (%)** | **Overweight n (%)** | **Normal n (%)** | **p-value** | **Obese n (%)** | **Overweight n (%)** | **Normal n (%)** | **p-value** |
| **Physical Activity (METs-min/wk)** | | | | 0.001 | | | | 0.010 |
| Low | 10 (15.9) | 15 (23.8) | 32 (50.8) | | 15 (23.4) | 21 (32.8) | 24 (37.5) | |
| Moderate | 18 (10.1) | 43 (24.0) | 108 (60.3) | | 45 (21.1) | 50 (23.5) | 100 (46.9) | |
| High | 25 (6.1) | 59 (14.3) | 296 (71.7) | | 51 (13.1) | 83 (21.4) | 225 (58.0) | |
| **DQI-I** | | | | 0.311 | | | | 0.699 |
| Low | 18 (8.9) | 29 (14.4) | 141 (69.8) | | 41 (17.2) | 52 (21.8) | 125 (52.5) | |
| Moderate | 19 (8.2) | 40 (17.2) | 160 (68.7) | | 35 (16.9) | 56 (27.1) | 100 (48.3) | |
| High | 16 (7.3) | 48 (21.8) | 135 (61.4) | | 35 (15.9) | 46 (20.9) | 124 (56.4) | |
| **WC (cm)** | | | | 0.000 | | | | 0.000 |
| Normal | 23 (4.0) | 72 (12.7) | 426 (75.0) | | 8 (3.1) | 18 (7.0) | 185 (72.3) | |
| Increased risk | 30 (34.5) | 45 (51.7) | 10 (11.5) | | 103 (25.2) | 136 (33.3) | 164 (40.1) | |
| **WHR** | | | | 0.000 | | | | 0.000 |
| Normal | 22 (5.3) | 58 (13.9) | 306 (73.4) | | 14 (7.2) | 36 (18.6) | 115 (59.3) | |
| Increased risk | 31 (13.0) | 59 (24.8) | 130 (54.6) | | 97 (20.6) | 118 (25.1) | 234 (49.7) | |
| **Hypertension** | | | | 0.000 | | | | 0.000 |
| Hypertensive | 29 (13.6) | 66 (30.8) | 110 (51.4) | | 41 (23.4) | 54 (30.9) | 70 (40.0) | |
| Non Hypertensive | 24 (5.4) | 51 (11.6) | 326 (73.9) | | 70 (14.3) | 100 (20.4) | 279 (56.9) | |

*BMI-Body Mass Index; DQI-I – Diet Quality Index-International; WC – Waist Circumference; WHR-Waist-Hip Ratio;*

#### 4.5.3.2 : Predictors of Obesity by Sex among Adults in AK and CR States, Nigeria

Table 4.22 presents findings on independent associations of socio-demographic characteristics with obesity. The female sex, increasing age, higher income and being married were all associated with increased risk of obesity. Compared to males, females were 2 times more likely to be obese (OR = 2.2; CI: 1.7, 2.9; $p < 0.001$). Every one year increase in age was associated with a unit increase in the risk of obesity (OR = 1.0; CI: 1.0, 1.0; p = 0.002), and was significant among both males (OR = 1.0; CI: 1.0, 1.0; p =0.043) and females (OR = 1.0; CI: 1.0, 1.0; p = 0.029). Higher income had significant associations with increased risk of obesity among both males and females. Compared to lower income, higher income was associated with 1.5 times higher increase in the risk of obesity (OR = 1.5; CI: 1.1, 2.0; p =0.003) and was significant among both males (OR = 1.5; CI: 1.1, 2.3; p =0.025) and females (OR = 1.6; CI: 1.0, 2.4; p =0.030). Marital status predicted obesity significantly in this study. Compared to those who are not currently in the marital relationship, married adults were 2 times more likely to be obese (OR = 2.1; CI: 1.6, 2.7; $p<0.001$) and this was applicable to both males (OR = 2.2; CI: 1.4, 3.8; $p<0.001$) and females (OR = 2.0; CI: 1.4, 2.8; $p<0.001$). Compared to the Ibibios, the risk of obesity was significantly lower among the Efiks/Ejaghams (OR = 0.7; CI: 0.5, 0.9; p = 0.006), though this observation was specifically true of females (OR = 0.5; CI: 0.4, 0.8; p = 0.001). In other words, the risk of obesity was significantly lower only among females of the Efiks/Ejaghams ethnicity and not among the males. Compared to adults with low PA pattern, higher PA pattern was associated with significantly lower risk of obesity (OR = 0.5; CI: 0.3, 0.7; $p<0.001$) and this was applicable to both males (OR = 0.5; CI: 0.3, 1.0; p = 0.041) and females (OR = 0.4; CI: 0.3, 0.8; p = 0.005).

**Table 4.22: Predictors of Obesity by Sex among Adults in Akwa Ibom and Cross River States, Nigeria**

| | Combined | | Men | | Women | |
|---|---|---|---|---|---|---|
| | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***P*** | **Adjusted OR (95%CI)** | ***p*** |
| Sex# (Females) | 2.2 (1.7, 2.9) | 0.000* | | | | |
| Age (in years) | 1.0 (1.0, 1.0) | 0.002* | 1.0 (1.0, 1.0) | 0.043* | 1.0 (1.0, 1.0) | 0.029* |
| Income (>₦20,000) | 1.5 (1.1, 2.0) | 0.003* | 1.5 (1.1, 2.3) | 0.025* | 1.6 (1.0, 2.4) | 0.030* |
| Marital status@(married) | 2.1 (1.6, 2.7) | 0.000* | 2.2 (1.4, 3.5) | 0.000* | 2.0 (1.4, 2.8) | 0.000* |
| Ethnic background (Ibibio as reference) | | | | | | |
| Efik/Ejagham | 0.7 (0.5, 0.9) | 0.006* | 0.9 (0.6, 1.4) | 0.715 | 0.5 (0.4, 0.8) | 0.001* |
| Others | 0.7 (0.3, 1.6) | 0.368 | 0.4 (0.1, 2.0) | 0.282 | 0.9 (0.3, 2.6) | 0.802 |
| PA (moderate/high) | 0.5 (0.3, 0.7) | 0.000* | 0.5 (0.3, 1.0) | 0.041* | 0.4 (0.3, 0.8) | 0.005* |
| DQI (moderate/high) | 1.1 (0.8, 1.4) | 0.488 | 1.2 (0.8, 1.8) | 0.410 | 1.0 (0.7, 1.5) | 0.867 |

**Differences are statistically significant at* $\alpha_{0.05}$

*BMI was categorized using respondents with normal weight as reference compared to respondents with overweight/obesity*

*#males as reference*

*≤₦20, 000 as reference*

*@currently unmarried as reference (unmarried include singles, widowed and divorced)*

*PA-physical activity using respondents with low PA as reference*

*DQI- diet quality index using respondents with low DQI as reference*

#### 4.5.3.3 Predictors of Obesity by Age Groups among Adults in AK and CR States, Nigeria

Findings on independent associations of socio-demographic characteristics with obesity in different age groups are presented in Table 4.23. Compared to males, the risk of obesity increased significantly higher among females, and this was observed for both younger (OR = 2; CI: 1.8, 3.4; $p<0.001$) and older females (OR = 2.3; CI: 1.5, 3.6; $p<0.001$). The risk of developing obese increased significantly with age only among adults in the younger age groups (OR = 1.1; CI: 1.0, 1.1; $p < 0.001$), the effect of age on increased risk of obesity was not observed among older adults. The risk of obesity was significantly higher among married adults when compared to those not currently married. This observation was observed for both younger (OR = 1.6; CI: 1.2, 2.3; $p = 0.005$) and older adults (OR = 2.7; CI: 1.6, 4.5; $p<0.001$). Compared to moderate or high PA levels, low PA levels significantly increased the risk of obesity across both age groups.

**Table 4.23: Predictors of Obesity by Age Groups among Adults in Akwa Ibom and Cross River States, Nigeria**

| | Combined | | 20 – 39 years | | ≥ 40 years | |
|---|---|---|---|---|---|---|
| | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***P*** | **Adjusted OR (95%CI)** | ***p*** |
| Sex# (Females) | 2.2 (1.7, 2.9) | 0.000* | 2.4 (1.8, 3.4) | 0.000* | 2.30 (1.5, 3.6) | 0.000* |
| Age (in years) | 1.0 (1.0, 1.0) | 0.002* | 1.1 (1.0, 1.1) | 0.000* | 0.99 (1.0, 1.0) | 0.612 |
| Income (>₦20,000) | 1.5 (1.1, 2.0) | 0.003* | 1.4 (1.0, 2.1) | 0.056 | 1.53 (1.0, 2.4) | 0.059 |
| Marital status@(married) | 2.1 (1.6, 2.7) | 0.000* | 1.6 (1.2, 2.3) | 0.005* | 2.70 (1.6, 4.5) | 0.000* |
| Ethnic background (Ibibio as reference) | | | | | | |
| Efik/Ejagham | 0.7 (0.5, 0.9) | 0.006* | 0.7 (0.5, 1.0) | 0.059 | 0.69 (0.5, 1.1) | 0.097 |
| Others | 0.7 (0.3, 1.6) | 0.368 | 0.5 (0.2, 1.6) | 0.252 | 1.86 (0.5, 9.4) | 0.450 |
| PA (moderate/high) | 0.5 (0.3, 0.7) | 0.000* | 0.5 (0.3, 0.8) | 0.007* | 0.48 (0.3, 1.0) | 0.034* |
| DQI (moderate/high) | 1.1 (0.8, 1.4) | 0.488 | 0.9 (0.7, 1.3) | 0.528 | 1.81 (1.1, 2.9) | 0.012* |

**Differences are statistically significant at* $\alpha_{0.05}$
*BMI was categorized using respondents with normal weight as reference compared to respondents with overweight/obesity*
*#males as reference*
*≤ ₦20,000 as reference*
*@currently unmarried as reference (unmarried include singles, widowed and divorced)*
*PA-physical activity using respondents with low PA as reference*
*DQI- diet quality index using respondents with low DQI as reference*

#### 4.5.4.1.1 : Associations between Socio-demographic Characteristics and Increased Waist Circumference among Adults in AK and CR States, Nigeria

Table 24 presents findings on associations between socio-demographic characteristics and increased WC in this study. Prevalence of increased WC differed significantly by States, 40.0% in Akwa Ibom and 34.6% in Cross River State, $p = 0.045$. It was higher in rural residence (41.0%), than in urban setting (31.2%), $p < 0.001$. Compared to the 13.3% prevalence of increased WC among males, 61.5% of females had increased WC, $p < 0.001$. It also differed by age, and was higher among adults ≥ 40 years old (46.0%) than those aged < 40 years (33.3%), $p < 0.001$. Prevalence of increased WC increased steadily from 54.3% among single adults to 44.8% among married adults and then 54.3% among the widowed, $p < 0.001$, and was higher among the Ibibios (40.5%) than among the Efik/Ejakam (32.6%), $p = 0.009$.

Though not statistically significant, prevalence of increased WC decreased from 40.6% to 37.4% and 35.2% among adults with primary, secondary and tertiary education, respectively, $p = 0.621$. Prevalence of increased WC was not related to employment status ($p = 0.109$), although 41.4% of adults without employment had increased WC, against 36.4% among those with employment. Estimated household income did not have significant association with prevalence of increased WC, $p = 0.527$.

**Table 4.24a: Associations between Socio-demographic Characteristics and Increased Waist Circumference among Adults in Akwa Ibom and Cross River States, Nigeria**

| Characteristics | WC<br>Increased risk<br>n (%) | <br>Normal<br>n (%) | p-value |
|---|---|---|---|
| **State** | | | |
| Akwa Ibom | 293 (39.97.0) | 440 (60.3) | 0.045* |
| Cross river | 203 (34.6) | 384 (65.4) | |
| **Residence** | | | |
| Rural | 352 (41.0) | 506 (59.0) | 0.000* |
| Urban | 144 (31.2) | 318 (68.8) | |
| **Household Size** | | | |
| ≤ 5 | 294 (37.4) | 492 (62.6) | 0.876 |
| > 5 | 202 (37.8) | 332 (62.2) | |
| **Sex** | | | |
| Male | 87 (13.3) | 568 (86.7) | 0.000* |
| Female | 409 (61.5) | 256 (38.5) | |
| **Age (years)** | | | |
| 20 - 39 | 290 (33.3) | 582 (66.7) | 0.000* |
| ≥ 40 | 206 (46.0) | 242 (54.0) | |
| **Formal Education** | | | |
| None | 24 (36.9) | 41 (63.1) | 0.621 |
| Primary | 116 (40.6) | 170 (59.4) | |
| Secondary | 257 (37.4) | 431 (62.7) | |
| Tertiary | 99 (35.2) | 182 (64.8) | |
| **Employed** | | | |
| Yes | 366 (36.4) | 640 (63.6) | 0.109 |
| No | 130 (41.4) | 184 (58.6) | |

*n (%) – Number (Percentage)*
**Differences in* socio-demographic *characteristics across WC categories are significant at* $\alpha_{0.05}$

**Table 4.24b: Associations between Socio-demographic Characteristics and Increased Waist Circumference among Adults in Akwa Ibom and Cross River States, Nigeria**

| Characteristics | Increased risk n (%) | Normal n (%) | p-value |
|---|---|---|---|
| **Estimated Household Income** | | | |
| ≤ ₦20,000.00 | 359 (38.1) | 583 (61.9) | 0.527 |
| > ₦20,000.00 | 137 (36.2) | 241 (63.8) | |
| **Marital Status** | | | |
| Single | 107 (22.3) | 372 (77.7) | 0.000* |
| Married | 320 (44.8) | 394 (55.2) | |
| Widowed[@] | 69 (54.3) | 58 (45.7) | |
| **Ethnic Origin** | | | |
| Ibibio | 313 (40.5) | 459 (59.5) | 0.009* |
| Efik/Ejagham | 169 (32.6) | 349 (67.4) | |
| Others | 14 (46.7) | 16 (53.3) | |

*@ - includes divorced and separated individuals*
*n (%) – Number (Percentage)*
**Differences in* socio-demographic *characteristics across WC categories are significant at* $\alpha_{0.05}$

**4.5.4.1.2 : Associations of Physical Activity, Diet Quality, BMI, WHR and Hypertension with WC among Adults in AK and CR States, Nigeria.**

Table 4.25 presents findings on associations of physical activity, diet quality, BMI, WHR and hypertension with WC among adults in the study. Prevalence of increased WC had an inverse relationship with PA level among both males and females in this study, though, this observation was significant only among males, $p = 0.009$. Compared to 10.2% increased WC among adults with high PA levels, 18.4% and 19.0% of males with moderate and low PAs had increased WC. Increased WC was not related to diet quality among both males and females, $p > 0.05$.

There were significant associations between increased WC and prevalence of hypertension among both males and females in this study. Compared to 6.8% of abdominally obese men with no hypertension, 26.6% of men with increased WC were found to have hypertension, $p < 0.001$. Also, compared to 58.8% of abdominally obese females without hypertension, up to 69.1% of abdominally obese females had hypertension, $p = 0.009$.

**Table 4.25: Associations of Physical Activity, Diet Quality, BMI, WHR and Hypertension with WC among Adults in Akwa Ibom and Cross River States, Nigeria**

| | WC | | | | | |
|---|---|---|---|---|---|---|
| | Males | | | Females | | |
| **Characteristic** | **Increased Risk n (%)** | **Normal n (%)** | **p-value** | **Increased Risk n (%)** | **Normal n (%)** | **p-value** |
| **Physical Activity (METs-min/wk)** | | | 0.009 | | | 0.145 |
| Low | 12 (19.0) | 51 (81.0) | | 44 (68.8) | 20 (31.3) | |
| Moderate | 33 (18.4) | 146 (81.6) | | 138 (64.8) | 75 (35.2) | |
| High | 42 (10.2) | 371 (89.8) | | 227 (58.5) | 161 (41.5) | |
| **DQI-I** | | | 0.971 | | | 0.707 |
| Low | 27 (13.4) | 175 (86.6) | | 145 (60.9) | 93 (39.1) | |
| Moderate | 30 (12.9) | 203 (87.1) | | 132 (63.8) | 75 (36.2) | |
| High | 30 (13.6) | 190 (86.4) | | 132 (60.0) | 88 (40.0) | |
| **BMI (kg/m$^2$)** | | | 0.000 | | | 0.000 |
| Underweight | 2 (4.1) | 47 (95.9) | | 6 (11.8) | 45 (88.2) | |
| Normal weight | 10 (2.3) | 426 (97.7) | | 164 (47.0) | 185 (53.0) | |
| Overweight | 45 (38.5) | 72 (61.5) | | 136 (88.3) | 18 (11.7) | |
| Obese | 30 (56.6) | 23 (43.4) | | 103 (92.8) | 8 (7.2) | |
| **WHR** | | | 0.000 | | | 0.000 |
| Normal | 21 (5.0) | 396 (95.0) | | 61 (31.4) | 133 (68.9) | |
| Increased risk | 66 (27.7) | 172 (72.3) | | 348 (73.9) | 123 (26.1) | |
| **Hypertension** | | | 0.000 | | | 0.009 |
| Hypertensive | 57 (26.6) | 157 (73.4) | | 121 (69.1) | 54 (30.9) | |
| Non Hypertensive | 30 (6.8) | 411 (93.0) | | 288 (58.8) | 202 (41.2) | |

*WC-Waist Circumference; DQI-I-Diet Quality Index-International; BMI: body Mass Index; WHR-Waist-Hip Ratio*
*n (%)-Number (percentage*)

#### 4.5.4.2. Predictors of Increased Waist Circumference by Sex among Adults in AK and CR States, Nigeria

Information on predictors of increased WC among adults in this study are presented in Table 4.26. Adults in urban areas were less likely to have increased WC when compared to those in rural settings, (OR = 0.7; CI: 0.5, 1.0 p = 0.029) and this was particularly true among urban females (OR = 0.7; CI: 0.5, 0.9; p = 0.021), (Table 4.22). Compared to males, females had over 13 times higher risk of abdominal obesity measured by WC (OR = 13.4; CI: 9.9, 18.14; p<0.001). The risk of increased WC increased with increasing age in the whole sample (OR = 1.0; CI: 1.0, 1.0; p<0.001), and this effect cut across both sexes (OR = 1.0; CI: 1.0, 1.1; p = 0.003) for males and (OR = 1.0; CI: 1.0, 1.0; p = 0.001) for females, respectively. Also, being married was associated with increased risk of elevated WC in the whole sample (OR = 2.3; CI: 1.7, 3.1; p<0.001) as well as among both males (OR = 4.7; CI: 2.3, 9.5; p<0.001) and females (OR = 1.9; CI: 1.3, 2.6; p<0.001).

**Table 4.26: Predictors of Increased Waist Circumference by Sex among Adults in Akwa Ibom and Cross River States, Nigeria**

| | Combined | | Men | | Women | |
|---|---|---|---|---|---|---|
| | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***p*** |
| State[a] (Cross River) | 1.0 (0.5, 1.8) | 0.934 | 1.7 (0.6, 4.4) | 0.289 | 0.8 (0.4, 1.6) | 0.447 |
| Residence[b] (urban) | 0.7 (0.5, 1.0) | 0.029* | 0.9 (0.5, 1.4) | 0.560 | 0.7 (0.5, 0.9) | 0.021* |
| Sex[c] (Females) | 13.4 (9.9, 18.1) | 0.000* | | | | |
| Age (in years) | 1.0 (1.0, 1.0) | 0.000* | 1.0 (1.0, 1.1) | 0.003* | 1.0 (0.0, 1.0) | 0.001* |
| Marital status[d] (married) | 2.3 (1.7, 3.1) | 0.000* | 4.7 (2.3, 9.5) | 0.000* | 1.9 (1.3, 2.6) | 0.000* |
| Ethnic background (Ibibio as reference) | | | | | | |
| Efik/Ejagham | 0.6 (0.3, 1.2) | 0.137 | 0.5 (0.2, 1.4) | 0.188 | 0.7 (0.3, 1.4) | 0.325 |
| Others | 1.8 (0.7, 4.8) | 0.219 | 0.2 (0.2, 6.4) | 0.851 | 2.5 (0.6, 9.9) | 0.183 |
| PA (moderate/high) | 0.7 (0.4, 1.1) | 0.097 | 0.8 (0.4, 1.6) | 0.482 | 0.7 (0.4, 0.2) | 0.171 |
| DQI (moderate/high) | 1.0 (0.8, 1.4) | 0.776 | 0.9 (0.6, 1.6) | 0.794 | 1.1 (0.8, 1.5) | 0.657 |

*WC was categorized using respondents with normal WC as reference compared to respondents with increased risk of abdominal obesity*
*a-Akwa-Ibom as reference*
*b-rural as reference*
*c-males as reference*
*d-currently unmarried as reference (unmarried include singles, widowed and divorced)*
*PA-physical activity using respondents with low PA as reference*
*DQI- diet quality index using respondents with low DQI as reference*

#### 4.5.4.3. Predictors of Increased Waist Circumference among Adults by Age Groups in AK and CR States, Nigeria

Table 4.27 presents findings on independent associations of socio-demographic characteristics with elevated WC in different age groups. The risk of elevated WC was lower only among younger adults residing in urban settings (OR = 0.7; CI = 0.5, 1.0; $p=0.049$), and was significantly increased in females across age groups-(OR = 22.0; CI = 14.2, 34.3; $p<0.001$) for younger adults and (OR = 8.7; CI = 5.4, 14.0; $p<0.001$) for older adults. Increased age associated with increased risk of increased WC among younger adults only (OR = 1.1; CI = 1.1, 1.1; $p<0.001$). Being married associated with increased risk of increased WC in both younger adults (OR = 1.8; CI = 1.2, 2.6; $p = 0.002$) and older adults (OR = 1.8; CI = 1.1, 3.0; $p = 0.017$), respectively.

**Table 4.27: Predictors of Increased Waist Circumference by Age Groups among Adults in Akwa Ibom and Cross River States, Nigeria**

| | Combined Adjusted OR (95%CI) | *p* | 20 – 39 years Adjusted OR (95%CI) | *p* | >40 years Adjusted OR (95%CI) | *p* |
|---|---|---|---|---|---|---|
| State[a] (Cross River) | 1.0(0.5, 1.8) | 0.934 | 1.2 (0.6, 2.7) | 0.648 | 0.6 (0.3, 1.2) | 0.563 |
| Residence[b] (urban) | 0.7 (0.5, 1.0) | 0.029* | 0.7 (0.5, 1.0) | 0.049* | 0.8 (0.5, 1.2) | 0.231 |
| Sex[c] (Females) | 13.4 (9.9, 18.1) | 0.000* | 22.0 (14.2, 34.3) | 0.000* | 8.7 (5.4, 14.0) | 0.000* |
| Age (in years) | 1.0 (1.0, 1.0) | 0.000* | 1.1 (1.1, 1.1) | 0.000* | 1.0 (1.0, 1.0) | 0.277 |
| Marital status[d] (married) | 2.3 (1.7, 3.1) | 0.000* | 1.8 (1.2, 2.6) | 0.002* | 1.8 (1.1, 3.0) | 0.017* |
| Ethnic background (Ibibio as reference) | | | | | | |
| Efik/Ejagham | 0.6 (0.3, 1.2) | 0.137 | 0.5 (0.2, 1.1) | 0.099 | 0.9 (0.3, 2.5) | 0.891 |
| Others | 1.8 (0.7, 4.8) | 0.219 | 1.3 (0.4, 4.3) | 0.666 | 4.3 (0.7, 26.2) | 0.114 |
| PA (moderate/high) | 0.7 (0.4, 1.1) | 0.097 | 0.8 (0.4, 1.4) | 0.401 | 0.6 (0.3, 1.2) | 0.123 |
| DQI (moderate/high) | 1.0 (0.8, 1.4) | 0.776 | 1.3 (0.9, 1.9) | 0.212 | 0.9 (0.5, 1.4) | 0.547 |

*WC was categorized using respondents with normal WC as reference compared to respondents with increased risk of abdominal obesity*
*a-Akwa-Ibom as reference*
*b-rural as reference*
*c-males as reference*
*d-currently unmarried as reference (unmarried include singles, widowed and divorced)*
*PA-physical activity using respondents with low PA as reference*
*DQI- diet quality index using respondents with low DQI as reference*

#### 4.5.5.1.1 : Associations between Socio-demographic Characteristics and Increased Waist-Hip-Ratio among Adults in AK and CR States, Nigeria

Findings on associations between increased WHR with socio-demographic characteristics are presented in Table 4.28. A total of 51.2% of adults had increased WHR in Akwa Ibom State when compared to 56.9% in Cross River, the differences in these rates were statistically significant, $p = 0.038$. Increased WHR differed significantly between rural (56.9%) and urban (47.8%) centres, $p = 0.002$. It was 70.8% among females against 36.3% among males, $p < 0.001$. Abdominal obesity, measured by was more prevalent among older adults (65.3%) compared to those forty years and below (49.2%), $p < 0.001$. Increased WHR differed significantly by formal education, $p = 0.006$, and was 61.9% among those with primary education, 52.8% among adults with secondary education and 47.3% recorded for those with tertiary education. Increased WHR was 60.2% among adults with employment when compared to those without employment (51.7), $p = 0.008$. It was more prevalent among the widowed (76.4%), followed by married adults (60.8%) and unmarried (37.2%), $p < 0.001$.

**Table 4.28a: Associations between Socio-demographic Characteristics and Increased Waist-Hip-Ratio among Adults in Akwa Ibom and Cross River States, Nigeria**

| Characteristics | WHR<br>Increased risk n (%) | Normal n (%) | p-value |
|---|---|---|---|
| **State** | | | |
| Akwa Ibom | 375 (51.2) | 358 (48.8) | 0.038* |
| Cross river | 334 (56.9) | 253 (43.1) | |
| **Residence** | | | |
| Rural | 488 (56.9) | 370 (43.1) | 0.002* |
| Urban | 221 (47.8) | 241 (52.2) | |
| **Household Size** | | | |
| ≤ 5 | 410 (52.2) | 376 (47.8) | 0.094 |
| > 5 | 299 (56.0) | 235 (44.0) | |
| **Sex** | | | |
| Male | 238 (36.3) | 417 (63.7) | 0.000* |
| Female | 471 (70.8) | 194 (29.2) | |
| **Age (years)** | | | |
| 20 - 39 | 416 (47.7) | 456 (52.3) | 0.000* |
| ≥ 40 | 293 (65.4) | 155 (34.6) | |
| **Formal Education** | | | |
| None | 36 (55.4) | 29 (44.6) | 0.006* |
| Primary | 177 (61.9) | 109 (38.1) | |
| Secondary | 363 (52.8) | 325 (47.2) | |
| Tertiary | 133 (47.3) | 148 (52.7) | |
| **Employment** | | | |
| Yes | 520 (51.7) | 486 (48.3) | 0.008* |
| No | 189 (60.2) | 125 (39.8) | |

**Differences in* socio-demographic *characteristics between WHR categories are significant at* $\alpha_{0.05}$
*n (%)-Number (percentage***)**

**Table 4.28b: Associations between Socio-demographic Characteristics and Increased Waist-Hip-Ratio among Adults in Akwa Ibom and Cross River States, Nigeria**

| | WHR | | |
|---|---|---|---|
| **Characteristics** | **Increased risk n (%)** | **Normal n (%)** | **p-value** |
| **Estimated Household Monthly Income** | | | |
| ≤ ₦20,000.00 | 510 (54.1) | 432 (45.9) | 0.622 |
| > ₦20,000.00 | 199 (52.7) | 179 (47.4) | |
| **Marital Status** | | | |
| Single | 178 (37.2) | 301 (62.8) | 0.000* |
| Married | 434 (60.8) | 280 (39.2) | |
| Widowed[@] | 97 (76.4) | 30 (23.6) | |
| **Ethnic origin** | | | |
| Ibibio | 399 (51.7) | 373 (48.3) | 0.115 |
| Efik/Ejagham | 296 (57.1) | 222 (42.9) | |
| Others | 14 (46.7) | 16 (53.3) | |

*@ - includes divorced and separated individuals*
**Differences in* socio-demographic *characteristics between WHR categories are significant at* $\alpha_{0.05}$
*n (%)-Number (percentage*)

#### 4.5.5.1.2 : Associations of Physical Activity, Diet Quality, BMI, WC and Hypertension with WHR among Adults in AK and CR States, Nigeria

Table 4.29 presents findings on the associations of physical activity, diet quality, BMI, WC and hypertension with WHR among adults **in** the study. Findings revealed that, prevalence of increased WHR was higher among participants with high PA levels in males ($p = 0.009$). There was no association between physical activity and WHR in females ($p>0.05$). When assessing the association between BMI and WHR among adults in the study, it was revealed that, a substantial proportion of both males and females with normal BMI values had increased WHR. A total of 130 (29.8%) of males and 234 (67.0%) of females with normal BMI had increased WHR. Prevalence of hypertension differed significantly with increased WHR only among males, ($p =0.035$).

**Table 4.29: Associations of Physical Activity, Diet Quality, BMI, WC and Hypertension with WHR among Adults in Akwa Ibom and Cross River States, Nigeria**

| | WHR | | | | | |
|---|---|---|---|---|---|---|
| | Males | | | Females | | |
| **Characteristic** | Increased Risk **n (%)** | Normal **n (%)** | **p-value** | Increased Risk **n (%)** | Normal **n (%)** | **p-value** |
| **Physical Activity (METs-min/wk)** | | | 0.009 | | | 0.764 |
| Low | 31 (49.2) | 32 (50.8) | | 44 (68.8) | 20 (31.3) | |
| Moderate | 74 (41.3) | 105 (58.7) | | 148 (69.5) | 65 (30.5) | |
| High | 133 (32.2) | 280 (67.8) | | 279 (71.9) | 109 (28.1) | |
| **DQI-I** | | | 0.493 | | | 0.498 |
| Low | 67 (33.2) | 135 (66.8) | | 162 (68.1) | 76 (31.9) | |
| Moderate | 86 (39.6) | 147 (63.1) | | 149 (72.0) | 58 (28.0) | |
| High | 85 (38.6) | 135 (61.4) | | 160 (72.7) | 60 (27.3) | |
| **BMI (kg/m$^2$)** | | | 0.000 | | | 0.000 |
| Underweight | 18 (36.7) | 31 (63.3) | | 22 (43.1) | 29 (56.9) | |
| Normal weight | 130 (29.8) | 306 (70.2) | | 234 (67.0) | 115 (33.0) | |
| Overweight | 59 (50.4) | 58 (49.6) | | 118 (76.6) | 36 (23.4) | |
| Obese | 31 (58.5) | 22 (41.5) | | 97 (87.4) | 14 (12.6) | |
| **WC (cm)** | | | 0.000 | | | 0.000 |
| Normal | 172 (30.3) | 396 (69.7) | | 123 (48.0) | 133 (52.0) | |
| Increased risk | 66 (75.9) | 21 (24.1) | | 348 (85.1) | 61 (14.9) | |
| **Hypertension** | | | 0.001 | | | 0.071 |
| Hypertensive | 97 (45.3) | 117 (54.7) | | 132 (75.4) | 43 (24.6) | |
| Non Hypertensive | 141 (32.0) | 300 (68.0) | | 339 (69.2) | 151 (30.8) | |

*WHR-Waist-Hip Ratio; DQI-I-Diet Quality Index-International; BMI-Body Mass Index; WC-Waist Circumference*
*n (%)-Number (percentage)*

#### 4.5.5.2 : Predictors of Increased Waist- Hip-Ratio by Sex among Adults in AK and CR States, Nigeria

Findings on independent associations of socio-demographic characteristics with increased WHR are presented in Table 4.30. The risk of increased WHR was not related to States, but when stratified into sex, the males in Cross River State were about 1.5 times more likely to have increased WHR, when compared to those in Akwa Ibom, (OR = 1.5; CI: 1.1, 2.2; p = 0.048). The female sex and higher age constituted significant predictors of increased WHR in the whole sample. Females were 4 times more likely to have increased WHR (OR = 4.8; CI: 3.7, 6.1; p<0.001) when compared to males. Every year increase in age was associated with a unit increase in the risk of increased WHR (OR = 1.0; CI: 1.0, 1.1; p<0.001) in the whole sample, and was applicable to both males (OR = 1.0; CI: 1.0, 1.1; p<0.001) and females (OR = 1.0; CI: 1.0, 1.0; p = 0.002). Increased risk of increased WHR was associated with secondary education only among men (OR = 3.3; CI = 1.0, 11.0; p<0.048). Compared to unmarried adults, the risk of increased WHR was significantly increased among married adults in the whole sample (OR = 1.6; CI: 1.2, 2.1; p<0.001), this observation was obtained for both males (OR = 1.5; CI: 1.0, 2.3; p = 0.033) and females (OR = 1.6; CI: 1.1, 2.3; p = 0.011).

**Table 4.30. Predictors of Increased Waist- Hip-Ratio by Sex among Adults in Akwa Ibom and Cross River States, Nigeria**

| | Combined | | Men | | Women | |
|---|---|---|---|---|---|---|
| | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***p*** |
| State[a] (Cross River) | 1.2 (0.9, 1.5) | 0.168 | 1.5 (1.1, 2.2) | 0.016* | 0.9 (0.7, 1.3) | 0.700 |
| Residence[b] (urban) | 0.8 (0.6, 1.0) | 0.072 | 0.9 (0.7, 1.3) | 0.738 | 0.7 (0.5, 1.0) | 0.052 |
| Sex[c] (Females) | 4.8 (3.7, 6.1) | 0.000* | | | | |
| Age (in years) | 1.0 (1.0, 1.1) | 0.000* | 1.0 (1.0, 1.1) | 0.000* | 1.0 (1.0, 1.0) | 0.002* |
| Education (none as reference) | | | | | | |
| Primary | 1.6 (0.9, 3.1) | 0.114 | 2.8 (0.8, 9.4) | 0.106 | 1.5 (0.7, 3.5) | 0.308 |
| Secondary | 1.5 (0.8, 2.6) | 0.216 | 3.3 (1.0, 11.0) | 0.048* | 1.0 (0.5, 2.2) | 0.944 |
| Tertiary | 1.2 (0.6, 2.2) | 0.609 | 2.9 (0.9, 9.6) | 0.088 | 0.8 (0.3, 1.7) | 0.516 |
| Employment[d] (yes) | 0.8 (0.6, 1.0) | 0.082 | 0.7 (0.4, 1.0) | 0.052 | 0.9 (0.6, 1.3) | 0.529 |
| Marital status[e] (married) | 1.6 (1.2, 2.1) | 0.000* | 1.5 (1.0, 2.3) | 0.033* | 1.6 (1.1, 2.3) | 0.011* |
| PA (moderate/high) | 0.9 (0.6, 1.3) | 0.445 | 0.7 (0.4, 1.2) | 0.149 | 1.1 (0.6, 1.9) | 0.854 |
| DQI (moderate/high) | 1.2 (0.9, 1.5) | 0.248 | 1.1 (0.8, 1.7) | 0.511 | 1.2 (0.9, 1.8) | 0.275 |

*WHR was categorized using respondents with normal WHR as reference compared to respondents with increased risk of abdominal obesity*
*a-Akwa-Ibom as reference*
*b-rural as reference*
*c-males as reference*
*d-unemployed as reference*
*e-currently unmarried as reference (unmarried include singles, widowed and divorced)*
*PA-physical activity using respondents with low PA as reference*
*DQI- diet quality index using respondents with low DQI as reference*

#### 4.5.5.3 Predictors of Increased Waist- Hip-Ratio by Age groups among Adults in AK and CR States, Nigeria

Findings on independent associations of socio-demographic characteristics with increased Waist-Hip-Ratio are presented in Table 4.31. The effect of female sex on increased WHR persisted across age groups, (OR = 5.4; CI: 3.9, 7.3; $p<0.001$) for younger females and (OR = 3.6; CI: 2.3, 5.7; $p<0.001$) for older females. Waist-Hip-Ratio was lower in urban residence among older adults only (OR = 0.6; CI: 0.4, 1.0; p = 0.036) and increased by increased age among younger adults (OR = 1.1; CI: 1.0, 1.1; $p<0.001$). Being married was associated with increased risk of elevated WHR only among younger adults (OR = 1.7; CI = 1.2, 2.3; p=0.003).

**Table 4.31. Predictors of Increased Waist- Hip-Ratio by Age groups among Adults in Akwa Ibom and Cross River States, Nigeria**

| | Combined | | 20 – 39 years | | >40 years | |
|---|---|---|---|---|---|---|
| | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***p*** |
| State[a] (Cross River) | 1.2 (0.9, 1.5) | 0.168 | 1.3 (1.0, 1.8) | 0.083 | 1.1 (0.7, 1.7) | 0.662 |
| Residence[b] (urban) | 0.8 (0.6, 1.0) | 0.072 | 0.9 (0.7, 1.3) | 0.602 | 0.6 (0.4, 1.0) | 0.036* |
| Sex[c] (Females) | 4.8 (3.7, 6.1) | 0.000* | 5.4 (3.9, 7.3) | 0.000* | 3.6 (2.3, 5.7) | 0.000* |
| Age (in years) | 1.0 (1.0, 1.1) | 0.000* | 1.1 (1.0, 1.1) | 0.000* | 1.0 (1.0, 1.0) | 0.663 |
| Education (none as reference) | | | | | | |
| Primary | 1.6 (0.9, 3.1) | 0.114 | 2.2 (0.8, 5.6) | 0.110 | 1.4 (0.6, 3.5) | 0.421 |
| Secondary | 1.5 (0.8, 2.6) | 0.216 | 2.0 (0.8, 4.9) | 0.135 | 1.1 (0.5, 2.5) | 0.869 |
| Tertiary | 1.2 (0.6, 2.2) | 0.609 | 1.6 (0.6, 4.0) | 0.343 | 0.9 (0.4, 2.3) | 0.874 |
| Employment[d] (yes) | 0.8 (0.6, 1.0) | 0.082 | 0.8 (0.5, 1.1) | 0.108 | 0.8 (0.5, 1.3) | 0.359 |
| Marital status[e] (married) | 1.6 (1.2, 2.1) | 0.000* | 1.7 (1.2, 2.3) | 0.003* | 1.0 (0.6, 1.7) | 0.925 |
| PA (moderate/high) | 0.9 (0.6, 1.3) | 0.445 | 1.0 (0.6, 1.6) | 0.844 | 0.7 (0.4, 1.5) | 0.389 |
| DQI (moderate/high) | 1.2 (0.9, 1.5) | 0.248 | 1.2 (0.9, 1.7) | 0.217 | 1.1 (0.7, 1.7) | 0.743 |

*WHR was categorized using respondents with normal WHR as reference compared to respondents with increased risk of abdominal obesity*
*a-Akwa-Ibom as reference*
*b-rural as reference*
*c-males as reference*
*d-unemployed as reference*
*e-currently unmarried as reference (unmarried include singles, widowed and divorced)*
*PA-physical activity using respondents with low PA as reference*
*DQI- diet quality index using respondents with low DQI as reference*

### 4.6.0 Objective Five: Determine the prevalence of hypertension and its associations with diet quality and physical activity among adults in AK and CR States, Nigeria.

1. Blood pressure measurements were classified based on the JNC-8 guidelines on prevention, detection, evaluation and treatment of Hypertension.
2. Results on blood pressure measurements were presented in mean (±SD).
3. Prevalence of hypertension was reported in number and percentages.
4. Statistical differences in mean blood pressure measurements between States were determined using the independent samples t-Test, while, Chi-Square test and multiple logistic regressions were conducted to assess relationships between obesity and socio-demographic characteristics.

#### 4.6.1.1 Mean Blood Pressure Measurements and Prevalence of Hypertension among Adults in AK and CR States, Nigeria

Findings on mean blood pressure measurements and blood pressure categories are found in Table 4.32. Mean SBP and DBP were 122.2±14.9 mmHg and 79.1±12.6 mmHg, respectively. While the mean DBP was within the normal range, mean SBP fell within the range defined for pre-hypertension. The overall prevalence of hypertension was 29.5%; (28.5% in Akwa Ibom and 30.7% in Cross River State). Prevalence of pre-hypertension was 47.3%; Akwa Ibom had 49.2% prevalence, while Cross River State had 44.8%.

**Table 4.32: Mean Blood Pressure Measurements and Prevalence of Hypertension among Adults in Akwa Ibom and Cross River States, Nigeria**

| **Characteristics** | | **Akwa Ibom** | **Cross River** | **Total** |
|---|---|---|---|---|
| Blood Pressure | Mean±SD SBP | 123.0±13.19 | 121.3±16.7 | 122.2±14.9 |
| | Mean±SD DBP | 78.73±10.76 | 79.6±14.6 | 79.1±12.6 |
| Blood Pressure Classifications | Normal | 163 (22.2) | 144 (24.5) | 307 (23.3) |
| | Pre-Hypertension | 361 (49.3) | 263 (44.8) | 624 (47.3) |
| | Stage I Hypertension | 160 (21.8) | 92 (15.7) | 252 (19.1) |
| | Stage II Hypertension | 49 (6.9) | 88 (15.0) | 137 (10.4) |
| | Overall Hypertension | 209 (28.5) | 180 (30.7) | 389 (29.5) |

#### 4.6.1.2. Mean Blood Pressure Measurements and Prevalence of Hypertension between Adult Males and Females in AK and CR States, Nigeria

Findings on mean blood pressure measurements and blood pressure categories among males and females are found in Table 4.33. Mean systolic blood pressure among males was 122.82±13.37 mmHg, while that of females was 121.64±16.19 mmHg. Mean diastolic blood pressure among males was 79.56±12.26 mmHg, and that of females was 78.66±12.88 mmHg, respectively.

**Table 4.33: Mean Blood Pressure Measurements and Prevalence of Hypertension between Adult Males and Females in Akwa Ibom and Cross River States, Nigeria**

| **Characteristics** | | **Males** | **Females** | **p-value** |
|---|---|---|---|---|
| Mean Blood Pressure | Mean±SD SBP | 122.82±13.37 | 121.64±16.19 | 0.140 |
| | Mean±SD DBP | 79.56±12.26 | 78.66±12.88 | 0.197 |
| Blood Pressure Classifications | Normal | 131 (20.0) | 176 (26.5) | 0.008 |
| | Pre-Hypertension | 310 (47.3) | 314 (47.2) | |
| | Stage I Hypertension | 144 (22.0) | 108 (16.2) | |
| | Stage II Hypertension | 70 (10.7) | 67 (10.1) | |
| | Overall Hypertension | 214 (32.7) | 175 (26.3) | |

#### 4.6.2.1.1 Associations between Socio-demographic Characteristics and Hypertension among Adults in AK and CR States, Nigeria

Findings on associations between high blood pressure and socio-demographic characteristics are presented in Table 4.34. Prevalence of high blood pressure differed significantly by sex and were 32.7% and 26.3% among males and females, respectively, $p = 0.011$. Hypertension related significantly with age, $p < 0.05$, and was 20.6% and 46.7% among younger and older adults, respectively. Prevalence of high blood pressure was 27.1% among adults with ≤ N20, 000.00 estimated household income compared to 35.4% recorded for those with higher income, and was significantly related to income in this study, $p = 0.003$. Hypertension increased significantly from 19.4% among single adults to 34.2% among married counterparts and then to 40.9% among the widowed, $p < 0.001$.

Hypertension was higher in urban areas (32.5%) than in rural settings, 27.9%, though not statistically significant, $p = 0.080$. Hypertension was not related to education in this study $p = 0.757$, and was higher among those with no formal education 35.4% and lowest among those with tertiary education, 28.8%. Though not related to employment status, ($p = 0.055$), prevalence of hypertension was 25.2% among adults with no employment and 30.8% among those with employment.

**Table 4.34a: Associations between Socio-demographic Characteristics and Hypertension among Adults in Akwa Ibom and Cross River States, Nigeria**

| | Hypertension | | |
|---|---|---|---|
| **Characteristics** | **Hypertensive n (%)** | **Non Hypertensive n (%)** | **p-value** |
| **State** | | | |
| Akwa Ibom | 209 (28.5) | 524 (71.5) | 0.394 |
| Cross river | 180 (30.7) | 407 (69.3) | |
| **Residence** | | | |
| Rural | 239 (27.9) | 619 (72.1) | 0.080 |
| Urban | 150 (32.5) | 312 (67.5) | |
| **Household Size** | | | |
| ≤ 5 | 223 (28.4) | 563 (71.6) | 0.288 |
| > 5 | 166 (31.1) | 368 (68.9) | |
| **Sex** | | | |
| Male | 214 (32.7) | 441 (67.3) | 0.011* |
| Female | 175 (26.3) | 490 (73.7) | |
| **Age (years)** | | | |
| 20 - 39 | 180 (20.6) | 692 (79.4) | 0.000* |
| ≥ 40 | 209 (46.7) | 239 (53.3) | |
| **Formal Education** | | | |
| None | 23 (35.4) | 42 (64.6) | 0.757 |
| Primary | 83 (29.0) | 203 (71.0) | |
| Secondary | 202 (29.4) | 486 (70.6) | |
| Tertiary | 81 (28.8) | 200 (71.2) | |
| **Employment** | | | |
| Yes | 310 (30.8) | 696 (69.2) | 0.055 |
| No | 79 (25.2) | 235 (74.8) | |

*n (%) – Number (Percentage)*

**Differences in* socio-demographic *characteristics between blood pressure categories are significant at* $\alpha_{0.05}$

**Table 4.34b: Associations between Socio-demographic Characteristics and Hypertension among Adults in Akwa Ibom and Cross River States, Nigeria**

| Characteristics | Hypertension Hypertensive n (%) | Non Hypertensive n (%) | p-value |
|---|---|---|---|
| **Estimated Household Income** | | | |
| ≤ ₦20,000.00 | 255 (27.1) | 687 (72.9) | 0.003* |
| > ₦20,000.00 | 134 (35.5) | 244 (64.6) | |
| **Marital Status** | | | |
| Single | 93 (19.4) | 386 (80.6) | 0.000* |
| Married | 244 (34.2) | 470 (65.8) | |
| Widowed@ | 42 (42.9) | 75 (59.1) | |
| **Ethnic Origin** | | | |
| Ibibio | 222 (28.8) | 550 (71.2) | 0.795 |
| Efik/Ejagham | 158 (30.5) | 360 (69.5) | |
| Others | 9 (30.0) | 21 (70.0) | |

*n (%) – Number (Percentage)*
**Differences in* socio-demographic *characteristics between blood pressure categories are significant at* $\alpha_{0.05}$

#### 4.6.2.1.2 : Associations of Physical Activity, Diet Quality, BMI and WC with Hypertension among Adults in AK and CR States, Nigeria

There was no association between physical activity and hypertension among adults in this study, $p > 0.05$, (Table 4.35). While the prevalence of hypertension among females with moderate diet quality was 30.9%, about 28.2% of those with high diet quality had hypertension. Prevalence of hypertension was associated with diet quality only among females, $p = 0.035$. The BMI had significant associations with hypertension among both males and females in the study, $p < 0.001$. Among males, prevalence of both OW (56.4%) and OB (54.7%) were higher among those with hypertension when compared to 43.6% and 45.3% reported among males with no hypertension. Among females, prevalence of both OW (35.1%) and OB (36.9%) were higher among those with hypertension when compared to 64.9% and 63.1% reported among females with no hypertension.

Prevalence of hypertension among males with increased WC (65.5%) was higher than the value (27.6%) recorded for those with normal WC. Among females, prevalence of hypertension was higher among those with increased WC (29.6%) when compared to 21.1% hypertension observed among those with normal WC. Increased WC had significant relationships with prevalence of hypertension among both males and females, $p < 0.05$. Prevalence of hypertension had significant associations with increased WHR only among males in the study, $p = 0.001$. While 40.8% of males with increased WHR had hypertension, hypertension was found in 28.1% of males with normal WHR. Prevalence of hypertension (28.0%) was higher among females with increased WHR, when compared to 22.2% reported among those with normal values; however, this difference was not statistically significant, $p = 0.071$.

**Table 4.35: Associations of Physical Activity, Diet Quality, BMI and WC with Hypertension among Adults in Akwa Ibom and Cross River States, Nigeria**

| | Hypertension | | | | | |
|---|---|---|---|---|---|---|
| | Males | | | Females | | |
| **Characteristic** | **Hypertensive n (%)** | **Non Hypertensive n (%)** | **p-value** | **Hypertensive n (%)** | **Non Hypertensive n (%)** | **p-value** |
| **Physical Activity (METs-min/wk)** | | | 0.166 | | | 0.961 |
| Low | 24 (38.1) | 39 (61.9) | | 16 (25.0) | 48 (75.0) | |
| Moderate | 66 (36.9) | 113 (63.1) | | 57 (26.8) | 156 (73.2) | |
| High | 124 (30.0) | 289 (70.0) | | 102 (26.3) | 286 (73.7) | |
| **DQI** | | | 0.114 | | | 0.035 |
| Low | 59 (29.2) | 143 (70.8) | | 49 (20.6) | 189 (79.4) | |
| Moderate | 88 (37.8) | 145 (62.2) | | 64 (30.9) | 143 (69.1) | |
| High | 67 (30.5) | 153 (69.5) | | 62 (28.2) | 158 (71.8) | |
| **BMI ($kg/m^2$)** | | | 0.000 | | | 0.000 |
| Underweight | 9 (18.4) | 40 (81.6) | | 10 (19.6) | 41 (80.4) | |
| Normal weight | 110 (25.2) | 326 (74.8) | | 70 (20.1) | 279 (79.9) | |
| Overweight | 66 (56.4) | 51 (43.6) | | 54 (35.1) | 100 (64.9) | |
| Obese | 29 (54.7) | 24 (45.3) | | 41 (36.9) | 70 (63.1) | |
| **WC (cm)** | | | 0.000 | | | 0.009 |
| Normal | 157 (27.6) | 411 (72.4) | | 54 (21.1) | 202 (78.9) | |
| Increased risk | 57 (65.5) | 30 (34.5) | | 121 (29.6) | 288 (70.4) | |
| **WHR** | | | 0.001 | | | 0.071 |
| Normal | 117 (28.1) | 300 (71.9) | | 43 (22.2) | 151 (77.8) | |
| Increased risk | 97 (40.8) | 141 (59.2) | | 132 (28.0) | 339 (72.0) | |

*DQI-Diet Quality Index-International; BMI-Body Mass Index; WC- Waist Circumference, WHR-Waist-Hip Ratio*
*n (%)-Number (percentage)*

#### 4.6.2.2 Predictors of Hypertension by Sex among Adults in AK and CR States, Nigeria

Compared to males, risk of hypertension was significantly lower among females (OR = 0.5; CI: 0.4, 0.7; $p < 0.001$), Table 4.36. Increasing age, higher BMI and diet quality all increased hypertension risk in the whole sample, $p<0.05$. Compared to younger age, the risk of hypertension was 3 times higher in older adults (OR = 3.1; CI: 2.4, 4.2; $p < 0.001$), and was applicable to both sexes (OR = 2.1; CI: 1.4, 3.2; $p < 0.001$) for males and (OR = 4.3; CI: 2.8, 6.4; $p < 0.001$) for females, respectively. Having employment increased the risk of hypertension only in females (OR = 1.9; CI = 1.2, 3.1; $p = 0.008$). Compared to low diet quality, higher diet quality significantly increased the risk of hypertension in the whole sample (OR = 1.4; CI = 1.0, 1.8; $p = 0.031$), and this was attributable to increased risk of hypertension among females with high diet quality (OR = 1.6; CI = 1.0, 2.4; $p = 0.037$). Risk of hypertension with increased WC was only observed among men (OR = 2.3; CI = 1.2, 4.1; $p = 0.007$).

**Table 4.36: Predictors of Hypertension by Sex among Adults in Akwa Ibom and Cross River States, Nigeria**

| | Combined | | Men | | Women | |
|---|---|---|---|---|---|---|
| | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***p*** |
| Sex[a] (Females) | 0.5 (0.4, 0.7) | 0.000* | | | | |
| Age (>40years) | 3.1 (2.4, 4.2) | 0.000* | 2.1 (1.4, 3.2) | 0.000* | 4.3 (2.8, 6.4) | 0.000* |
| Employment[b] (yes) | 1.3 (0.9, 1.8) | 0.142 | 0.9 (0.6, 1.4) | 0.552 | 1.9 (1.2, 3.1) | 0.008* |
| Income[c] (>₦20,000) | 1.2 (0.9, 1.6) | 0.180 | 1.1 (0.7, 1.6) | 0.646 | 1.2 (0.8, 1.9) | 0.349 |
| Marital status[d] (married) | 1.0 (0.8, 1.3) | 0.953 | 1.2 (0.8, 1.8) | 0.348 | 0.9 (0.6, 1.3) | 0.548 |
| PA (moderate/high) | 1.1 (0.7, 1.8) | 0.558 | 1.0 (0.5, 1.9) | 0.967 | 1.2 (0.6, 2.4) | 0.595 |
| DQI (moderate/high) | 1.4 (1.0, 1.8) | 0.031* | 1.2 (0.8, 1.8) | 0.353 | 1.6 (1.0, 2.4) | 0.037* |
| BMI (overweight/obese) | 2.3 (1.7, 3.1) | 0.000* | 2.4 (1.5, 3.7) | 0.000* | 2.1 (1.4, 3.3) | 0.001* |
| WC (increased risk) | 1.4 (1.0, 2.1) | 0.052 | 2.3 (1.2, 4.1) | 0.007* | 1.1 (0.7, 1.8) | 0.695 |

*a-males as reference*
*b-unemployed as reference*
*c-lower income as reference*
*d-currently unmarried as reference (unmarried include singles, widowed and divorced)*
*PA-physical activity using respondents with low PA as reference*
*DQI- diet quality index using respondents with low DQI as reference*

#### 4.6.2.3 Predictors of Hypertension by Age Groups among Adults in AK and CR States, Nigeria

Table 4.37 presents information on predictors of hypertension among adults in different age groups. When stratified into age, effect of gender on hypertension was particularly lower in females below forty years (OR = 0.4; CI = 0.2, 0.6; $p < 0.001$). Employment increased hypertension only in younger adults (OR = 1.7; CI = 1.1, 2.6; p = 0.026). Higher diet quality particularly increased the risk of hypertension in younger adults (OR = 2.2; CI = 1.5, 3.3; $p < 0.001$). Higher BMI increased hypertension in both age groups- (OR = 2.2; CI = 1.5, 3.3; $p<0.001$) for younger adults and (OR = 3.1; CI = 1.9, 5.1; $p< 0.001$) for older adults, respectively. Risk of hypertension with increased WC was only observed among men (OR = 2.3; CI = 1.2, 4.1; p = 0.007) as well as younger adults, (OR = 1.8; CI = 1.1, 3.2; p = 0.031).

**Table 4.37: Predictors of Hypertension by Age Groups among Adults in Akwa Ibom and Cross River States, Nigeria**

| | Combined | | 20 – 39 years | | >40 years | |
|---|---|---|---|---|---|---|
| | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***p*** | **Adjusted OR (95%CI)** | ***p*** |
| Sex[a] (Females) | 0.5 (0.4, 0.7) | 0.000* | 0.4 (0.2, 0.6) | 0.000* | 0.8 (0.5, 1.4) | 0.454 |
| Age (>40years) | 3.1 (2.4, 4.2) | 0.000* | | | | |
| Employment[b] (yes) | 1.3 (0.9, 1.8) | 0.142 | 1.7 (1.1, 2.6) | 0.026* | 0.9 (0.6, 1.5) | 0.674 |
| Income[c] (>₦20,000) | 1.2 (0.9, 1.6) | 0.180 | 1.1 (0.8, 1.7) | 0.569 | 1.3 (0.81, 1.9) | 0.314 |
| Marital status[d] (married) | 1.0 (0.8, 1.3) | 0.953 | 1.0 (0.7, 1.5) | 0.963 | 1.0 (0.6, 1.6) | 0.986 |
| PA (moderate/high) | 1.1 (0.7, 1.8) | 0.558 | 1.0 (0.5, 1.8) | 0.963 | 1.3 (0.7, 2.5) | 0.490 |
| DQI (moderate/high) | 1.4 (1.0, 1.8) | 0.031* | 2.2 (1.5, 3.3) | 0.000* | 0.7 (0.5, 1.1) | 0.170 |
| BMI (overweight/obese) | 2.3 (1.7, 3.1) | 0.000* | 2.2 (1.4, 3.3) | 0.000* | 3.1 (1.9, 5.1) | 0.000* |
| WC (increased risk) | 1.4 (1.0, 2.1) | 0.052 | 1.8 (1.1, 3.2) | 0.031* | 0.9 (0.6, 1.6) | 0.776 |

*a-males as reference*
*b-unemployed as reference*
*c-lower income as reference*
*d-currently unmarried as reference (unmarried include singles, widowed and divorced)*
*PA-physical activity using respondents with low PA as reference*
*DQI- diet quality index using respondents with low DQI as reference*

# CHAPTER FIVE

# DISCUSSION

## 5.1 Socio-demographic Information

The participants in this study comprised of mostly Christians. This is because, Christianity is the most popular religion in South South Nigeria, of which Akwa Ibom and Cross River States are included. Most respondents in this study were of middle age, as indicated in the overall mean age reported in the study. The age range of respondents in this study is comparable to 31.7 years reported among respondents in a study on hypertension in South South Nigeria (Ekanen *et al.,* 2013), but lower than 46.0 years among participants of the study on abdominal obesity and its correlates in Tanzania (Munyogwa and Mtumwa, 2018). However, Onuoha *et al.* (2016) reported a much lower mean age (25.4 years) among participants in a study on central obesity and blood pressure in South East Nigeria. Most respondents in the present study attained at least secondary education, an indication that most are literate. Findings indicate that, agricultural activities are predominant as occupation in the region.

## 5.2 Objective One: Assess nutrient intake adequacy of adults in AK and CR States, Nigeria.

This study evaluated the adequacy of nutrients intakes in the population. The overall mean value for energy intake in this study can be compared to the range of 1,831.9 to 2,496.3Kcal reported among adults in two South Eastern States in Nigeria (Davidson and Ene-Obong, 2017). Mean energy intake among adults in this study is however lower than the value of 11,475kj which is equivalent to 2,742.6 Kcal reported among Black women in South Africa (Hattingh, Walsh, Bester, and Oguntibeju, 2008) but higher than 1,547.5kcal to 1,583.2Kcal of energy intake reported among women in Southern Ethiopia (Asayehu, Lachat, Henauw, and Gebreyesus, 2017), as well as 1,627kcal recorded among adult women in Osun State, Nigeria (Oladoyinbo *et al.,* 2017). High energy intakes were also reported among South African adults across sex and age groups, with mean intakes exceeding recommended values (Kolahdooz, Spearing, and Sharma, 2013). Energy intake adequacy was lower among adult males in this study. Similar observations were made among rural males and females in two South Eastern States in Nigeria (Davidson and Ene-Obong, 2017). Consuming diets that provide sufficient intake of energy, particularly when selected from nutrient dense foods is desirable to cater for daily energy needs while ensuring adequate intake of nutrients, and as well protect against problems of protein energy malnutrition on a long term basis. Where energy intake is sub-optimal, consumption of other essential nutrients are likely to fall below recommended levels (Kim *et al.,* 2015; Angeles-agdeppa *et al.,* 2019). However, individuals must avoid excessive energy intake.

Protein intake adequacy among adults in this study exceeded 100% of the RNI values for both men and women. Adequate protein intakes have been observed in adult populations in selected locations in Nigeria. A study in South Western Nigeria indicated that, up to 85.6% of the study population attained adequate protein intake (Oladoyinbo *et al.,* 2017). Also Davidson and Ene-Obong, (2017) recorded protein intake adequacy that ranged from 74.2% to 98.9% among adults in South Eastern Nigeria. The observation that both males and females exceeded protein recommendations in this study is contrary to the common notion that, the African diet is most often characterized by poor consumption of protein sources (Mustapha, 2014; Agada and Igbokwe, 2015; Ahmed and Salih, 2019). Akwa Ibom and Cross River States in Nigeria are located in coastal regions. This implies that individuals and families in the region could have access to ample supplies of assorted sea foods, in addition to other protein sources in the region. The availability of these foods in the region again translates to sufficient consumption of high quality proteins in the population.

Fibre intake was below recommendations in this study. The observation that fibre intake was low in this study could have resulted in part from limited data on dietary fibre contents of most indigenous foods/dishes in Nigeria, which made it difficult to estimate fibre intakes among respondents in the study. It could also have resulted from the changing dietary intake patterns observed recently in developing countries (Otemuyiwa and Adewusi, 2014). Moreover, consumption of vegetables (which constitutes a proven strategy for ensuring optimum intake of dietary fibre now falls below recommended intake levels in most settings (Olawuyi and Adeoye, 2018; Raaijmakers *et al.,* 2018).

Micronutrient intakes, especially vitamins A, B1, B2, thiamine, riboflavin, folate and calcium were suboptimal for most adults in the study. The study in South Eastern region in Nigeria reported adequate intake levels for calcium to range from 50.9% to 80.9% in the study populations. This is however higher than 34.6% to 39.4% reported in the present study. Whereas, only 1.6% attained adequate calcium intakes among women in Iwo, a community in South Western Nigeria (Oladoyinbo *et al.*, 2017). Mekonnen, Trijsburg, Achterbosch, Brouwer, Kennedy, Linderhof, Ruben, and Talsma, (2021) reported shortfalls in adequate intakes of certain micronutrients including iron and riboflavin. Inadequate micronutrient intakes constitute a common problem globally, including Nigeria (Harika and Faber, 2015; Angeles-agdeppa *et al*., 2019). Findings on micronutrient intakes in this study corroborate the report that, the continuous decline in the micronutrient density of meals occurs only in the African region (Beal, Massiot, Arsenault, and Smith, 2017). Micronutrient deficiencies as observed in this study may have resulted from the prevailing dietary patterns in the African region. It is a commonplace for individuals to adopt intake patterns that consist predominantly of starchy staples, with moderate intakes of legumes, pulses, fish and vegetables, but with minimal intakes of fruits and animal source foods, especially egg and dairy products (Mustapha, 2014; Agada and Igbokwe, 2015; Ahmed and Salih, 2019).

## 5.3 Objective Two: Assess the quality of diets among adults in AK and CR States, Nigeria.

Findings from this study indicated that the overall dietary intakes among adults in the region is of average quality, an observation indicating a trend similar to diet quality across some other regions. The mean DQI-I value obtained in this study is comparable to 59.1 ± 8.7 to 61.7 ± 7.1 reported among Korean women (Shin *et al.*, 2015); as well as 59.5 ± 0.3 reported among adults in Tunisia (Abassi, Sassi, Ati, Gharbia, Delpeuch, and Traissac, 2019). Within Nigeria, a study on diet quality among women of reproductive age recorded a mean DQI-I value of 58.8 ± 8.1 (Onyeji and Sanusi, 2018). Good quality diets are important for ensuring adequate supplies of essential nutritional elements while limiting the risk of diet related diseases.

Within the DQI-I assessed in this study, the within-group variety for protein sources had minimal representation in the overall diets, and implying adults in these regions do not consider the importance of selecting foods across and within major food groups. Abassi *et al.* (2019) reported a much lower diet quality score for within group variety for protein sources among both men (1.7±0.0) and women (2.1±0.1). Variety in dietary intakes entails the inclusion of assorted food materials that are drawn across major food groups, while increasing the number of those selected within nutrient rich food groups to enhance dietary intake patterns that are commensurate with those desirable for healthy nutritional outcomes (Steyn and Ochse, 2013; USDA, 2015; de Oliveira Otto *et al.,* 2018). This finding is in line with reports that diets in developing settings are generally low in animal source foods (Mustapha, 2014; Agada and Igbokwe, 2015; Ahmed and Salih, 2019). Low scores for protein sources in this study undermine the roles of these foods in human nutrition and well-being in the region. Animal source foods are paramount in meeting daily requirements of essential amino acids, a role lacking in plant source protein foods except and if only complemented with other animal source foods or with appropriate plant protein containing the limiting amino acid. Food cost, low income, social norms and beliefs constitute some factors responsible for lower intakes of animal source foods in some settings; and could also apply in this study (Haileselassie, Redae, Berhe, Henry, Nickerson, Tyler, and Mulugeta, 2020).

Dietary adequacy entails adopting consumption patterns that supply energy and essential dietary elements in amounts sufficient enough to meet nutritional needs without necessarily exceeding healthy limits. The mean value obtained for the adequacy component in this study is slightly higher than 22.3 ± 4.7 reported among women in South Eastern Nigeria (Onyeji and Sanusi, 2018) but lower than the range, 29.5 ± 3.0 to 30.5 ± 3.9 discovered among Korean adults (Shin *et al.,* 2015) and 31.6 ± 0.1 among adults in Tunisia (Abassi *et al.,* 2019). Although the dietary adequacy component of the DQI-I in this study was above average, some items in the component had low scores. Calcium inadequacy is particularly a problem among adults due to its independent influence on the risk of chronic diseases that is common with advancing age (Jackson, Williams, McEvoy, MacDonald-Wicks, and

Patterson, 2016). This study revealed sub-optimal intakes of fruits and vegetables in the region. Failure to meet daily recommended intakes of fruits and vegetables amidst increased intake of fat, sugars, salt and or sodium is linked to the rise in micronutrient deficiency diseases and chronic diseases worldwide (WHO, 2019a). Low vegetable intakes in this study contradicts the common notion that vegetables (especially green leafy vegetables) constitute important dietary components in African diets (Okpechi *et al.,* 2013; Agada and Igbokwe, 2015; Okop, Ndayi, Tsolekile, Sanders, and Puoane, 2019). Studies reporting vegetable intakes in the African regions often measure dietary intake patterns using dietary diversity and food frequencies as tools for evaluating dietary intakes. It is possible that, while most individuals and households report daily vegetable consumptions, consumptions may be in amounts that are below recommendations and therefore too small to provide the necessary essential nutrients in the diet.

Moderation in dietary intakes emphasizes limited intakes of components that must be restricted to protect against development of diet-related illnesses. Moderation component in dietary intakes assessed in this study was higher than 13.2 ± 0.1 recorded among adults in Tunisia (Abassi *et al.*, 2019) and 11.6 ± 6.3 to 12.3 ± 5.6 among Korean adults (Shin *et al.*, 2015). Within Nigeria, Onyeji and Sanusi (2018) reported a mean value of 25.0 ± 3.8 for moderation in intakes among adults in South Eastern Nigeria. Diets among adults in this study consisted moderate consumptions of cholesterol and empty calorie foods. The usefulness of empty calorie foods or discretionary calories is in providing the additional energy intake needed to meet daily energy requirements after meeting nutrients intake levels from nutrient-dense foods at a particular energy level. However, the need for additional calorie to meet recommendations can also be met by consuming nutrient-dense foods above recommended levels. Lower intake of cholesterol in this study is commendable and falls in line with dietary guideline recommendations (Institute of Medicine, 2005; USDA, 2015). Animal foods, including egg yolk, dairy products, shellfish, meats and poultry, constitute important sources of dietary cholesterols (USDA, 2015; Xu, McClure, and Appel, 2018). Low consumption of animal source foods in the regions (noted in findings on within-group variety) could account for the low consumption of cholesterol in this study. Moderations in total and saturated fats were low, implying that adults exceeded the recommended intake levels of these dietary components and could be at risk of several chronic disease markers (Eckel *et al*., 2014)

Appropriate distribution of energy sources ensures dietary intakes that provide essential nutrients within energy intake limits compatible with good health (Institute of Medicine, 2005; Gil *et al.*, 2015). Overall balance in dietary intakes seems to constitute a common nutritional problem in most populations. Low values have been reported for this component from previous studies. The study among women of reproductive age in South Eastern Nigeria recorded 2.0 ± 1.8 for overall balance in energy sources (Onyeji and Sanusi, 2018). Abassi *et al.* (2019) recorded 3.5 ± 0.1 among Tunisian adults. In Korea, an overall balance in energy sources was recorded to be 2.1 ± 1.9 (Shin *et al.*, 2015). Low performance in overall balance in this study indicates a failure to derive total energy intakes within recommended limits for each energy sources. Total energy consumption, derived from total fat beyond the AMDRs is most likely to increase consumption of saturated fats over mono and poly-unsaturated fatty acids (Eckel *et al.*, 2014).

Consumption of dietary elements, be it single nutrients, individual food items or dietary principles as in food variety indicated within the DQI-I differed notably between the two States. Apart from variety, dietary intakes in Cross River met recommended intake levels for most components than those reported in Akwa Ibom. Information on individual dietary items within major components also revealed significantly higher mean values in Cross River than those in Akwa Ibom State. Higher diet quality indicators in Cross River State observed consistently in this study can be attributed to geographical differences which often exert remarkable influences on dietary intakes through variations in food prices, access to food outlets, quality and quantity of food available, food taboos, knowledge and perceptions, social norms, culture etc (Kabir, Miah and Islam, 2018). Agriculture constitutes important economic activity in Cross River State, especially in less developed settings. Besides the ample supply of varied food sources, subsistence farming settlements can exert some resilience against trends consistent with nutrition transition. These factors may have influenced the quality of diets in Cross River against what is obtainable in Akwa Ibom State.

Diet quality differed by urban-rural settings and was significantly higher among urban dwellers when compared to those in rural settings. Individuals usually change their diets (in response) to changing living conditions, especially after moving from rural to urban settings. Although the urban area presents consumers with more options in terms of available food supplies of both traditional and novel foods (Rothman *et al.,* 2019), urban residents, because of educational attainment, are better equipped to make healthy food choices than those in rural settings who may not have such exposures (Vogel, Lewis, Ntani, Cummins, Cooper, Moon, and Baird, 2017; Thorpe, Milte, Crawford, and Mcnaughton, 2019). Also, higher income among urban dwellers can contribute to higher food quality in the setting, when compared to those in the rural settings, who may be of low socioeconomic status and cannot afford good quality meals (Martin *et al.,* 2017). This may have been the case in this study. Diet quality was especially higher among men who reside in urban centres. Males, especially the younger, single, employed and educated adults constitute that segment of the population, who by some reasons, spend most of their time away from home and thus have limited time for preparing and eating meals at home (Lee *et al.,* 2016). Although eating foods away from home is often linked to low diet quality and over-nutrition due to high total energy content and poor nutrient density, these foods also have higher dietary diversity (Lee *et al.,* 2016). Few analyses of the nutritive values of restaurants and other fast food meals in Nigeria reveal that, although these foods are high in total energy and fat, they are not necessarily low in most vital nutrients (Otemuyiwa and Adewusi, 2014; Udezo, Onigbinde, Adaramola, Aleshinloye, Jegede, Ogunnowo, Shokunbi, and Adewumi, 2019). It is, therefore, possible in certain conditions, for individuals to meet daily recommended intake for some food components in restaurants meals.

Although diet quality seemed to have been higher among males than females, there was no statistically significant sex differences in diet quality in this study. This is contrary to consistent reports on gender differences in diet quality. Females usually attain higher diet quality than males in most studies (Verger, 2012; Asghari *et al.,* 2013; Alkerwi *et al.,* 2016; Koksal *et al.,* 2017; Bivoltsis *et al.,* 2018; Pestoni *et al.,* 2019). Women tend to consume healthier foods and adhere to good nutritional principles for several reasons, ranging from better knowledge on the health effects of good nutrition, quest for good body size and gender roles which saddles women with the responsibility of catering for the families (Arganini *et al.,* 2012). In the latter case, women have the opportunity to consume healthy meals prepared at home more frequently than men. However, Abassi *et al.* (2019) reported significantly lower diet quality among females when compared to males in North Africa.

Diet quality was not related to age in this study. This finding is contrary to reports that, diet quality increases with age in most populations. Findings from the study by Koksal *et al.*, (2017) among Turkish adults indicated diet quality scores increased with increasing age. Also, older adults in US consistently had higher diet quality scores over a 12 year period compared to younger adults (Sotos-Prieto *et al.*, 2017). Panizza *et al.* (2018) reported older adults had significantly higher diet quality scores when compared to younger ones among a multi-ethnic cohort from Hawaii and California. However, older adults seem to adopt more healthy dietary patterns than the younger ones. Because health consciousness increases with advancing age (Yoshida *et al.,* 2017), older people are more likely to select foods that they believe are healthy and follow nutrition principles that ensure good health (de Andrade *et al.*, 2016; Winpenny *et al.*, 2018). This notion probably explains the direct association, often reported for diet quality and increasing age in studies (Livingstone and McNaughton, 2016; Bivoltsis *et al.,* 2018).

Diet quality in Efik/Ejagham ethnicity was higher than that of the Ibibios. This finding is in conformity to those from other studies, where dietary intakes were reported to differ by cultural differences. Cultural differences in consumption of selected food items have been reported among adults in Atlanta (Declercq *et al.,* 2017). Some components of diet quality were seen to differ significantly between European adults and Ghanain immigrants (Danquah *et al.,* 2018). Cultural norms account for most differences in dietary practices and patterns between ethnic groups. Consumption of specific food types, meals frequency, snacking behaviours, regular meal locations, food product selections, and to an extent, health-conscious behaviour is most often than not dictated by culture (Ng *et al.,* 2018). Although the two ethnic groups share much in common in terms of food culture, diversity in both plants and animal food materials could contribute significantly to differences in diet quality.

## 5.4 Objective Three: Determine physical activity of adults in AK and CR States, Nigeria

Occupation or job related PA and household chores constituted the most important means of physical activity, whereas individuals rarely engaged in transport-related and leisure-time activities. The observation that daily economic activities in the workplace and domestic activities contributed most to the overall daily PA patterns has already been documented in previous findings (Nang *et al.,* 2010; Vandelanotte *et al*., 2015; Santos *et al.,* 2016). However, contributions to overall PA in most populations are not limited to job- and domestic-related PAs. Leisure-time PA made the highest contribution to daily PA in Brazil among older adults (Scarabottolo *et al.,* 2019). In a French cohort, domestic-related PA constituted the highest contributor to daily PA (Cloix *et al.,* 2015). The observation that, PA domains contributing most to daily PA in these studies differ from what is observed in the present study may be explained by the fact that participants in the previous studiescomprised mostly of older adults. It is possible that, participants in the later studies were retired from official jobs and therefore devoted time to activities in domains other than job-related duties.

Generally, more individuals in Akwa Ibom State engaged in occupation or job-related activities, especially moderate-intensity activities. The observation that vigorous-intensity PA at work were higher in Cross River than in Akwa Ibom could have resulted from the predominant energy-demanding farming activities in Cross River State. Farming comprises heavy carrying and lifting activities that last about 90 minutes of muscle strengthening PA (Racine, Laditka, Dmochowski, Alavanja, Lee, and Hoppin, 2012). With this, most farmers stand the chances of meeting or even exceeding vigorous-intensity or muscle-strengthening PA guidelines (Racine *et al.,* 2012).

The second most important PA domain in this study was domestic chores (especially moderate-intensity inside PA inside the house). Domestic chores have always constituted important domain of physical activity in studies (Murphy *et al.,* 2013; Polito *et al.,* 2016). Studies on physical activity in the African region adopt various methods other than IPAQ long form to report PA. Mashili et al. (2018) conducted a study to assess the socio-demographic antecedents of PA among adults in Tanzania using the GPAQ, but no information on domestic-related PA was reported. However, findings from a study on PA among adults in Northern Nigeria indicated that, domestic and garden work-related activities constituted the second most important contributor to overall weekly PA after occupation-related PA in the study population (Oyeyemi, Bello, Philemon, Aliyu, Majidadi, and Oyeyemi, 2014). Most individuals, especially females, engage in one or more household chores to meet personal needs or those of the entire household. However, participation in outside yard domestic chores in this study was low, which raises concerns over the possible health benefits of energy expended in household activities. This is because physical activity involving domestic household chores are often of low intensity when expressed as metabolic equivalents (Goh, Govindharajulu, Camps, Tan, and Henry, 2016). Also, moderate-intensity domestic household activities may not confer the expected health benefits of PA due to the fact that domestic chores often result in fatigue and perceived exertion without necessarily resulting in the volume of energy expenditure sufficient to alter body compositions as a result of small muscle group contractions (Murphy, Donnelly, Breslin, Shibli, and Nevill, 2013).

Walking was a more common means of active transport when compared to cycling in this study. Walking has often been reported as a more common means of movement, contributing significantly to the overall daily physical activity for all age groups and gender, while cycling is far less common (Laird, Kelly, Brage, and Woodcock, 2018). The use of cars and motor vehicles for transportation has overtaken the traditional transport systems of walking and cycling. The use of active transport, (which consists of walking and cycling) is considered a better way of expending energy through physical activity than travelling by cars (Laird *et al.*, 2018).

Leisure-time physical activity (LTPA) is known for its attendant reducing effects on all-cause, CVD-related, and cancer-related mortality (Saint-maurice, Coughlan, Kelly, Keadle, Cook, and Carlson, 2019). However, it rarely forms important component of daily PA in individuals (Nang *et al.*, 2010; Santos *et al.*, 2016; Macek *et al.*, 2019). Leisure-time PA was reported as the least contributor to the overall weekly PA among adults in Northern

Nigeria (Oyeyemi *et al.*, 2014). Findings from assessment of PA in 22 African countries revealed that LTPA made the least contributions to total weekly PA in the countries under study, whereas work and transport-related PA were the most common form of PA in the populations (Guthold, Louazani, Riley, Cowan, Bovet, Damasceno, Sambo, Tesfaye, and Armstrong, 2011). Within LTPA, participants in this study relied mostly on walking as major form of recreational activity. Although walking assumes the most common component of leisure time activity, very few individuals ever record participation in it, a trend equally observed in the present study. Akarolo-Anthony and Adebamowo, (2014) reported in their findings that walking was the most common form of activity performed during leisure-time PA among adult Nigerians. Selected factors, including health, younger age, available time and health benefits accruing from participation in PA constitute significant determinants of LTPA in populations (Paggi, 2016; Codina and Pestana, 2019).

Moderate-to-high PA patterns were prevalent among adults in this study. Only few adults had low PA patterns in this study. The WHO recommends moderate-to-high PA patterns for healthy living (WHO, 2011a). On this basis, the prevalent PA patterns in the region arein line with the WHO recommendations. Physical inactivity constitutes a global health challenge (WHO, 2014; WHO, 2018). Reports on PA levels among adults from different regions are inconsistent (Polito *et al.*, 2010; Loyen *et al.*, 2016; Özköslü *et al.*, 2017). The PA patterns revealed in the present study can be compared to those found among adults in Italy (Polito *et al.*, 2016), Asia (Nang *et al.*, 2010), Tanzania (John *et al.*, 2017; Mashili *et al.*, 2018) and Poland (Macek *et al.*, 2019). The high proportion of adults with moderate-to-high PA in this study is probably due to prevalent moderate and walking intensity activities in the region. Major occupations (including farming, skilled work, company/casual work and petty trading) constitute energy demanding activities in the population. Skilled workers often engage in more energy demanding PA (Vandelanotte *et al.*, 2015; Malambo, Kengne, Lambert, Villiers, and Puoane, 2016).

Physical activity patterns did not differ significantly among adults between the two States. This observation is not out of place as cultural similarities (within the two States) could be reflected in most lifestyle factors, including physical activity. Urban-rural differences constituted significant determinant of PA in this study. Unsurprisingly, bivariate analyses revealed significantly higher PA patterns among rural people when compared to those in urban settings. Higher prevalence of low PA in urban areas has been reported in some other settings, including Cameroon (Assah *et al.*, 2015) and Tanzania (Mashili *et al.*, 2018). Multivariate analyses revealed that the urban-rural differences in PA were only significant among younger adults (≤40 years), who were likely the most economically active group in the population. While leisure time PA may constitute important determinant of PA in the urban setting (Miranda *et al.*, 2016), rural residents often engage more in labour-intensive economic activities, which eventually attributes higher PA to rural areas. Assah *et al.* (2015) noted that, rural dwellers in Cameroon had higher physical activity patterns and participation in work-related PA than those in urban settings. However, rural people often engage more in energy demanding skilled work for economic activity than those in urban centres (Malambo *et al.*, 2016).

Physical activity did not differ significantly between males and females in this study. This report is in contrast to that of the report by Oyeyemi *et al.* (2018) where males had higher PA patterns than females. Reports on sex differences in PA are not consistent across populations (Nang *et al.*, 2010; Polito *et al.*, 2010; John *et al.*, 2017). Such inconsistencies may be attributed to differences in socio-cultural differences. While PA may be higher among males in urban centres, rural females may score higher in PA compared to their male counterparts (John *et al.*, 2017). Generally, females are likely to engage more in domestic chores (Nang *et al.*, 2010; Polito *et al.*, 2010) but may perform higher in moderate PA as well as occupational activities than males in certain cultures (Macek *et al.*, 2019; Scarabottolo *et al.*, 2019). Thus, gender similarities in PA between males and females in this study may be due to effects of activity in specific domains concealing out on the total PA between males and females.

Although not statistically significant, mean age decreased across PA levels, from low through moderate to high, indicating the possibility that younger people engage more in higher PA than older adults. There are no consistent reports on the associations between age and PA among adults (Nang *et al.*, 2010; Polito *et al.*, 2010; Lahti, Laaksonen, Lahelma, and Rahkonen, 2011; dos Santos *et al.,* 2016; Macek *et al.,* 2019). Low PA often observed among older adults may be due to less involvement in economic activities (Nang *et al.*, 2010), though they tend to have higher LTPA participation in few cases (Lahti *et al.*, 2011). However, LTPA contributes minimally to overall PA in populations (Nang *et al.,* 2010; dos Santos *et al.,* 2016). Participants in this study comprised adults within the active age range who are still active in their sources of livelihood. This is important because occupation-related PA constitutes the most important contributor to total PA in adults (Nang *et al.*, 2010; Vandelanotte *et al.*, 2015; dos Santos *et al.*, 2016). Lack of association between PA and age among adults was also reported in Tanzania (John *et al.*, 2017).

Physical activity decreased steadily across educational levels such that adults with tertiary education had the lowest rate. Educated adults are more likely to engage in less strenuous jobs than uneducated counterparts. Higher income from gainful employment of educated individuals further promotes physical inactivity through sedentary lifestyle. Fan *et al.* (2015) reported that higher education, especially at younger or middle age, was associated with the highest level of physical inactivity. In this study, multivariate analyses showed that, while secondary education increased the chances of attaining moderate-to-high PA among men, tertiary education among women significantly decreased the odds of meeting at least moderate PA. Men who attain secondary education as the highest educational qualification may be limited in the number of job opportunities they can access and may so end up with skilled work as major means of livelihood. Skilled work is associated with higher physical activity (Vandelanotte *et al.,* 2015; Malambo *et al.,* 2016). Hence, the likelihood of attaining physical activity recommendations among men with only secondary education. On the other hand, women who attain tertiary education can acquire better jobs with more pay and can therefore afford to use more labour-saving devices in most daily engagements, a lifestyle that is consistent with increased physical inactivity. Physical activity did not differ by income levels in this study. However, the observation that low PA was higher among adults with higher income in this study contradicts earlier reports (Kari, Pehkonen, Hirvensalo, Yang, and Hutri-, 2015; Puciato, Rozpara, Mynarski, V, Markiewicz-patkowska, and Ma, 2018) where higher income constituted a significant predictor of high PA, but consistent with the notion that higher income (found mostly among those with higher socioeconomic status) usually enhance physical inactivity through sedentary lifestyle (Stalsberg, 2018).

There were significant inverse associations between PA and anthropometric indices (except WHR) in this study. Higher anthropometric measures related inversely with low PA in the population. These observations fall in line with the principle that obesity results from excess energy intake over expenditure. As well, PA did not differ significantly by blood pressure levels in this study. This observation is contrary to the common notion that physical activity may reduce blood pressures and thereby prevent hypertension through improvements in physiological processes and disease biomarkers (Hegde and Solomon, 2016; Fan *et al.*, 2018). However, most studies reporting reducing effects of physical activity on blood pressure usually consist of those on interventional studies involving physical exercise rather than overall physical activity pattern (Werneck *et al.*, 2018). Where overall PA is measured, the results more often report significant effects of specific domains (especially LTPA and commuting PA) only on blood pressures (Diaz *et al.*, 2018; Byambasukh, Snieder, Corpeleijn, and Activity, 2020). It is possible that specific domains may have had significant associations with blood pressure in this study rather than the overall PA.

## 5.5 Objective Four: Assess the prevalence of obesity and its associations with diet quality and physical activity among adults in AK and CR States, Nigeria.

The prevalence of obesity reported in this study is comparable to a number of findings from previous studies. According to the WHO, 13.0% of the world's adult population is affected by obesity (WHO, 2020), while 10.6% of adults in African region are obese (World Health Organization, 2016a). A 12.8% prevalence of obesity was reported in the Niger Delta Region in Nigeria (Idung *et al.,* 2014). As well, another 12.0% prevalence of obesity was recorded among adults in Norway (Brumpton *et al.,* 2013). Prevalence of obesity recorded in this study, however differs from the findings from some other selected studies. A 7.9% prevalence of obesity was reported among adults in China (Hu *et al.,* 2017) and 17.2% prevalence among adults in a semi-urban community in South-South Nigeria (Ekanem *et al.,* 2013). The study also revealed that one out of five respondents in the study was overweight. Although it's common for more people to be overweight than obese in any given population, the worldwide trends in the ever-increasing prevalence of obesity (Ng *et al.,* 2014; WHO, 2020) creates concerns over the possibility of overweight individuals in this study transiting to more severe forms of obesity in the nearest future. There's therefore an urgent need for timely intervention in order to forestall any possible outbreak of chronic health problems arising as complications of obesity in the region.

The use of BMI is effective in screening for chronic diseases. However WC and WHR are more accurate in identifying individuals who are at risk of chronic diseases than BMI (Brumpton *et al.,* 2013). Within the context of normal BMI, increased WC is considered a potent predisposing factor to obesity-related complications. The high prevalence of abdominal obesity in the study may be indicative of the probable burden of metabolic diseases in the region. Approximately 37.6% of adults in this study had increased WC, a value comparable to 37.4% elevated WC among adults in Southern China (Hu *et al.,* 2017) and 39.4% in a South Eastern Nigeria (Onuoha *et al*., 2016). Chukwuonye *et al.* (2013) recorded 21.6% among adults Abia State, Nigeria. Also, a 34.7% abdominal obesity measured by WC was reported among adults in a setting in South Western Nigeria (Raimi, Odusan, and Fasanmade, 2015). However, the prevalence of abdominal obesity measured by WC in this study was higher than 24.9% discovered among adults in Tanzania- (Munyogwa and Mtumwa, 2018). The prevalence of elevated WHR reported in this study is comparable to 50.8% found among adults in Ivory Coast (Malik *et al.,* 2019) and 57.8% among adults in South Western Nigeria (Raimi *et al.,* 2015).

Abdominal obesity (both WC and WHR) differed significantly among adults between States, whereas, the two States had similar prevalence of general obesity. Differences in dietary intakes and their corresponding outcome in nutritional status have always varied with various factors, including geographical locations (Lee *et al.,* 2019; Islam, Kathak, Sumon, and Molla, 2020). A common observation in selected studies indicate geographical differences in obesity prevalence based on locations. In the United States, the odds of being obese was significantly higher among men living in Midwest when compared to those in the Northeast, while it was lower among those in the West (Kelley *et al.,* 2015). Again, prevalence of obesity was reported to differ in different locations in US. For instance, it was higher in the South where African American populations are found, lower in the Northeast where the Hispanics are accommodated and higher in the Midwest and West where the unemployed individuals are mostly found (Myers, Candice, Tim, Slack., Martin, Corby K., Broyles, Stephanie T and Heymsfield, 2015). Selected factors, including race/ethnicity, age, sex and education (Kelley *et al.,* 2015; Myers *et al.,* 2016) could also mediate geographical influences in prevalence of obesity. Location could influence food intake and result in over-nutrition through improved socioeconomic status: a factor inversely associated with obesity in most developed countries but directly associated with obesity in less-developed settings, to a greater extent in the African region (Micklesfield *et al.*, 2013). Disparities in food availability (Lee *et al.*, 2019) could contribute to geographical differences in obesity. It is possible that some of these factors could have interacted to cause significant differences in abdominal obesity among adults in this study.

Obesity was not related to urban-rural differences in this study, however, both bivariate and multivariate analyses showed that the risk of elevated WC was significantly lower among adults living in urban centres. Selected factors (especially those influencing food intake and physical activity) could cause urban-rural differences in obesity. There are inconsistent findings regarding differences in obesity prevalence between the rural and urban settings. Findings from most studies reveal higher prevalence of obesity (both general and abdominal) in urban areas when compared to rural settings. Abdominal obesity was reported to be 33.56% in urban areas and 15.7% in the rural settings (Munyogwa and Mtumwa, 2018). Yayehd *et al.* (2017) reported a significantly higher risk of obesity among adults in urban area, when compared to less developed setting. This notion is contrary to the findings in this study, where abdominal obesity (elevated WC) was higher in rural areas than in urban areas. The increased prevalence of obesity in the urban centres over those obtained in rural settings is often attributed to increasing rate of urbanization (Oyewole and Atinmo, 2015). Urbanization comes with increased sedentary lifestyle and nutrition transition from consumption of minimally processed traditional meals to that of energy dense and highly processed meals in urban centres. In this study, multiple logistic regressions also indicated that the risk of elevated WC was lower among females and younger adults living in urban areas. Women usually exhibit a higher level of health-seeking behaviours (Everett and

Zajacova, 2015) and follow healthier dietary patterns. Awareness of the complications of overweight and obesity can lead to motivation to attain and maintain healthy body weight and consequent engagement in active weight maintenance activities among women (Nanda, Mohabbat, Nagaraju, Varayil, Ratrout, Abu-Lebdeh, S., and Majka, 2015). These observations could apply to this very setting, where females and younger adults living in urban areas, due to education and enlightenment on healthy lifestyles, engage in healthy lifestyle behaviours, thereby leading to a significantly lower risk of obesity.

Prevalence of obesity differed significantly by sex, and was particularly higher among females. This finding is in line with reports from previous studies, where obesity is often reported in higher proportions among females (Joseph-Shehu and Ncama, 2018; Malik *et al.,* 2019). Females have higher predisposition to obesity from several reasons. This could result from an interplay among several biological, social and behavioural factors that commonly predispose the female gender to obesity. Most importantly, the female sex is a predisposing factor to obesity due to certain complex and interwoven biological phenomena (Reue, 2017). These consist of the stronger genetic influences in obesity among females than males; predisposing effect of the female chromosome XX to higher risk of obesity; and increased risk of diet-induced obesity than males (Link and Reue, 2017; Reue, 2017; Salinero *et al.,* 2018). Changing living conditions arising from improved socioeconomic status have been reported to exerted greater influence on increased food intake and physical inactivity or sedentary life among females, not males (Kanter and Caballero, 2012; Micklesfield *et al.,* 2013). Also, differences in cultural roles and societal expectations where women are expected to prepare meals for the family can increase their exposure to increased food and energy intake.

There were significant differences in prevalence of obesity by age groups. The risk of obesity increased significantly with age in the whole population for all three indices, corroborating reports from other findings (Mogre *et al.,* 2015; Joseph-Shehu and Ncama, 2018; Munyogwa, 2018). The increased risk of obesity with age in this study corroborates the principle that adiposity in humans increase with age, especially between the third and seventh decades of life (Jura and Kozak, 2016).

While obesity and elevated WC were not associated with education, increased WHR differed significantly across educational levels, such that the lowest rates were seen among adults with lower education. Abdominal obesity has been observed to increase among adults with lower socioeconomic status (Kim *et al.,* 2019) in Korea and those with primary education in Ivory Coast (Malik *et al.*, 2019). These observations are in line with the popular inverse associations between education and obesity in studies (Devaux *et al.,* 2011). However, gender and the economic development of the settings usually play critical roles in these associations, such that the inverse associations occur most often in high-income settings, while low-income settings seem to have direct relationships (Cohen *et al.,* 2013). As well, elevated WHR related significantly with employment. Elevated WHR was higher among adults without employment than those with employment. Similar observations had been obtained in previous studies (Härkönen *et al.,* 2011; Some *et al.,* 2014; Lee *et al.,* 2019). Generally, obesity seems to be higher in unemployed individuals, though this observation differs between males and females. While obese females are more likely to be unemployed or hold any professional positions that attract higher earnings (Härkönen *et al.*, 2011; Lee *et al.,* 2019), this may not necessarily apply for obese males (Lee *et al.,* 2019). The lower employment rates among obese females are often blamed on discrimination at the workplace (Härkönen *et al.,* 2011).

Estimated household income had significant associations with obesity but not with abdominal obesity in this study. Obesity related inversely with higher household income. Reports on the nature of associations between obesity and income vary from study to study. The most popular is the inverse association between obesity and higher household income (Kim and Knesebeck, 2018; Andoy-galvan, Lugova, Patil, Wong, Chinna, Baloch, Suleiman, and Nordin, 2020), which again depends on the economic development of the setting. While inverse association could exist between obesity and income at high-income levels, Templin *et al.* (2019) reported that such observations were absent at lower income level. Yao and Asiseh (2019) reported a "U" shaped association between increasing income and BMI in China. That is to say that BMI first decreased with increasing household income and over time increased with increasing income. The differences in the association between obesity and income could result from influences from other factors, including obesity measurement, gender, education, age and marital status (Kim and Knesebeck, 2018; Yao and Asiseh, 2019).

Obesity had significant association with marital status in this study. Both general and abdominal obesity were significantly lower among single adults compared to married individuals. Multivariate analysis indicated an increased risk of obesity among married adults when compared to those who were currently not married (singles, widowed, separated/divorced). When stratified into sex and age groups, the relationship cut across both sexes and age groups. These findings corroborate reports from some previous studies (Ajayi *et al.*, 2016; Joseph-Shehu and Ncama, 2018; Munyogwa and Mtumwa, 2018; Malik *et al.*, 2019). Married people are sometimes less concerned about their body image; and married women in particular may lose any concern they initially had before marriage about proper nutrition to attain desirable body size (Teachman, 2016). Obesity, measured by both BMI and WC related significantly with ethnicity in this study. Compared to Ibibio, the risk of obesity was significantly lower in Efik/Ejagham ethnicity, and this was observed for only women and younger adults. Ethnicity constitutes one of the important correlates of obesity. Differences in prevalence of obesity by race/ethnicity constitute frequent findings in most studies (Wang, Southerland, Wang, Bailey, Alamian, Stevens, and Wang, 2017; Sutaria, Mathur, and Hull, 2019)

All anthropometric measures related inversely with PA in the bivariate analyses. Both median PA values and PA levels differed significantly between obese and none obese adults. Prevalence of general and abdominal obesity decreased steadily from low PA, such that the lowest rates were reported among adults with high PA. Multiple logistic regression analysis revealed a significantly higher risk of obesity for adults with low PA in all age groups. Although not statistically significant, the risk of having abdominal (WC and WHR) obesity was lower among adults with moderate-to-high PA than those with low PA. The risk of obesity and its comorbidities from physical inactivity has been reported extensively in studies (Idung *et al.,* 2014; Mogre *et al.,* 2015; Munyogwa and Mtumwa, 2018; WHO, 2020). This study reveals that low physical activity constitutes an important cause for concern over the risk of obesity among adults in the region.

Bivariate analyses indicated a direct relationship between diet quality and prevalence of obesity among adults. Prevalence of obesity increased steadily with diet quality, such that, the highest prevalence was recorded among adults with high diet quality. Though not statistically significant, multiple logistic regressions indicated an increased risk of obesity among those with moderate-to-high diet quality. Moderate-to-high diet quality (diet quality scores at $2^{nd}$ and $3^{rd}$ terciles) significantly increased the likelihood of obesity only among older adults. These observations are contrary to the expected inverse associations usually observed in most studies (Chiuve *et al.,* 2012; Sotos-Prieto *et al.,* 2017; Bivoltsis *et al.,* 2018; Panizza *et al.,* 2018; Pestoni *et al.,* 2019). Whatever accounted for the direct relationship between diet quality and obesity cannot be explained within the scope of this study. However, similar findings had been reported in Turkey, where diet quality had positive correlations with BMI among adults (Koksal *et al.,* 2017). The DQI-I used in evaluating diet quality in this study, consist of different dimensions that should effectively screen the quality of diet. It is important to examine individual contributions of each diet quality component on energy intake and overall weight gain. This is because, specific non-primary sources of food energy, including protein foods (particularly meat group) will most likely increase the risk of obesity (Declercq *et al.,* 2017; Cheung *et al.,* 2018) when consumed in excess amounts over time. Also, food variety (within and between major food groups) when based primarily on selection of energy dense items within a major food group can as well increase the chances of obesity in consumers (de Oliveira Otto *et al.,* 2018; Karimbeiki *et al.,* 2018).

### 5.6 Objective Five: Determine the prevalence of hypertension and its associations with diet quality and physical activity among adults in AK and CR States, Nigeria.

Prevalence of hypertension was high among adults in this study. Several lifestyle risk factors linked to increased blood pressure and higher prevalence of hypertension are controllable (World Health Organization, 2013a) and sometimes interact with cultural issues to constitute predominant trends in specific regions, leading to differences in disease rates across locations. The rate of hypertension among adults in this study is lower than those indicated in earlier studies in different parts of the country (Ekanem *et al.,* 2013; Murthy *et al.,* 2013; Okpechi *et al.,* 2013; Olamoyegun *et al.,* 2016) though comparable to 28% in a community in South South Nigeria (Akpan *et al.,* 2015) and 27% reported by WHO for African Regions (WHO, 2019b).

Systolic hypertension, indicated by the mean SBP was higher in this study and was within the range designated for prehypertension, whereas, mean DBP was within the normal range. This finding is in line with the principle that, while DBP begins to decline at some point in adult life, SBP continues to rise, giving rise to systolic hypertension over that of DBP (Oliveros, Patel, Kyung, Fugar, Goldberg, Madan, and Williams, 2020). This also indicates the tendency for increased systolic high blood pressure in the region: a phenomenon that may lead to isolated systolic hypertension as the population ages. Although the risk of CVDs associates with all blood pressure components, systolic blood pressure constitutes the highest risk factor for cardiovascular disease conditions among all blood pressure components (Ripley and Barbato, 2019). Pre-hypertension (47.3%) was common among adults in this study. An implication for likely CVDs that may overwhelm the region in the nearest future. Most individuals whose blood pressure levels indicate prehypertension will most likely have hypertension, and possibly other cardiovascular conditions later on in life. Prehypertension is a disease on its own, in the sense that it requires daily life adjustments and even antihypertensive medications to prevent full-blown hypertension (Khanam, Lindeboom, Razzaque, Niessen, and Milton, 2015).

The rate of hypertension did not differ among adults by State. Again, hypertension did not relate significantly with differences in residential settings, although the rate obtained in the urban area was higher. Findings from some studies in Nigeria indicate higher prevalence of hypertension in urban than in rural areas (Sarki *et al.,* 2015; Ajayi *et al.,* 2016; Raji *et al.,* 2017) with only a few studies reporting otherwise (Okpechi *et al.,* 2013; Akpan *et al.,* 2015). Discrepancies on hypertension prevalence in locations could be attributed to factors that predispose individuals differently to the risk of hypertension in different settings. Lack of education may predispose rural dwellers to higher rates of hypertension through risky lifestyles and limited awareness on prevention and management of the disease (Wang *et al.,* 2018). Persistent traditional lifestyle may also protect against exposure to risky lifestyles; and consequently prevent the disease in rural areas (Soubeiga, Millogo, Bicaba, Doulougou, and Kouanda, 2017). In urban centres, changes in lifestyles and exposure to risk factors accompanying urbanization (Soubeiga *et al.,* 2017) could predispose individuals to a higher risk of the disease.

Hypertension related significantly with sex and was higher among males. Multivariate analyses indicated a significantly lower rate among females, especially the younger females. These findings are in line with reports in the literature on sex differences in hypertension (Ghosh *et al.,* 2016). Some other reasons could contribute to higher prevalence of hypertension among males. Males usually engage in risky lifestyles such as smoking and drinking to a larger extent than females, and stand the risk of developing the disease consequently (Arrey *et al.,* 2016). Ghosh *et al.* (2016) attributed the significant effect of education on hypertension in men to better employment opportunities in highly paid jobs associated with physical inactivity and stress, whereas women with corresponding education may not have such employment opportunities within the same setting. Lower risk of hypertension among younger females in this study corroborates reports that increased risk of hypertension among males only occurs in young age due to biological and behavioural factors (Everett and Zajacova, 2015). The risk of hypertension is especially lower in young females because of the activities of oestrogen, which confers some kind of protective effects against hypertension only in young females. However, after menopause, such effect diminishes and the risk of hypertension begins to rise in females and sometimesexceeds those in males (Everett and Zajacova, 2015; Ghosh *et al.,* 2016; Bosu *et al.,* 2019).Gender differences in health-seeking behaviours could also predispose more males to hypertension when compared to females. Females, right from adolescents through adulthood, seek and receive health care services to a greater extent than males (Everett andZajacova, 2015).

Hypertension related significantly with age in this study. Bivariate analysis revealed a significantly higher prevalence of hypertension among older adults when compared to younger ones. Logistic regressions indicated a significantly higher risk of hypertension among adults older than 40 years when compared to the younger group. Several other studies have equally reported higher risk of hypertension with increasing age (Ekanem *et al.,* 2013; Murthy *et al.,* 2013; Arrey *et al.,* 2016; Bello-Ovosi *et al.,* 2018). The chances of developing hypertension with increasing age is attributed to a cascade of physiological events in the vasculature that ultimately lead to the blood vessels becoming stiffened in response to advanced age. It has been explained that the blood vessels begin to harden as one ages resulting in increased chances of developing hypertension (World Health Organization, 2013a).

Hypertension had a significant relationship with estimated household income. Prevalence of hypertension was higher among adults with higher household income (>₦20,000.00) than those with lower income. Though not significant, multivariate analysis indicated a higher risk of hypertension among adults with higher income compared to those with lower income. Findings on the relationship between hypertension and income seems to vary from study to study. However, some studies report inverse associations between hypertension and income (Antignac *et al.,* 2018). Also, the Chi-Square test revealed significant differences in the prevalence of hypertension by marital status. Although not statistically significant, the likelihood of being hypertensive was lower among married adults when compared to those that are not married, and this differed between men and women and between age groups. Marital status may not necessarily relate to hypertension and other cardiovascular disorders among adults (Schwandt, Coresh, and Hindin, 2010).

Physical activity did not have any significant influence on blood pressures in this study. Prevalence of hypertension did not differ significantly among PA levels; there were no differences in median PA values in different blood pressure groups. Multivariate analysis did not reveal any significant differences in the likelihood of having hypertension based on PA levels. However, it was noted that, compared to those with low PA, the risk of hypertension was higher among individuals with moderate or high PA level, an observation that was consistent across sex and age groups. This report is in variance with the inverse associations commonly reported between physical activity and risk of hypertension (Turi *et* *al.,* 2014; Werneck, *et al.,* 2018). In respect to PA, increased risk of hypertension may be attributed to selected domains of PA, such as leisure-time and commuting PA rather than the overall PA pattern (Medina *et al.,* 2018; Byambasukh *et al.,* 2020). Effects of specific physical activity domains on health may have accounted for the lack of significant association between hypertension and the overall physical activity patterns in this study. Physical activity during leisure-time and active transport (two domains of PA that frequently relates negatively to hypertension) contributed the least to physical activity among adults in this study. There's a need to investigate further on the contribution of individual PA domain to the risk of hypertension in the population.

There were significant associations between diet quality and hypertension in this study. Mean diet quality scores were significantly higher among the hypertensive group compared to those without hypertension. There were significant differences in diet quality scores between blood pressure categories. Multivariate analysis showed an increased risk of hypertension among individuals with moderate-to-high diet quality, compared to those with low diet quality, especially among women and those in the younger age group. This observation may not be unrelated to the direct association between diet quality and obesity in this study. Since obesity is a major determinant of cardiovascular conditions, it therefore implies that the direct association between diet quality and obesity among adults in this study extended to hypertension. In other words, adults with higher diet quality scores who were obese are also more likely to develop hypertension. Using DQI-I to estimate dietary intakes seem to overestimate diet quality among adults in these regions. This creates the need for extensive and comprehensive description of dietary patterns and their associations with individual ethno-demographic characteristics to have a proper definition of diet quality in these regions.

In all three measures of obesity, mean anthropometric indices were significantly higher among the hypertensive group compared to those with normal blood pressure. Also, prevalence of hypertension increased steadily with higher categories for all three anthropometric indices, such that obese individuals had the highest prevalence of hypertension. The risk of hypertension was significantly higher among overweight and obese adults when compared to those with normal body weight and was consistent across sex and age groups. The risk of hypertension was equally higher among abdominally obese adults, though this effect was significant only among males and younger adults. These observations are in line with existing literature, where obesity constitutes a serious risk factor for high blood pressure (Idung *et al.,* 2014; Heymsfield and Wadden, 2017; Lukács *et al.,* 2019; Malik *et al.,* 2019), thereby predisposing individuals to increased risk of cardiovascular disorders and other NCDs as well as the subsequent disease burdens.

# CHAPTER SIX
# SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 6.1 Summary

This study was conducted to assess the association between diet quality, physical activity, obesity and hypertension among adults in AK and CR States, Nigeria. Findings from the study revealed adequate macronutrients intakes, although fibre intake was inadequate. Micronutrient intakes, especially vitamins A, B1, B2, thiamine, riboflavin, folate and calcium were suboptimal for most adults in the study. Iron intakes were adequate only among males and older females, but inadequate among females below age 50 years.

Dietary adequacy, moderation and appreciably, food variety contributed most to the overall quality of diets in the study. Dietary intakes varied in major food groups but not in within-group variety for protein sources. Dietary adequacy was characterized by higher intakes of grain/tuber, protein, vitamin C, and iron but low dietary fibre, calcium, vegetable and fruit intakes. There were considerable moderations in consumption of cholesterol and empty calorie foods but not in total and saturated fats. Restriction in sodium intake was moderate. The overall balance in macro-nutrient intakes, most especially in fatty acid ratios was low in this study.

A moderate-to-high physical activity pattern was prevalent among adults in this study. Job-related activities contributed most to the overall physical activity. This was followed by domestic (especially moderate-intensity inside chores) and active transport (especially walking) related PAs. Leisure-time PA rarely contributed to the physical activity of adults in this study.

Prevalence of obesity was high among adults. Abdominal obesity, assessed by WC and WHR was highly prevalent among adults in the study. Prevalence of obesity had no significant relationship with diet quality, but decreased significantly with physical activity among adults in the study.

The study revealed a high prevalence of hypertension among adults. Prevalence of hypertension increased significantly with diet quality, but had no significant association with physical activity. There was a significant direct association between prevalence of obesity and that of hypertension among adults in the study.

## 6.2 Conclusion

The overall quality of dietary intakes was not related to the prevalence of obesity among adults in Akwa Ibom and Cross River States, Nigeria. Higher physical activity was associated with lower prevalence of obesity, but not hypertension among adults in the region.

## 6.3 Recommendations

1. Theres need for increased awareness, through nutrition education on health hazards of micronutrient malnutrition, food sources and proper food selections that enhance optimal nutrition as a way of forestalling widespread malnutrition in populations.
2. Increased physical activity can be promoted to prevent and control obesity by sensitizing individuals on simple ways of attaining recommended PA levels.

## 6.4 Contribution to knowledge

This study has provided information on the quality of dietary intakes, physical activity patterns, prevalence of obesity and hypertension among adults in two States in South-South Nigeria. Specifically, it has:

i. filled the gap in knowledge on individual nutrient intakes and subsequently provided information on compliance with Dietary Reference Intakes.

ii. been able to describe the overall quality of dietary intakes, taking into account the necessary aspects of diet that are important for optimal nutrition while preventing both under-nutrition and over-nutrition related problems.

iii. been able to identify priority areas that need appropriate interventions to ensure optimal nutritional well-being of adults.

iv. identified the prevalent physical activity patterns among adults in both States.

v. revealed the contributions of individual domains to the overall physical activity, hence identifying the areas of needs for appropriate interventions.

vi. provided information on the extent of the problem of obesity (determined by different measures) and hypertension in the regions.

vii. provided information on the importance of dietary intakes and physical activity in the development of obesity and hypertension.

## 6.5 Suggestions for Further Research

1. This study should be replicated within smaller geographical regions as well as in other States in South South geo-political zone, Nigeria.
2. Further studies should explore the individual contributions of selected dietary components to the overall quality of intakes.
3. It is also important to investigate the associations between individual dietary components and the risk of chronic diseases.
4. The associations between individual domains of physical activity and risk of chronic diseases should be investigated.

## 6.6 Limitations of the Study

This study had some limitations; one of which was the cross-sectional design, allowing inference to be drawn only on association rather than causation. In addition, the study may have been prone to nonresponse bias if respondents were different from those who did not participate in the study within the population. Secondly, the use of a single 24-hour recall measured consumption for only one day and may not capture usual dietary intake patterns.

## REFERENCES

Abassi, M. M., Sassi, S., Ati, J. El, Gharbia, H. Ben, Delpeuch, F., and Traissac, P. 2019. Gender inequalities in diet quality and their socioeconomic patterning in a nutrition transition context in the Middle East and North Africa : a cross-sectional study in Tunisia. *Nutrition Journal* 18.18.

Abdool-Gaffar, M. S., Ambaram, A., Ainslie, G. M., Bolliger, C. T., Feldman, C., Geffen, L., Irusen, E. M., Joubert, J., Lalloo, U. G., Mabaso, T. T., Nyamande, K., O'Brien, J., Otto, W., Raine, R., Richards, G., Smith, C., Stickells, D., Venter, A., Visser, S., Wong, M. and COPD Working Group. 2011. Guideline for the management of chronic obstructive pulmonary disease--2011 update. *South African Medical Journal*101:61–73.

Abris, G. P., Provido, S. M. P., Hong, S., Yu, S. H., Lee, B., Eun, J., and Id, L. 2018. Association between dietary diversity and obesity in the Filipino Women ' s Diet and Health Study (FiLWHEL): A cross-sectional study. *PLoS ONE* 13.11:e0206490.

Acham, H., Oldewage-theron, W. H., and Egal, A. A. 2012. Dietary diversity , micronutrient intake and their variation among black women in informal settlements in South Africa : A cross-sectional study. *International Journal of Nutrition and Metabolism* 4.2:24–39.

Agada, M. O., and Igbokwe, E. M. 2015. Dietary Diversity of Rural Households in North Central Nigeria Dietary Diversity of Rural Households in North Central Nigeria. *European Journal of Nutrition and Food Safety* 5.3:150–155.

Ahmed, A. E., and Salih, O. A. 2019. Assessment of the Minimum Dietary Diversity of Reproductive Women in Saudi Arabia. *Pakistan Journal of Nutrition* 18:615–622.

Ajayi, I. O. O., Adebamowo, C., Adami, H. O., Dalal, S., Diamond, M. B., Bajunirwe, F., Guwatudde, D., Njelekela, M., Nankya-Mutyoba, J., Chiwanga, F. S., Volmink, J., Kalyesubula, R., Laurence, C., Reid, T. G., Dockery, D., Hemenway, D., Spiegelman, D. and Holmes, M. D. 2016. Urban-rural and geographic differences in overweight and obesity in four sub-Saharan African adult populations: a multi-country cross-sectional study. *BMC Public Health* 16:1126.

Akanbi, M., Agaba, P., Ozoh, O., Ocheke, A., Gimba, Z., Ukoli, C., and Agaba, E. 2017. Obesity and obstructive sleep apnea risk among Nigerians. *Journal of Medicine in the Tropics* 19.2:115.

Akarolo-Anthony, S. N., and Adebamowo, C. A. 2014. Prevalence and correlates of leisure-time physical activity among Nigerians. *BMC Public Health* 14.1:529.

Akinroye, K. K., and Adeniyi, A. F. 2018. Results from Nigeria's 2018 report card on physical activity for children and youth. *Journal of Physical Activity and Health* 15.2:S393–S394.

Akpan, E. E., Ekrikpo, U. E., Udo, A. I. A., and Bassey, B. E. 2015. Prevalence of hypertension in akwa ibom state, south-south nigeria: Rural versus urban communities study. *International Journal of Hypertension* 2015.ID975819.

Aktar, N., Qureshi, N. K., and Ferdous, H. S. 2017. Obesity: A Review of Pathogenesis and Management Strategies in Adult. *Delta Medical College Journal* 5.1:35–48.

Akwa Ibom State Government. 2007. Projected Population 2007-2015: Ministry of Economic Development, Uyo, Akwa Ibom State. Retrieved on the 6th December, 2021 from http://www.nigerianstat.gov.ng/pdfuploads/Population.pdf.

Alkerwi, A., Vernier, C., Crichton, G. E., Sauvageot, N., Shivappa, N., and Hébert, J. R. 2015. Cross-comparison of diet quality indices for predicting chronic disease risk: findings from the Observation of Cardiovascular Risk Factors in Luxembourg (ORISCAV-LUX) study. *British Journal of Nutrition* 113.2:259–269.

Alricsson, M. 2013. Physical Activity Why and How? *Journal of Biosafety & Health Education* 01.04:1–2.

Andoy-galvan, J. A., Lugova, H., Patil, S. S., Wong, Y. H., Chinna, K., Baloch, G. M., Suleiman, A. and Nordin, R. 2020. Income and obesity in an urban poor community: a cross-sectional study. *F1000Research* 9.160.

Angeles-agdeppa, I., Sun, Y., Denney, L., Tanda, K. V, Octavio, R. A. D., Carriquiry, A., and Capanzana, M. V. 2019. Food sources, energy and nutrient intakes of adults: 2013 Philippines National Nutrition Survey 18,59.

Anjali, and Sabharwal, M. 2018. Current Research in Nutrition and Food Science Perceived Barriers of Young Adults for Participation in Physical Activity. *Current Research in Nutrition and Food Science* 06.2:437–449.

Antignac, M., Diop, I. B., De Terline, D. M. Q., Kramoh, K. E., Balde, D. M., Dzudie, A., Houenassi, M. D., Hounsou, D., Ikama, M. S., Kane, A., Kimbally-Kaki, S. G., Kingue, S., Kouam, C. K., Limbole, E., Kuate, L. M., Mipinda, J. B., N'Guetta, R., Nhavoto, C., Sesso, Z., Ali, A., S., Toure, I. A., Plouin, P. F., Perier, M. C., Narayanan, K., Empana, J. P. and Jouven, X. 2018. Socioeconomic status and hypertension control in sub-saharan Africa the multination EIGHT study (evaluation of hypertension in Sub-Saharan Africa). *Hypertension* 71.4:577–584.

Arganini, C., Saba, A., Comitato, R., Virgili, F., and Turrini, A. 2012. Gender Differences in Food Choice and Dietary Intake in Modern Western Societies. Public Health- Social and Behavioral Health, Prof. Jay Maddock (Ed.), pages 83 - 102. InTech. Available from: http://www.intechopen.com/books/public-health-social-and-behavioral-health/gender-differences-in-food- choice-and-dietary-intake-in-modern-western-societies.

Arrey, W. T., Dimala, C. A., Atashili, J., Mbuagbaw, J., and Monekosso, G. L. 2016. Hypertension, an emerging problem in rural Cameroon: Prevalence, risk factors, and control. *International Journal of Hypertension* 2016.5639146.

Asayehu, T. T., Lachat, C., Henauw, S. De, and Gebreyesus, S. H. 2017. Dietary behaviour, food and nutrient intake of women do not change during pregnancy in Southern Ethiopia. *Maternal and Child Nutrition* 13.2:1–10.

Asghari, G., Mirmiran, P., Hosseni-esfahani, F., Nazeri, P., Mehran, M., and Azizi, F. 2013. Dietary Quality among Tehranian Adults in Relation to Lipid Profile : Findings from the Tehran Lipid and Glucose Study. *Journal of Health, Population and Nutrition* 31.1:37–48.

Assah, F., Mbanya, J. C., Ekelund, U., Wareham, N., and Brage, S. 2015. Patterns and correlates of objectively measured free-living physical activity in adults in rural and urban Cameroon. *J Epidemiol Community Health* 69:700–707.

Awada, R., Parimisetty, A., and Lefebvre dHellencourt, C. 2013. Influence of Obesity on Neurodegenerative Diseases. In *Neurodegenerative Diseases* 381–401. IntechOpen. https://doi.org/10.5772/53671.

Awopeju, O. F., Fawale, M. B., Olowookere, S. A., Salami, O. T., Adewole, O. O., and Erhabor, G. E. 2020. The risk of obstructive sleep apnea and its association with indices of general and abdominal obesity in a Nigerian family practice clinic: a cross-sectional study. *Alexandria Journal of Medicine* 56.1:14–20.

Beal, T., Massiot, E., Arsenault, J. E., and Smith, M. R. 2017. Global trends in dietary micronutrient supplies and estimated prevalence of inadequate intakes. *PLoS ONE* 12.4:e0175554.

Bell, K., Twiggs, J., and Olin, B. R. 2015. Hypertension : The Silent Killer : Updated JNC-8 Guideline. In *Continuing Education*. Downloaded on 10th December, 2021 from https://cdn.ymaws.com/www.aparx.org/resource/resmgr/CEs/CE_Hypertension_The_Silent_K.pdf.

Bello-Ovosi, B. O., Asuke, S., Abdulrahman, S. O., Ibrahim, M. S., Ovosi, J. O., Ogunsina, M. A., and Anumah, F. O. 2018. Prevalence and correlates of hypertension and diabetes mellitus in an urban community in north-western Nigeria. *Pan African Medical Journal* 29:97.

Bivoltsis, A., Trapp, G. S. A., Knuiman, M., Hooper, P., and Ambrosini, G. L. 2018. Can a Simple Dietary Index Derived from a Sub-Set of Questionnaire Items Assess Diet Quality in a Sample of Australian Adults ? *Nutrients* 2018.10:486.

Bosu, W. K. 2015. The prevalence, awareness, and control of hypertension among workers in West Africa: A systematic review. *Global Health Action* 8.1:26227.

Bosu, W. K., Aheto, J. M. K., Zucchelli, E., and Reilly, S. T. 2019. Determinants of systemic hypertension in older adults in Africa: A systematic review. *BMC Cardiovascular Disorders*, 2019 (19): 173.

Brumpton, B., Langhammer, A., Romundstad, P., Chen, Y., and Mai, X. M. 2013. General and abdominal obesity and incident asthma in adults: The HUNT study. *European Respiratory Journal* 41.2:323–329.

Burggraf, C., Teuber, R., Brosig, S., and Meier, T. 2018. Review of a priori dietary quality indices in relation to their construction criteria *76*.10:747–764. https://doi.org/10.1093/nutrit/nuy027.

Byambasukh, O., Snieder, H., and Corpeleijn, E. 2020. Relation Between Leisure Time, Commuting, and Occupational Physical Activity With Blood Pressure in 125 402 Adults: The Lifelines Cohort. *Journal of the American Heart Association* 9.4:e014313.

Center for Disease Control and Prevention. 2011. Strategies to Prevent Obesity and Other Chronic Diseases: The CDC Guide to Strategies to Increase the Consumption of Fruits and Vegetables. Atlanta: U.S. Department of Health and Human Services. Retrieved on 8th August, 2021 from http://www.cdc.gov/obesity/downloads/fandv_2011_web_tag508.pdf.

Chan, R., Wong, V. W., Chu, W. C., Lai-, G., Wong, H., Li, L. S., Leung, J., Chim, A. M. and Yeung, D. K. 2015. Diet-Quality Scores and Prevalence of Nonalcoholic Fatty Liver Disease : A Population Study Using Proton-Magnetic Resonance Spectroscopy. *PloS One* 10.9:e0139310.

Cheung, L. T. F., Chan, R. S. M., Ko, G. T. C., Lau, E. S. H., Chow, F. C. C., and Kong, A. P. S. 2018. Diet quality is inversely associated with obesity in Chinese adults with type 2 diabetes. *Nutrition Journal* 2018.17:63.

Chiuve, S. E., Fung, T. T., Rimm, E. B., Hu, F. B., Mccullough, M. L., Wang, M., Stampfer, M. J. and Willett, W. C. 2012. Alternative Dietary Indices Both Strongly Predict Risk of Chronic Disease 1 – 3. *The Journal of Nutrition 142*:1009–1018. https://doi.org/10.3945/jn.111.157222.TABLE.

Christofoletti, M., Del Duca, G. F., Gripa, L. T., and de Assis, M. A. A. 2016. Sedentary behavior at leisure time and its association with physical activity in school context of children in Southern Brazil. *Journal of Physical Education* 27:e2755.

Chukwuonye, I. I., Chuku, A., John, C., Ohagwu, K. A., Imoh, M. E., Isa, S. E., Ogah, O. S. and Oviasu, E. 2013. Prevalence of overweight and obesity in adult Nigerians - A systematic review. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy* 6:43–47.

Cloix, L., Caille, A., Helmer, C., Bourdel-marchasson, I., and Fagot-campagna, A. 2015. Physical activity at home , at leisure , during transportation and at work in French adults with type 2 diabetes : The ENTRED physical activity study. *Diabetes and Metabolism* 41.1:37–44.

Cochran, W. G. 1963. Sampling Techniques, 2nd Ed., New York: John Wiley and Sons, Inc.

Cockx, L., Colen, L., De Weerdt, J., and Gomez Y Paloma, S. 2019. Urbanization as a driver of changing food demand in Africa. *EUR 28756 EN, Publications Office of the European Union, Luxembourg*. Retrieved on 8th August, 2021 from https://ec.europa.eu/jrc.

Codina, N., and Pestana, J. V. 2019. Time Matters Di ff erently in Leisure Experience for Men and Women : Leisure Dedication and Time Perspective. *International Journal of Environmental Research and Public Health, 2019*(16): 2513.

Cohen, A. K., Rai, M., Rehkopf, D. H., and Abrams, B. 2013. Educational attainment and obesity : A systematic review. *Obes Rev.* 14.12:989–1005.

Conklin, A. I., Monsivais, P., Khaw, K., Wareham, N. J., and Forouhi, N. 2016. Dietary Diversity , Diet Cost , and Incidence of Type 2 Diabetes in the United Kingdom : A Prospective Cohort Study. *PLoS Med* 13.7:e1002085.

Craig, C., Marshal, A. L., Sjostrom, Mi., Bauman, A. E., Booth, M. L., Ainsworth, B. E., Pratt, M., Ekelund, U., Yngve, A., Sallis, J. F. and Oja, P. 2003. International Physical Activity Questionnaire: 12-Country Reliability and Validity. *Medicine & Science in Sports & Exercise 35*.8:1381–1395.

da Silva, C. I., Hino, A. A., Lopes, A., Ekelund, U., Brage, S., Gonçalves, H., Menezes, A. B., Reis, R. S. and Hallal, P. C. 2017. Built environment and physical activity : domain- and activity-specific associations among Brazilian adolescents. *BMC Public Health* 17:616.

Danquah, I., Galbete, C., Meeks, K., Nicolaou, M., Klipstein, K., Addo, J., Addo, J., Graft, A. D., Stephen, A., Peter, K. A., Baffour, A., Boateng, D., Bedu, G., Joachim, A., Liam, S., Ellis, S., Dabo, O. and Agyemang, C. 2018. Food variety , dietary diversity , and type 2 diabetes in a multi - center cross - sectional study among Ghanaian migrants in Europe and their compatriots in Ghana : the RODAM study. *European Journal of Nutrition* 57.8:2723–2733.

Davidson, G. I., and Ene-Obong, H. N. 2017. Nutrients Intake of Adults in Urban and Rural Households in Abia and Ebonyi States , Nigeria. *Journal of Scientific Research & Reports* 16.5:1–11.

de Andrade, S. C. ., Previdelli, Á. N. ., Cesar, C. L. G. ., Marchioni, D. M. L. ., and Fisberg, R. M. 2016. Trends in diet quality among adolescents, adults and older adults: A population-based study. *Preventive Medicine Reports* 4:391–396.

de Oliveira Otto, M. C., Anderson, C. A. M., Dearborn, J. L., Ferranti, E. P., Mozaffarian, D., Rao, G., Rao, G., Wylie-Rosett, J. and Lichtenstein, A. H. 2018. Dietary Diversity: Implications for Obesity Prevention in Adult Populations: A Science Advisory From the American Heart Association. *Circulation* 138.11:e160–e168.

Declercq, V., Cui, Y., Forbes, C., Grandy, S. A., Keats, M., Parker, L., Sweeney, E., Yu, Z. M. and Id, T. D. 2017. Association between Diet Quality and Adiposity in the Atlantic PATH Cohort. *Nutrients* 2017.9:1155.

Devaux, M., Sassi, F., Church, J., Cecchini, M., and Borgonovi, F. 2011. Exploring the Relationship Between Education and Obesity. *OECD Journal: Economic Studies* 2011.1:121–123.

Diaz, K. M., Booth, J. N., Seals, S. R., Abdalla, M., Dubbert, P. M., Sims, M., Ladapo, J. A., Redmond, N., Muntner, P. and Shimbo, D. 2017. Physical activity and incident hypertension in African Americans. *Hypertension* 69.3:421–427.

Dietary Guidelines Advisory Committee. 2004. Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2005. U.S. Department of Agriculture, Agricultural Research Service.

dos Santos, M. C., Giovâni Firpo Del Duca1, Elusa Santina Antunes de Oliveira, Mauro Virgílio Gomes de Barros, M. V. N. 2016. Physical activity in commuting , household , leisure time , or work : which domain is associated with lower stress in adult workers? *Brazilian Journal of Physical Activity and Health* 21.2:133–143.

Dowda, M., Ross, S. E. T., Mciver, K. L., Dishman, R. K., and Pate, R. R. 2017. Physical Activity and Changes in Adiposity in the Transition from Elementary to Middle School. *Childhood Obesity* 13.1:53–62.

Eckel, R. H., Jakicic, J. M., Ard, J. D., De Jesus, J. M., Houston Miller, N., Hubbard, V. S., Lee, I. M., Lichtenstein, A. H., Loria, C. M., Millen, B. E., Nonas, C. A., Sacks, F. M., Smith, S. C., Svetkey, L. P., Wadden, T. A. and Yanovski, S. Z. 2014. 2013 AHA/ACC guideline on lifestyle management to reduce cardiovascular risk: A report of the American College of cardiology/American Heart Association task force on practice guidelines. *Circulation* 129.25 SUPPL. 1:76–99.

Ekanem, U. S., Opara, D. C., and Akwaowo, C. D. 2013. High blood pressure in a semi-urban community in south-south Nigeria: A community - Based study. *African Health Sciences* 13.1:56–61.

Everett, B., and Zajacova, A. 2015. Gender Differences in Hypertension and Hypertension Awareness Among Young Adults. *Biodemography Soc Biol.* 61.1:1–17.

FAO 1998. Carbohydrates in Human Nutrition. Report of a Joint FAO/ WHO Expert Consultation (FAO Food and Nutrition Paper 66) Food and Agriculture Organization: Rome. https://books.google.com.ng/books/about/Carbohydrates_in_Human_Nutrition.html?id=Mf3lxvWfA9oC&redir_esc=y

FAO. 2010. *Fats and fatty acids in human nutrition. Report of an expert consultation, 10 − 14 November 2008 Geneva. FAO food and nutrition paper* (Vol. 91). Downloaded on 12th December, 2021 from https://www.fao.org/3/i1953e/I1953E.pdf.

FAO/WHO. 2005. Human Vitamin and Mineral Requirements. *Geneva : World Health Organization* .2nd ed:341. Retrieved on 13th December, 2021 from http://apps.who.int/iris/handle/10665/42716.

FAO/WHO/UNU. 2004. Human energy requirements. Report os a Joint FAO/WHO/UNU Expert Consultation, Rome, 17-24 October 2001. Rome. FAO Food and Nutrition Technical Report Series 1. Downloaded on 12th December, 2021 from https://www.fao.org/3/y5686e/y5686e.pdf.

FAO/WHO/UNU. 2007. Protein and amino acid requirements in human nutrition. Report of a Joint WHO/FAO/UNU Expert Consultation, Geneva, Switzerland, WHO tecnicnical report series, 935.

Fan, M., Su, M., Tan, Y., Liu, Q., Ren, Y., Li, L., and Lv, J. 2015. Gender , Age , and Education Level Modify the Association between Body Mass Index and Physical Activity : A Cross-Sectional Study in Hangzhou, China. *PLoS One*10.5:e0125534.

Fan, M., Yu, C., Guo, Y., Bian, Z., Li, X., Yang, L., Chen, Y., Li, M., Li, X., Chen, J., Chen, Z., Lv, J., Li, L., and China Kadoorie Biobank Collaborative Group 2018. Effect of total, domain-specific, and intensity-specific physical activity on all-cause and cardiovascular mortality among hypertensive adults in China. *Journal of hypertension*, 36.4: 793–800.

Fishman, E., Böcker, L., and Helbich, M. 2015. Adult Active Transport in the Netherlands: An Analysis of Its Contribution to Physical Activity Requirements. *PLOS ONE* 10.4:e0121871.

Foley, A., Barnason, S., MacPherson-Dias, R., Stapleton, S. J., Bradford, J. Y., Horigan, A., Kaiser, J., Proehl, J. A., Slivinski, A. and Vanhoy, M. A. 2018. *Clinical Practice Guideline:* Non-Invasive Blood Pressure Measurement. Emergency Nurses Association. Retrieved on 8th September, 2020 from https://media.emscimprovement.center/documents/nibpmcpg.pdf.

Fonseca, D. C., Sala, P., Ferreira, M. de A., Reis, J., Torrinhas, R. S., Bendavid, I., and Waitzberg, D. L. 2018. Body weight control and energy expenditure. *Clinical Nutrition Experimental* 20:55–59.

Frese, E. M., Fick, A., and Sadowsky, S. H. 2011. Blood Pressure Measurement Guidelines for Physical Therapists. *Cardiopulmonary Physical Therapy Journal* 22.2:5–12.

Fruh, S. M. 2017. Obesity: Risk factors, complications, and strategies for sustainable long-term weight management. *Journal of the American Association of Nurse Practitioners* 29:S3–S14.

Fuchs, F. D., and Whelton, P. K. 2020. High Blood Pressure and Cardiovascular Disease. *Hypertension* 75:285–292.

GBD 2013 Mortality and Causes of Death Collaborators. 2015. Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet* 385.9963:117–171.

Gebremedhin S and Bekele T. 2021. Evaluating the African food supply against the nutrient intake goals set for preventing diet-related non-communicable diseases: 1990 to 2017 trend analysis. PLoS ONE 16(1): e0245241.

Ghosh, S., Mukhopadhyay, S., and Barik, A. 2016. Sex differences in the risk profile of hypertension: A cross-sectional study. *BMJ Open* 6.7:1–8.

Gibson, R.S. and Ferguson, E.L. 1999. An interactive 24-Hour recall for assessing the adequacy of iron and zinc intakes in developing countries. ILSI Press, Washington D.C.

Gil, Á., Victoria, E. M. De, and Olza, J. 2015. Indicators for the evaluation of diet quality. *Nutrición Hospitalaria* 31.3:128–144.

Goh, H. J., Govindharajulu, P., Camps, S. G., Tan, S. Y., and Henry, C. J. 2016. Gross and relative energy cost of domestic household activities in Asian men. *European Journal of Clinical Nutrition* 70.12:1414–1419.

Guenther, P. M., Casavale, K. O., Kirkpatrick, S. I., Reedy, J., .Hiza, H. A. ., Kuczynski, K. J., Kahle, L. L., and Krebs-Smith., S. M. 2013. Update of the Healthy Eating Index: HEI-2010. *Journal of the Academy of Nutrition and Dietetics*, *113*(4), 569–580.

Guenther, P. M., Reedy, J., Krebs-Smith, S. M., Reeve, B. B., and Basiotis, P. P. 2007. Development and evaluation of the Healthy Eating Index-2005: Technical report. *Development*, *2600*(202), 1–41.

Guthold, R., Louazani, S. A., Riley, L. M., Cowan, M. J., Bovet, P., Damasceno, A., Sambo, B. H., Tesfaye, F., and Armstrong, T. P. 2011. Physical activity in 22 African countries: results from the World Health Organization STEPwise approach to chronic disease risk factor surveillance. *American journal of preventive medicine*, 41(1), 52–60.

Ha, K., Kim, K., Chun, O. K., Joung, H., and Song, Y. 2018. Differential association of dietary carbohydrate intake with metabolic syndrome in the US and Korean adults: data from the 2007-2012 NHANES and KNHANES. European journal of clinical nutrition, 72(6), 848–860.

Haileselassie, M., Redae, G., Berhe, G., Henry, C. J., Nickerson, M. T., Tyler, B., and Mulugeta, A. 2020. Why are animal source foods rarely consumed by 6-23 months old children in rural communities of Northern Ethiopia? *PloS One*, 15.1:e0225707.

Han, T. S., Sattar, N., and Lean, M. 2006. ABC of obesity Assessment of obesity and its clinical implications. *BMJ* 333:695–698.

Harika, R., and Faber, M. 2015. Micronutrient Status and Dietary Intake of Iron, Vitamin A, Iodine, Folate and Zinc in Women of Reproductive Age and Pregnant Women in Ethiopia, Kenya, Nigeria and South Africa: A Systematic Review of Data from 2005 to 2015. *Nutrients* 2017.9:1096.

Härkönen, J., Räsänen, P., and Näsi, M. 2011. Obesity, Unemployment, and Earnings. *Nordic Journal of Working Life Studies* 1.2:23–38.

Hattingh, Z., Walsh, C. M., Bester, C. J., and Oguntibeju, O. O. 2008. Evaluation of energy and macronutrient intake of black women in Bloemfontein: A cross-sectional study. *African Journal of Biotechnology* 7.22:4019–4024.

Haynes, A., Hardman, C. A., Makin, A. D. J., Halford, J. C. G., Jebb, S. A., and Robinson, E. 2019. Visual perceptions of portion size normality and intended food consumption: A norm range model. *Food Quality and Preference* 72:77–85.

Health Canada. 2019. *Canada's Dietary Guidelines for Health Professionals and Policy Makers*. *Health Canada*. Retrieved from https://food-guide.canada.ca/static/assets/pdf/CDG-EN-2018.pdf.

Hegde, S. M., and Solomon, S. D. 2016. Influence of Physical Activity on Hypertension and Cardiac Structure and Function. *Current hypertension reports*, 17.10: 77.

Heindel, J. J., and Blumberg, B. 2019. Environmental Obesogens: Mechanisms and Controversies. *Annual Review of Pharmacology and Toxicology* 59:89–106.

Heymsfield, S. B., and Wadden, T. A. 2017. Mechanisms, pathophysiology, and management of obesity. *New England Journal of Medicine* 376.3:254–266.

Hill, J. O., Wyatt, H. R., and Peters, J. C. 2012. Energy balance and obesity. *Circulation* 126.1:126–132.

Hu, L., Huang, X., You, C., Li, J., Hong, K., Li, P., Wu, Y., Wu, Q., Wang, Z., Gao, R., Bao, H., and Cheng, X. 2017. Prevalence of overweight, obesity, abdominal obesity and obesity-related risk factors in southern China. *PLoS ONE, 12*(9), e0183934.

Idung, A. U., Abasiubong, F., Udoh, S. B., and Ekanem, U. S. 2014. Overweight and obesity profiles in Niger Delta Region, Nigeria. *African Journal of Primary Health Care and Family Medicine* 6.1:6–10.

INDDEX Project. 2018. Data4Diets: Building Blocks for Diet-related Food Security Analysis. Retrieved on 8th February, 2020 from https://inddex.nutrition.tufts.edu/data4diets.

Institute of Medicine. 2005. Summary Tables, Dietary Reference Intakes. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Retrieved on 20th January, 2020 from https://www.nal.usda.gov/sites/default/files/fnic_uploads/energy_full_report.pdf.

Institute of Medicine (US) Committee on Social Security Cardiovascular Disability Criteria. 2010. Ischemic Heart Disease - Cardiovascular Disability - NCBI Bookshelf. *National Academies Press (US)*. Retrieved on 12th December, 2021 from https://www.ncbi.nlm.nih.gov/books/NBK209964/.

Isara, A. R., and Okundia, P. O. 2015. The burden of hypertension and diabetes mellitus in rural communities in Southern Nigeria. *Pan African Medical Journal 20*:103.

Islam, F., Kathak, R. R., Sumon, A. H., and Molla, N. H. 2020. Prevalence and associated risk factors of general and abdominal obesity in rural and urban women in Bangladesh. *PLoS ONE* 15.5:e0233754.

Iwuala, S., Sekoni, A., Olamoyegun, M., Akanbi, M., Sabir, A., and Ayankogbe, O. 2015. Self-reported physical activity among health care professionals in South-West Nigeria. *Nigerian Journal of Clinical Practice* 18.6:790.

Jackson, J., Williams, R., McEvoy, M., MacDonald-Wicks, L., and Patterson, A. 2016. Is higher consumption of animal flesh foods associated with better iron status among adults in developed countries? A systematic review. *Nutrients 8*.2:1–27.

James, P. A., Oparil, S., Carter, B. L., Cushman, W. C., Dennison-Himmelfarb, C., Handler, J., Lackland, D. T., LeFevre, M. L., MacKenzie, T. D., Ogedegbe, O., Smith, S. C., Svetkey, L. P., Taler, S. J., Townsend, R. R., Wright, J. T., Narva, A. S., and Ortiz, E. 2014. 2014 Evidence-based guideline for the management of high blood pressure in adults: Report from the panel members appointed to the Eighth Joint National Committee (JNC 8). *JAMA - Journal of the American Medical Association*, 311(5), 507–520.

John, B., Todd, J., Mboya, I., Mosha, M., Urassa, M., and Mtuy, T. 2017. Physical activity and associated factors from a cross-sectional survey among adults in northern Tanzania. *BMC Public Health* 17:588.

Joseph-Shehu, E. M., and Ncama, B. P. 2018. Evaluation of health status and its predictor among university staff in Nigeria. *BMC Cardiovascular Disorders* 18:183.

Jura, M., and Kozak, L. P. 2016. Obesity and related consequences to ageing. *Journal of American Aging Association* 38:23.

Justine, M., Azizan, A., Hassan, V., Salleh, Z., and Manaf, H. 2013. Barriers to participation in physical activity and exercise among middle-aged and elderly individuals. *Singapore Medical Journal* 54.10:581–586.

Kabir, A., Miah, S., and Islam, A. 2018. Factors influencing eating behavior and dietary intake among resident students in a public university in Bangladesh : A qualitative study. *PLoS ONE* 13.6:e0198801.

Kanagasabai, T., Thakkar, N. A., Kuk, J. L., Churilla, J. R., and Ardern, C. I. 2015. Differences in physical activity domains, guideline adherence, and weight history between metabolically healthy and metabolically abnormal obese adults : a cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity* 12:64.

Kanter, R., and Caballero, B. 2012. Global Gender Disparities in Obesity : A Review 1. *Advances in Nutrition* 3.4:491–498.

Kari, J. T., Pehkonen, J., Hirvensalo, M., Yang, X., and Hutri, N. 2015. Income and Physical Activity among Adults : Evidence from Self-Reported and Pedometer- BasedPhysical Activity Measurements. *PloS One* 10.8: e0135651.

Karimbeiki, R., Pourmasoumi, M., Feizi, A., Abbasi, B., Hadi, A., Rafie, N. and Safavi, S. M. 2018. Higher dietary diversity score is associated with obesity: a case–control study. *Public Health* 157:127–134.

Kayode, O. O., and Alabi, Q. K. 2020. Food consumption patterns, physical activity and overweight and obesity among undergraduates of a private university in Nigeria. *Clinical Nutrition Experimental* 31:28–34.

Kelishadi, R., Poursafa, P. and Jamshidi, F. 2013. Role of environmental chemicals in obesity: A systematic review on the current evidence. *Journal of Environmental and Public Health* 2013:896789.

Kelley, E., Kelley, E. A., Bowie, J. V, Griffith, D. M., Bruce, M., Hill, S. and Thorpe, R. J. 2015. Geography , Race / Ethnicity, and Obesity Among Men in the United States. American Journal of Men's Health 10.3:228–236.

Kennedy, E., Ohls, J., and Fleming, K. 1995. The Healthy Eating Index. Design and Applications. *Journal of the American Dietetic Association* 95.10:1103–1108.

Khanam, M. A., Lindeboom, W., Razzaque, A., Niessen, L. and Milton, A. H. 2015. Prevalence and determinants of pre-hypertension and hypertension among the adults in rural Bangladesh: Findings from a community-based study. *BMC Public Health* 15.1:203.

Kim, H., Lim, H., and Choue, R. 2015. A Better Diet Quality is Attributable to Adequate Energy Intake in Hemodialysis Patients. *Clinical Nutrition Research* 4.1:46.

Kim, H. Y., Kim, J. K., Shin, G. G., Han, J. A., and Kim, J. W. 2019. Association between Abdominal Obesity and Cardiovascular Risk Factors in Adults with Normal Body Mass Index: Based on the Sixth Korea National Health and Nutrition Examin*ation Survey*. *Journal of Obesity and Metabolic Syndrome* 28.4:262–270.

Kim, S., Haines, P. S., Siega-Riz, A. M. and Popkin, B. M. 2003. The Diet Quality Index-International (DQI-I) Provides an Effective Tool for Cross-National Comparison of Diet Quality as Illustrated by China and the United States. *The Journal of Nutrition* 133.11:3476–3484.

Kim, T. J., and Knesebeck, O. Von. 2018. Income and obesity : what is the direction of the relationship ? A systematic review and meta-analysis. *BMJ Open* 8.e019862:13. https://doi.org/10.1136/bmjopen-2017-019862.

Kinlen, D., Cody, D., and O'Shea, D. 2018. Complications of obesity. *QJM: An International Journal of Medicine* 111.7:437–443.

Koehler, K., and Drenowatz, C. 2019. Integrated role of nutrition and physical activity for lifelong health. *Nutrients* 11.7:1437.

Koksal, E., Seyda, M., Ermumcu, K., and Mortas, H. 2017. Description of the healthy eating indices-based diet quality in Turkish adults : a cross-sectional study. *Environmental Health and Preventive Medicine* 22.1:12.

Kolahdooz, F., Spearing, K., and Sharma, S. 2013. Dietary Adequacies among South African Adults in Rural KwaZulu-Natal. *PLoS ONE 8*.6:

Kouris-Blazos, A., and Belski, R. 2016. Health benefits of legumes and pulses with a focus on Australian sweet lupins. *Asia Pacific Journal of Clinical Nutrition 25*.1:1–17.

Lahti, J., Laaksonen, M., Lahelma, E., and Rahkonen, O. 2011. Changes in leisure-time physical activity after transition to retirement : a follow-up study. *International Journal of Behavioral Nutrition and Physical Activity* 8:36.

Laird, Y., Kelly, P., Brage, S., and Woodcock, J. 2018. *Cycling and walking for individual and population health benefits: A rapid evidence review for health and care system decision-makers.* Public Health England. Retrieved on 3rd September, 2020 from https://www.research.ed.ac.uk/en/publications/cycling-and-walking-for-individual-and-population-health-benefits.

Lee, E., Choi, J., Ahn, A., Oh, E., Kweon, H., and Cho, D. 2015. Acceptable macronutrient distribution ranges and hypertension. *Clinical and experimental hypertension* 37(6): 463–467.

Lee, Y. D., Kim, K. W., Choi, K. S., Kim, M., Cho, Y. J., and Sohn, C. 2016. Development of dietary pattern evaluation tool for adults and correlation with Dietary Quality Index. *Nutrition Research and Practice* 10.3:305–312.

Lee, H., Ahn, R., Kim, T. H., and Han, E. 2019. Impact of Obesity on Employment and Wages among Young Adults : Observational Study with Panel Data. *International Journal of Environmental Research and Public Health* 16:139–145.

Lee, K. W., Song, W. O.and Cho, M. S. 2016. Dietary quality differs by consumption of meals prepared at home vs. outside in Korean adults. *Nutrition research and practice*, *10*(3), 294–304.

Lightfoot, J. T., De Geus, E. J. C., Booth, F. W., Bray, M. S., den Hoed, M., Kaprio, J., Scott, A. K., Pomp, D., Saul, M. C., Thomis, M. A., Theodore, G., and Bouchard, C.

2018. Biological/Genetic Regulation of Physical Activity Level: Consensus from GenBioPAC. *Medicine and science in sports and exercise*, 50.4: 863–873.

Link, J. C., and Reue, K. 2017. The Genetic Basis for Sex Differences in Obesity and Lipid Metabolism. *Annual Review of Nutrition* 37:225–245.

Livingstone, K. M., and McNaughton, S. A. 2016. Diet quality is associated with obesity and hypertension in Australian adults: a cross sectional study. *BMC Public Health* 16.1:1–10.

Livingstone, M. B. E., and Pourshahidi, L. K. 2014. Portion Size and Obesity. *Advances in Nutrition* 5.6:829–834. https://doi.org/10.3945/an.114.007104

Lockwood, W. 2019. Obesity : Methods of Assessment. Retrieved September 28, 2020, from https://www.rn.org/courses/coursematerial-211.pdf.

Loyen, A., Hecke, L. Van, Verloigne, M., Hendriksen, I., Lakerveld, J., Steene-johannessen, J., Vuillemin, A., Koster, A., Donnelly, A., Ekelund, U., Deforche, B., Bourdeaudhuij, I. De, Brug, J., and Ploeg, H. P. Van Der. 2016. Variation in population levels of physical activity in European adults according to cross-European studies : a systematic literature review within DEDIPAC. *International Journal of Behavioral Nutrition and Physical Activity*, 13, 72.

Lucini, D., Zanuso, S., Blair, S., and Pagani, M. 2015. A simple healthy lifestyle index as a proxy of wellness: a proof of concept. *Acta Diabetologica* 52.1:81–89.

Lukács, A., Horváth, E., Máté, Z., Szabó, A., Virág, K., Papp, M., Sándor, J., Ádány, R., and Paulik, E. 2019. Abdominal obesity increases metabolic risk factors in non-obese adults: A Hungarian cross-sectional study. *BMC Public Health*, 19, 1533.

Macek, P., Terek-derszniak, M., Zak, M., Biskup, M., Ciepiela, P., Krol, H., Smok-kalwat, J., and Gozdz, S. 2019. WHO recommendations on physical activity versus compliance rate within a specific urban population as assessed through IPAQ survey : a cross-sectional cohort study. *BMJ Open*, *9*, e028334. https://doi.org/10.1136/bmjopen-2018-028334.

Malambo, P., Kengne, A. P., Lambert, E. V, Villiers, A. De, and Puoane, T. 2016. Prevalence and socio-demographic correlates of physical activity levels among South African adults in Cape Town and Mount Frere communities in 2008-2009. *Archives of Public Health* 74:54.

Malik, S. K., Kouame, J., Gbane, M., Coulibaly, M., D. Ake, M., and Ake, O. 2019. Prevalence of abdominal obesity and its correlates among adults in a peri-urban population of West Africa. *AIMS Public Health* 6.3:334–344.

Maphosa, Y., and Jideani, V. A. 2016. Physicochemical characteristics of Bambara groundnut dietary fibres extracted using wet milling. *South African Journal of Science*, 112(1/2).

Martin, J. C., Moran, L. J., Teede, H. J., Ranasinha, S., Lombard, C. B., and Harrison, C. L. 2017. Exploring diet quality between urban and rural dwelling women of reproductive age. *Nutrients 9*:586.

Mashili, F. L., Kagaruki, G. B., Mbatia, J., Nanai, A., Saguti, G., Maongezi, S., Magimba, A., Mghamba, J., Kamugisha, M., Mgina, E., Mweya, C. N., Kaushik, R., and Mayige, M. T. 2018. Physical Activity and Associated Socioeconomic Determinants in Rural and Urban Tanzania : Results from the 2012 WHO-STEPS Survey. *International Journal of Population Research*, 2018, Article ID 4965193.

Masters, R. K., Reither, E. N., Powers, D. A., Yang, Y. C., Burger, A. E., and Link, B. G. 2013. The impact of obesity on US mortality levels: The importance of age and cohort factors in population estimates. *American Journal of Public Health* 103.10:1895–1901.

Medina, C., Janssen, I., Barquera, S., Bautista-Arredondo, S., González, M. E., and González, C. 2018. Occupational and leisure time physical inactivity and the risk of type II diabetes and hypertension among Mexican adults: A prospective cohort study. *Scientific Reports* 8:5399.

Mekonnen, D. A., Trijsburg, L., Achterbosch, T., Brouwer, I. D., Kennedy, G., Linderhof, V., Ruben, R., andTalsma, E. F. 2021. Food consumption patterns, nutrient adequacy, and the food systems in Nigeria. *Agricultural and Food Economics*, 9:16.

Messerli, F. H., Rimoldi, S. F., and Bangalore, S. 2017. The Transition From Hypertension to Heart Failure: Contemporary Update. *JACC: Heart Failure* 5.8:543–551.

Micklesfield, L. K., Lambert, E. V., Hume, D. J., Chantler, S., Pienaar, P. R., Dickie, K., Puoane, T., and Goedecke, J. H. 2013. Socio-cultural, environmental and behavioural determinants of obesity in black South African women. *Cardiovascular Journal of Africa*, 24(9), 369–375.

Min, T., and Stephens, J. W. 2015. Targeting abdominal obesity in diabetes. *Diabetes Management* 5.4:301–309.

Miranda, J. J., Carrillo-Larco, R. M., Gilman, R. H., Avilez, J. L., Smeeth, L., Checkley, W., Bernabe-Ortiz, A., Casas, J. P., Smith, G. D., Ebrahim, S., García, H. H., Huicho, L., Málaga, G., Montori, V. M., Diette, G. B., León-Velarde, F., Rivera, M., Wise, R. A., and Sacksteder, K. 2016. Patterns and determinants of physical inactivity in rural and urban areas in Peru: A population-based study. *Journal of Physical Activity and Health*, 13(6), 654–662.

Mogre, V., Nyaba, R., Aleyira, S., and Sam, N. B. 2015. Demographic, dietary and physical activity predictors of general and abdominal obesity among university students: a cross-sectional study. *SpringerPlus* 4:226.

Moschny, A., Platen, P., Klaaßen-Mielke, R., Trampisch, U., and Hinrichs, T. 2011. Barriers to physical activity in older adults in Germany: A cross-sectional study.

*International Journal of Behavioral Nutrition and Physical Activity* 8:121.

Munyogwa, M. J., and Mtumwa, A. H. 2018. The Prevalence of Abdominal Obesity and Its Correlates among the Adults in Dodoma Region, Tanzania: A Community-Based Cross-Sectional Study. *Advances in Medicine* 2018:6123156.

Murphy, M. H., Donnelly, P., Breslin, G., Shibli, S., and Nevill, A. M. 2013. Does doing housework keep you healthy ? The contribution of domestic physical activity to meeting current recommendations for health. *BMC Public Health* 13.1:1.

Murthy, G. V. S., Fox, S., Sivasubramaniam, S., Gilbert, C. E., Mahdi, A. M., Imam, A. U., and Entekume, G. 2013. Prevalence and risk factors for hypertension and association with ethnicity in Nigeria: Results from a national survey. *Cardiovascular Journal of Africa* 24.9:344–350. https://doi.org/10.5830/CVJA-2013-058.

Mustapha, I. . 2014. Analysis of Dietary Diversity of Food Consumption Pattern in Oyo State. *Global Journal of Biology, Agriculture and Health Sciences* 3.3:289–293.

Myers, Candice A., Tim, Slack., Martin, Corby K., Broyles, Stephanie T and Heymsfield, S. B. 2015. Regional Disparities in Obesity Prevalence in the United States : *Obesity (Silver Spring)* 23.2:481–487.

Nanda, S., Mohabbat, A. B., Nagaraju, D., Varayil, J. E., Ratrout, B., Abu-Lebdeh, S., H., and Majka, A. J. 2015. Improving Awareness of Patients with Obesity and its Healthcare Implications. *Quality in Primary Care 23*.4:201–204.

Nang, E. E. K., Khoo, E. Y., Salim, A., Shyong Tai, E., Lee, J., and Van Dam, R. M. 2010. Patterns of physical activity in different domains and implications for intervention in a multi-ethnic Asian population: a cross-sectional study. *BMC Public Health* 10:644.

National Health and Medical Research Council. 2013. *Australian Dietary Guidelines. Canberra*. *Nhmrc*. https://doi.org/10.1097/NT.0b013e31826c50af.

National Population Commission [Nigeria] and ICF. 2019. Nigeria Demographic and Health Survey, 2018. Abuja, Nigeria, and Rockville, Maryland, USA. Downloaded from https://dhsprogram.com/publications/publication-fr359-dhs-final-reports.cfm.

National Population Commission and ICF Macro. 2009. Nigeria Demographic and Health Survey 2008. Key findings. Retrieved from http://measuredhs.com/publications/publication-sr171-summary-reports-key-findings.cfm.

Ng, R. Y., Wong, Y., Yeo, J., Koh, C. L., Gan, S. and K.-E. 2018. The associations between dietary practices and dietary quality, biological health indicators, perceived stress, religiosity, culture, and gender in multi-cultural Singapore. *Journal of Ethnic Foods* 5.3:220–227.

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., Mullany, E. C., Biryukov, S., Abbafati, C., Abera, S. F., Abraham, J. P., Abu-Rmeileh, N. M., Achoki, T., AlBuhairan, F. S., Alemu, Z. A., Alfonso, R., Ali, M. K., Ali, R., and Guzman, N, E. 2014. Global, regional and national prevalence of overweight and obesity in children and adults 1980-2013: A systematic analysis. *The Lancet*, 384(9945), 766–781.

Nour, M., Lutze, S. A., Grech, A., and Allman-Farinelli, M. 2018. The relationship between vegetable intake and weight outcomes: A systematic review of cohort studies. *Nutrients* 10:1626.

Obayelu, O. A., and Osho, F. R. 2020. How diverse are the diets of low-income urban households in Nigeria? *Journal of Agriculture and Food Research* 2:100018.

Ofori, S. N., and Obosi, J. 2019. Prevalence of hypertension among office workers in a multi-national company in the Niger-Delta with the 2017 American College of Cardiology/American Heart Association Blood Pressure Guidelines. *Preventive Medicine Reports* 15:100899.

Ogwumike, O. O., Adeniyi, A. F., Dosa, B. T., Sanya, A. O., and Awolola, K. O. 2014. Physical activity and pattern of blood pressure in postmenopausal women with hypertension in Nigeria. *Ethiopian Journal of Health Sciences* 24.2:153–160.

Oh, G. C., and Cho, H.-J. 2020. Blood pressure and heart. *Clinical Hypertension 26*:1.

Okop, K. J., Ndayi, K., Tsolekile, L., Sanders, D., and Puoane, T. 2019. Low intake of commonly available fruits and vegetables in socio-economically disadvantaged communities of South Africa : influence of affordability and sugary drinks intake. *BMC Public Health* 2019.19:940.

Okpechi, I. G., Chukwuonye, I. I., Tiffin, N., Madukwe, O. O., Onyeonoro, U. U., Umeizudike, T. I., and Ogah, O. S. 2013. Blood Pressure Gradients and Cardiovascular Risk Factors in Urban and Rural Populations in Abia State South Eastern Nigeria Using the WHO STEPwise Approach. *PLoS ONE* 8.9:4–6.

Oladoyinbo, C., Ugwunna, U., and Ekerette, N. 2017. Dietary Diversity and Nutrient Adequacy among Women in Iwo Local Government Area, Osun State Nigeria. *African Journal of Food, Agriculture, Nutrition and Development* 17.4:12641–12656.

Olamoyegun, M. A., Oluyombo, R., Iwuala, S. O., and Asaolu, S. O. 2016. Epidemiology and patterns of hypertension in semi-urban communities, South-Western Nigeria. *Cardiovascular Journal of Africa* 27.6:356–360.

Olawuyi, A. T., and Adeoye, I. A. 2018. The prevalence and associated factors of non-communicable disease risk factors among civil servants in Ibadan, Nigeria. *PLOS ONE 13*.9:e0203587.

Oliveros, E., Patel, H., Kyung, S., Fugar, S., Goldberg, A., Madan, N., and Williams, K. A. 2020. Hypertension in older adults: Assessment, management, and challenges.

*Clinical Cardiology* 43.2:99–107.

Onuoha, Franklin M., Ebirim, Canice C., Ajonuma, Benneth C., Alabi, Nkechi A., Eseigbe, Patricia and Okezue, O. S. 2016. Correlation between central obes ity and blo od pressure in an adult Nigerian population. *Journal of Insulin Resistance* 1.1:1–5.

Onyeji, G. N., and Sanusi, R. A. 2018. Diet quality of women of childbearing age in South-east Nigeria. *Nutrition and Food Science* 48.2:348–364.

Otemuyiwa, I. O., and Adewusi, S. R. A. 2014. Nutrient Composition of Some Foods from a Nigerian Eatery. *Journal of Food Chemistry and Nutrition* 2.1:11–18.

Owoeye, O., Tomori, A., and Akinbo, S. 2016. Pedometer-determined physical activity profile of healthcare professionals in a Nigerian tertiary hospital. *Nigerian Medical Journal* 57.2:99.

Oyewole, O. E., Atinmo, T. 2015. *Proceedings of the Nutrition Society* 74.4:460–465.

Oyeyemi, A. L., Bello, U. M., Philemon, S. T., Aliyu, H. N., Majidadi, R. W., and Oyeyemi, A. Y. 2014. Examining the reliability and validity of a modi fi ed version of the International Physical Activity Questionnaire , long form ( IPAQ-LF ) in Nigeria : a cross-sectional study. *BMJ Open*, 4(e005820).

Oyeyemi, Adewale Luqman, Oyeyemi, A. Y., Omotara, B. A., Lawan, A., Akinroye, K. K., Adedoyin, R. A., and Ramírez, A. 2018. Physical activity profile of Nigeria: Implications for research, surveillance and policy. *Pan African Medical Journal* 30:175.

Özköslü, M. A., Daşkapan, A., Karataş, M., and Tekindal, M. A. 2017. Differences in Physical Activity and Physical Fitness Level in Patients. *Clinical and Experimental Health Sciences* 7:94–99.

Paggi, M. E., Jopp, D., and Hertzog, C. 2016. The Importance of Leisure Activities in the Relationship between Physical Health and Well- Being in a Life Span Sample. *Gerontology* 62:450–458.

Panizza, C. E., Shvetsov, Y. B., Harmon, B. E., Wilkens, L. R., Le Marchand, L., Haiman, C., Reedy, J., and Boushey, C. J. 2018. Testing the predictive validity of the healthy eating index-2015 in the multiethnic cohort: Is the score associated with a reduced risk of all-cause and cause-specific mortality? *Nutrients*, 2018(10), 425.

Papadaki, A., Johnson, L., Toumpakari, Z., England, C., Rai, M., Toms, S., Id, C. P., Zazpe, I., Mart, M. A., and Feder, G. 2018. Validation of the English Version of the 14-Item Mediterranean Diet Adherence Screener of the PREDIMED Study , in People at High Cardiovascular Risk in the UK. *Nutrients*, 10, 138.

Pestoni, G., Krieger, J., Sych, J. M., Faeh, D., and Rohrmann, S. 2019. Cultural Differences in Diet and Determinants of Diet Quality in Switzerland : Results from the National

Nutrition Survey menuCH. *Nutrients* 2019.11:126.

Pfeifer, K., Banzer, W., Ferrari, N., Eszter, F., Geidl, W., Graf, C., Hartung, V., Klamroth, S., Völker, K., and Vogt, L. 2017. National Recommendations for Physical Activity and Physical Activity Promotion. In A. Rütten and K. Pfeifer (Eds.), *Gesundheitswesen, Supplement* (Vol. 79). FAU UNIVERSITY PRESS.

Polito, A., Intorre, F., Ciarapica, D., Barnaba, L., Tagliabue, A., Ferraris, C., and Zaccaria, M. 2016. Physical Activity Assessment in an Italian Adult Population using the International Physical Activity Questionnaire. *Obesity Research Open Journal* 4.1:1–10.

Popkin, B. M., Adair, L. S., and Ng, S. W. 2012. Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition Reviews* 70.1:3–21.

Puciato, D., Rozpara, M. B., Mynarski, W. B. B., V, P. O., Markiewicz-patkowska, J., and Ma, B. 2018. Physical Activity of Working-Age People in View of Their Income Status. *BioMed Research International*, *2018:* 8298527.

Raaijmakers, I., Snoek, H., Maziya-Dixon, B., and Achterbosch, T. 2018. Drivers of vegetable consumption in urban Nigeria: Food choice motives, knowledge, and self-efficacy. *Sustainability*, 10 (4771).

Racine, E. F., Laditka, S. B., Dmochowski, J., Alavanja, M. C. R., Lee, D. C., and Hoppin, J. A. 2012. Farming activities and carrying and lifting: The agricultural health study. *Journal of Physical Activity and Health* 9.1:39 - 47.

Raimi, T. H., Odusan, O., and Fasanmade, O. 2015. High prevalence of central obesity in rural South-Western Nigeria: Need for targeted prevention. *Journal of Diabetes and Endocrinology* 6.3:12–18.

Raji, Y. R., Abiona, T., and Gureje, O. 2017. Awareness of hypertension and its impact on blood pressure control among elderly nigerians: report from the Ibadan study of aging. *The Pan African Medical Journal* 27:190.

Rana, J., Ahmmad, Z., Sen, K. K., Bista, S., and Islam, R. M. 2020. Socioeconomic differentials in hypertension based on JNC7 and ACC/AHA 2017 guidelines mediated by body mass index: Evidence from Nepal demographic and health survey. *PLOS ONE* 15.1:e0218767.

Reue, K. 2017. Sex differences in obesity: X chromosome dosage as a risk factor for increased food intake, adiposity and co-morbidities Karen. *Physiol Behav.* 176:174–182.

Rhodes, R. E., Janssen, I., Bredin, S. S. D., Warburton, D. E. R., and Bauman, A. 2017. Physical activity: Health impact, prevalence, correlates and interventions. *Psychology and Health* 32.8:942–975.

Ripley, B. L., and Barbato, A. 2019. *Hypertension*. (A. Bress, D. L. Nickerson, and K. Rice, Eds.), *PSAP 2019 BOOK. Cardiology*. Downloaded on 1st December, 2021 from https://www.accp.com/docs/bookstore/psap/p2019b1_sample.pdf.

Romieu, I., Dossus, L., Barquera, S., Blottière, H. M., Franks, P. W., Gunter, M., Hwalla, N., Hursting, S. D., Leitzmann, M., Margetts, B., Nishida, C., Potischman, N., Seidell, J., Stepien, M., Wang, Y., Westerterp, K., Winichagoon, P., Wiseman, M., and Willett, W. C. 2017. Energy balance and obesity: what are the main drivers? *Cancer Causes and Control*, 28(3), 247–258.

Rosendorff, C., Lackland, D. T., Allison, M., Aronow, W. S., Black, H. R., Blumenthal, R. S., Cannon, C. P., de Lemos, J. A., Elliott, W. J., Findeiss, L., Gersh, B. J., Gore, J. M., Levy, D., Long, J. B., O'Connor, C. M., O'Gara, P. T., Ogedegbe, G., Oparil, S. and White, W. B. 2015. Management of hypertension in patients with coronary artery disease. *Hypertension*, 65, 1372–1407.

Rothman, M., Ranneileng, M., Nel, R., and Walsh, C. 2019. Nutritional status and food intake of women residing in rural and urban areas of Lesotho. *South African Journal of Clinical Nutrition* 32.1:21–27.

Rozenberg, S., Body, J. J., Bruyère, O., Bergmann, P., Brandi, M. L., Cooper, C., Devogelaer, J. P., Gielen, E., Goemaere, S., Kaufman, J. M., Rizzoli, R., and Reginster, J. Y. 2016. Effects of Dairy Products Consumption on Health: Benefits and Beliefs—A Commentary from the Belgian Bone Club and the European Society for Clinical and Economic Aspects of Osteoporosis, Osteoarthritis and Musculoskeletal Diseases. *Calcified Tissue International*, 98(1), 1–17.

Rukundo, P. M., Oshaug, A., Andreassen, B. A., Kikafunda, J., Rukooko, B., and Iversen, P. O. 2016. Food variety consumption and household food insecurity coping strategies after the 2010 landslide disaster - The case of Uganda. *Public Health Nutrition* 19.17:3197–3209.

Saint-maurice, P. F., Coughlan, D., Kelly, S. P., Keadle, S. K., Cook, M. B., and Carlson, S. A. 2019. Association of Leisure-Time Physical Activity Across the Adult Life Course With All-Cause and Cause-Specific Mortality. *JAMA network open* 2.3:e190355.

Salinero, A. E., Anderson, B. M., and Zuloaga, K. L. 2018. Sex differences in the metabolic effects of diet-induced obesity vary by age of onset Sex differences in the metabolic effects of diet-induced obesity vary by age of onset. *International Journal of Obesity* 42:1088–1091.

Samson-Akpan, P. E., Eyo, M. B., and Joshua, A. M. 2013. Physical Activity for Quality Living Among Academic Staff in Nigerian Universities. *Hamdard Medicus 56*.3:78.

Santos, M., Del Duca, G., Oliveira, E., Barros, M., and Nahas, M. 2016. Physical activity in commuting, household, leisure-time, or work: which domain is associated with lower stress in adult workers? *Revista Brasileira de Atividade Física & Saúde*

21.2:133–143.

Sanusi, R. A. 2010. An Assessment of Dietary Diversity in Six Nigerian States. *African Journal of Biomedical Research* 13:161–167. Retrieved from www.ajbrui.net

Sarki, A. M., Nduka, C. U., Stranges, S., Kandala, N. B., and Uthman, O. A. 2015. Prevalence of hypertension in low- and middle-income countries: A systematic review and meta-analysis. *Medicine (United States)* 94.50:e1959.

Sattelmair, J., Pertman, J., Ding, E. L., Kohl, H. W., Haskell, W., and Lee, I. M. 2011. Dose response between physical activity and risk of coronary heart disease: A meta-analysis. *Circulation* 124.7:789–795.

Scarabottolo, C. C., Cyrino, E. S., Nakamura, P. M., Tebar, W. R., Canhin, S., Gobbo, L. A., Giulliano, D., and Christofaro, D. 2019. Relationship of different domains of physical activity practice with health- related quality of life among community-dwelling older people : a cross-sectional study. *BMJ Open*, 9, e027751.

Schwandt, H. M., Coresh, J., and Hindin, M. J. 2010. Marital Status, Hypertension, Coronary Heart Disease, Diabetes, and Death Among African American Women and Men: Incidence and Prevalence in the Atherosclerosis Risk in Communities (ARIC) Study Participants. *J Fam Issues* 31.9:1211–1229.

Sharma, B., Chavez, R. C., and Nam, E. W. 2018. Prevalence and correlates of insufficient physical activity in school adolescents in Peru. *Revista de Saude Publica* 52:1–13.

Shin, M.-K., Kim, Y.-S., Kim, J.-H., Kim, S.-H., and Kim, Y. 2015. Dietary Patterns and Their Associations with the Diet Quality Index-International (DQI-I) in Korean Women with Gestational Diabetes Mellitus. *Clinical Nutrition Research* 4.4:216.

Skåre, J., Brantsæter, A., Frøyland, L., Hemre, G.-I., Knutsen, H., Lillegaard, I., and Torstensen, B. 2015. Benefit-risk Assessment of Fish and Fish Products in the Norwegian Diet – An Update. *European Journal of Nutrition & Food Safety* 5.4:260–266.

Soh, S. M., Chung, S. J., and Yoon, J. 2020. Dietary and Health Characteristics of Korean Adults According to the Level of Energy Intake from Carbohydrate: Analysis of the 7th (2016-2017) Korea National Health and Nutrition Examination SurveyData. *Nutrients*, *12*(2), 429.

Sokunbi, G., and Tersoo-Ivase, I. 2015. Physical activity pattern and its association with functional limitation, physical health, and emotional wellbeing of nurses with low back pain. *Nigerian Journal of Experimental and Clinical Biosciences* 3.2:84.

Some, M., Rashied, N., and Ohonba, A. 2014. The impact of obesity on employment in South Africa. *Studies in Economics and Econometrics*, 40:2, 87-104.

Sotos-Prieto, M., Bhupathiraju, S. N., Mattei, J., Fung, T. T., Li, Y., Pan, A., Willett, W.

C., Rimm, E. B., and Hu, F. B. 2017. Association of changes in diet quality with total and cause-specific mortality. *New England Journal of Medicine, 377*(2), 143–153.

Soubeiga, J. K., Millogo, T., Bicaba, B. W., Doulougou, B., and Kouanda, S. 2017. Prevalence and factors associated with hypertension in Burkina Faso: A countrywide cross-sectional study. *BMC Public Health* 17.1:64.

Stalsberg, R. 2018. Are Differences in Physical Activity across Socioeconomic Groups Associated with Choice of Physical Activity Variables to Report? Int J Environ Res Public Health. 15.5: 922.

Steyn, N., and Ochse, R. 2013. Food-Based Dietary Guidelines for South Africa: "Enjoy a variety of foods" as a food-based dietary guideline. *South African Journal of Nutrition* 26.3:13–17.

Sutaria, S., Mathur, R., and Hull, S. A. 2019. Does the ethnic density effect extend to obesity? A cross-sectional study of 415 166 adults in east London. *BMJ Open* 2019.9:e024779. Retrieved from https://bmjopen.bmj.com/content/bmjopen/9/5/e024779.full.pdf.

Tabasum, F., Beigh, M., and Hussain, S. Z. 2018. Obesity : Causes , consequences and management. *International Journal of Medical and Health Research* 4.4:53–58.

Tackling, G. ., and Borhade, M. B. 2019. Hypertensive Heart Disease - StatPearls - NCBI Bookshelf. *StatPearls Publishing*. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK539800/.

Teachman, J. 2016. Body Weight, Marital Status, and Changes in Marital Status. *J Fam Issues* 37.1:74–96.

Templin, T., Hashiguchi, C. O. T., Thomson, B., Dieleman, J., and Eran, B. 2019. The overweight and obesity transition from the wealthy to the poor in low- and middle-income countries : A survey of household data from 103 countries. *Plos Med* 16.11:e1002968.

Thaker, V. V. 2017. Genetic and Epigenetic Causes of Obesity. *Adolescent Medicine: State of the Art Review* 28.2:379–405.

Thorpe, M. G., Milte, C. M., Crawford, D., and Mcnaughton, S. A. 2019. Education and lifestyle predict change in dietary patterns and diet quality of adults 55 years and over. *Nutrition journal*, 18.1: 67.

Tong, T. Y. N., Wareham, N. J., Khaw, K. T., Imamura, F., and Forouhi, N. G. 2016. Prospective association of the Mediterranean diet with cardiovascular disease incidence and mortality and its population impact in a non-Mediterranean population: The EPIC-Norfolk study. *BMC Medicine* 14:135.

Tørris, C., Småstuen, M. C., and Molin, M. 2018. Nutrients in fish and possible associations with cardiovascular disease risk factors in metabolic syndrome. *Nutrients* 10:952.

Trichopoulou, A., Kouris-Blazos, A., Wahlqvist, M. L., Gnardellis, C., Lagiou, P., Polychronopoulos, E., Vassilakou, T., Lipworth, L., and Trichopoulos, D. 1995. Diet and overall survival in elderly people. *BMJ*, *311*(7018), 1457. https://doi.org/10.1136/bmj.311.7018.1457.

Turi, B. C., Codogno, J. S., Fernandes, R. A., and Monteiro, H. L. 2014. Physical activity, adiposity and hypertension among patients of public healthcare system. *Revista Brasileira de Epidemiologia* 17.4:925–937.

Udezo, P. C., Onigbinde, A. O., Adaramola, F. B.,, Aleshinloye, A. O., Jegede, D. O., Ogunnowo, A. A., Shokunbi, O. S. and Adewumi, A. G. 2019. *Nutritional investigation of three commonly consumed fast foods in two major fast food restaurants in Lagos State , Nigeria*. *5*(1), 81–86.

U.S. Department of Agriculture and U.S. Department of Health and Human Services. 2010. *Dietary Guidelines for Americans, 2010. 7th Edition, Washington, DC: U.S. Government Printing Office, December 2010.* . Retrieved on 24th August, 2020 from www.dietaryguidelines.gov

U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2015. *2015-2020 Dietary Guidelines for Americans. Eight Edition*. Retrieved from http://health.gov/dietaryguidelines/2015/guidelines/.

Uloko, A. E., Musa, B. M., Ramalan, M. A., Gezawa, I. D., Puepet, F. H., Uloko, A. T., Borodo, M. M., and Sada, K. B. 2018. Prevalence and Risk Factors for Diabetes Mellitus in Nigeria: A Systematic Review and Meta-Analysis. *Diabetes Therapy*, *9*(3), 1307–1316.

Vandelanotte, C., Short, C., Rockloff, M., Di Millia, L., Ronan, K., Happell, B., and Duncan, M. J. 2015. How do different occupational factors influence total, occupational, and leisure-time physical activity? *Journal of Physical Activity and Health* 12.2:200–207.

Verger, E. O., Mariotti, F., Holmes, B. A., Paineau, D., and Huneau, J.F. 2012. Evaluation of a Diet Quality Index Based on the Probability of Adequate Nutrient Intake ( PANDiet ) Using National French and US Dietary Surveys. *PLoS ONE* 7.8:e42155.

Vogel, C., Lewis, D., Ntani, G., Cummins, S., Cooper, C., Moon, G., and Baird, J. 2017. The relationship between dietary quality and the local food environment differs according to level of educational attainment : A cross- sectional study. *PloS One*, 12.8:e0183700.

Wang, J., Sun, W., Wells, G. A., Li, Z., Li, T., Wu, J., Zhang, Y., Liu, Y., Li, L., Yu, Y., Liu, Y., Qi, C., Lu, Y., Liu, N., Yan, Y., Liu, L., Hui, G., and Liu, B. 2018. Differences in prevalence of hypertension and associated risk factors in urban and rural residents of the Northeastern region of the people's republic of China: A cross-sectional study.

*PLoS ONE*, *13*(4), 1–14.

Wang, L., Southerland, J., Wang, K., Bailey, B. A., Alamian, A., Stevens, M. A., and Wang, Y. 2017. Ethnic Differences in Risk Factors for Obesity among Adults in California, the United States. *Journal of Obesity 2017*.2427483:10.

Werneck, A. O., Oyeyemi, A. L., Gerage, A. M., Cyrino, E. S., Szwarcwald, C. L., Sardinha, L. B., and Silva, D. R. 2018. Does leisure-time physical activity attenuate or eliminate the positive association between obesity and high blood pressure? *The Journal of Clinical Hypertension* 20.5:959–966.

Westerterp, K. R. 2017. Control of energy expenditure in humans. *European Journal of Clinical Nutrition* 71.3:340–344.

Whelton, P. K., Carey, R. M., Aronow, W. S., Casey, D. E., Collins, K. J., Himmelfarb, C. D., DePalma, S. M., Gidding, S., Jamerson, K. A., Jones, D. W., MacLaughlin, E. J., Muntner, P., Ovbiagele, B., Smith, S. C., Spencer, C. C., Stafford, R. S., Taler, S. J., Thomas, R. J., Williams, K. A., and Hundley, J. 2018. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults a report of the American College of Cardiology/American Heart Association Task Force on Clinical pr. In *Hypertension* 71.6.

Winpenny, E. M., Greenslade, S., Corder, K., and van Sluijs, E. M. F. 2018. Diet quality through adolescence and early adulthood: Cross-sectional associations of the dietary approaches to stop hypertension diet index and component food groups with age. *Nutrients* 10:1585.

World Health Organization. 2000. *Obesity: preventing and managing the global epidemic*. *WHO*. World Health Organization. Retrieved from https://www.who.int/nutrition/publications/obesity/WHO_TRS_894/en/.

World Health Organization. 2010. Global recommendations on physical activity for health. *Geneva: World Health Organization, Geneva, Switzerland.* 60. https://doi.org/10.1080/11026480410034349

World Health Organisation. 2011. *WHO | Waist Circumference and Waist–Hip Ratio. Report of a WHO Expert Consultation. Geneva, 8-11 December 2008.* Retrieved from http://www.who.int.

World Health Organization. 2013a. *A global brief on hypertension : silent killer, global public health crisis: World Health Day 2013. World Health Organization. https://apps.who.int/iris/handle/10665/79059*. Retrieved from www.who.int.

World Health Organization. 2013b. Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Recommendations for a public health approach. ISBN: 978 92 4 150572 7. World Health Organization, Geneva, Switzerland. https://www.who.int/hiv/pub/guidelines/arv2013/download/en/.

World Health Organization. 2014. Physical activity. Fact sheet No. 385. Retrieved from http://www.who.int/mediacentre/ factsheets/fs385/en.

World Health Organization. 2016a. Overweight and obesity. Global Health Observatory (GHO) data. Retrieved September 29, 2020, from https://www.who.int/gho/ncd/risk_factors/overweight_obesity/obesity_adults/en/.

World Health Organization. 2016b. Global NCD target: Reduce High Blood Pressure. Retrieved September 4, 2020, from https://www.who.int/publications/i/item/global-ncd-target-reduce-high-blood-pressure.

World Health Organization. 2018a. Noncommunicable diseases. Retrieved September 3, 2020, from https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases.

World Health Organisation. 2018b. Physical activity for health: More active people for a healthier world. *Who 45*.December 2017:33–34. Retrieved from file:///V:/HALO/HALO Staff/Longmuir/New Literature B/Global-action-plan-on-PA-DRAFT-2-Dec-2017.pdf

World Health Organization. 2019. Hypertension. Retrieved August 27, 2020, from https://www.who.int/news-room/fact-sheets/detail/hypertension.

World Health Organisation. 2020. Obesity and overweight. World Health Organisation, Geneva, Switzerland. Retrieved August 25, 2020, from https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight.

Xu, Z., McClure, S. T., and Appel, L. J. 2018. Dietary Cholesterol Intake and Sources among U . S Adults : Results from National Health and Nutrition. *Nutrients 2018*.10:771.

Yang, D., Zhu, X., Haegele, J. A., Wilson, P. B., and Wu, X. 2019. The association between health-related fitness and physical activity during weekdays: Do fit students exercise more after school? *Sustainability* 11:4127.

Yao, J., and Asiseh, F. 2019. An Economic Analysis of Household Income Inequality and BMI in China. *JOURNAL OF ECONOMIC DEVELOPMENT 44*.1:23–37.

Yayehd, K., N'cho-Mottoh, M. P., Pessinaba, S., Baragou, S., Tchérou, T., Afassinou, Y. M., Pio, M., Essam, N. S. A., Goeh-Akue, E., Damorou, F., and Belle, and L. 2017. Determinants of Adult Obesity in a Low-Income Population of Western Africa : Results from a Nationwide Cross-Sectional Survey. *Obesity & Control Therapies*, *4*(2), 1–9.

Yoshida, Y., Scribner, R., Chen, L., Broyles, S., Phillippi, S., and Tseng, T. S. 2017. Role of age and acculturation in diet quality among Mexican Americans - Findings from the National Health and Nutrition Examination Survey, 1999-2012. *Preventing Chronic Disease 14*:E59. https://doi.org/10.5888/pcd14.170004

Zhou, B., Bentham, J., Di Cesare, M., Bixby, H., Danaei, G., Cowan, M. J., Paciorek, C. J., Singh, G., Hajifathalian, K., Bennett, J. E., Taddei, C., Bilano, V., Carrillo-Larco, R. M., Djalalinia, S., Khatibzadeh, S., Lugero, C., Peykari, N., Zhang, W. Z., Lu, Y. and Eggertsen, R. 2017. Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19·1 million participants. *The Lancet*, 389(10064), 37–55.

**Appendix I: Study Questionnaire**

**DEPARTMENT OF HUMAN NUTRITION**
**FACULTY OF PUBLIC HEALTH**
**UNIVERSITY OF IBADAN**

***Questionnaire on Assessment of***
***Diet Quality, Physical Activity, Obesity and Hypertension among Adults in Akwa Ibom and Cross River States, Nigeria***

**Questionnaire Identification** **Questionnaire Number …........**

| S/N | Respondent ID | |
|---|---|---|
| 1 | Community: | |
| 2 | Senatorial District: | |
| 3 | State: | |

**Section A: Demographic and Socio-Economic Characteristics: Please tick the appropriate answer (√)**

**Information on Household Head**

| **4) Sex: ………………** | **5) Age ………………..** | **6) Family Size:…….** |
|---|---|---|
| **7). Primary Occupation** | **8). Highest Educational** | **7) Relationship to HH** |
| Civil/Public servant (7) | Informal (1) | Self (1) |
| Artisan/Registered Business (6) | Some Primary (2) | Wife (2) |
| Company Worker/casual worker (5) | Complete Primary (3) | Child (3) |
| Farming/Fishing (4) | Some Secondary (4) | Sibling (4) |
| Petty Trading (3) | Complete Secondary (5) | Others Specify…… |
| Not currently employed (2) | Tertiary (6) | |
| Others (1) | | |

**Information on Respondent**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 10. Sex…… | 11. Age……. | 12. State of Origin……….. | | 13. Ethnicity ……………… | | | |
| 14 | Religion | Christianity (1) | Islam (2) | Traditional (3) | Others (4) | | |
| 15 | Marital Status | Married (1) | Divorced (2) | Separated (3) | Widow (4) | Widower (5) | Single (6) |
| 16 | Educational Level | Tertiary (1) | Complete Secondary (2) | Some Secondary (3) | Complete Primary (4) | Some Primary (5) | Informal (6) |
| 17 | Primary Occupation | Civil/Public servant (1) | Registered Business/Artisan (2) | Farming/ Fishing (3) | Company/Casual Worker (4) | | |
| | | Petty Trading (5) | Home maker (6) | Not Currently employed (7) | Others (8) | | |
| 18 | Household Monthly income (₦) | ≤10,000 (1) | 10,001 - 20,000 (2) | 20,001 - 50,000 (3) | 50,001 - 100,000 (4) | >100,00 (5) | |
| 19 | Type of Accommodation | Duplex/Bungalow (5) | 2-3 bedrooms Flat (4) | Self Contend (3) | Single Room(s) (2) | Wooden/Thatched/Mud House (1) | |
| 20 | Primary Source of Energy for Household lighting | PHCN/ Generator (5) | PHCN/Rechargeable lamp (4) | PHCN only (3) | Kerosene lamp (2) | Candle wax (1) | |
| 21 | Primary Source of Energy for Cooking | Gas (4) | Electric hotplate (3) | Kerosene Stove (2) | Fire wood /Saw dust (1) | | |
| 22 | Primary Source of Water | Pipe borne (5) | Borehole (4) | Well (3) | Rain water (2) | River/Stream (1) | |
| 23 | Primary Methods of Refuse Disposal | Refuse Collector (5) | Incinerator (4) | Popular Dump Site (3) | Burying /Bush (2) | Dumping in gutter/streams (1) | |
| 24 | Methods of Sewage Disposal | Water closet (5) | Pit latrine (4) | Communal Latrine (3) | Bush (2) | Streams/River (1) | |

**SECTION B: DIETARY INTAKE ASSESSMENT (24 Hour Dietary Recall)**

| S/N (a) | Food/Drink (b) | Description of Food or Drink (c) | Place taken (d) | Time (e) | Quantity Eaten (f) | Weight Equivalent (g) |
|---|---|---|---|---|---|---|
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|---|---|
| Was food intake usual? (Y/N)<br><br>If no, how was it unusual?<br>............................. | Did you take any supplement? (Y/N).<br><br>If yes, specify …………………… |

**SECTION C: Assessment of Physical Activity: International Physical Activity Questionnaire**

| | | |
|---|---|---|
| We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport. | | |
| Think about all the **vigorous** and **moderate** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. | | |
| **Part 1: Job-Related Physical Activity:** The first section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. Do not include unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family. These are asked in Part 3. | | |
| 1 | Do you currently have a job or do any unpaid work outside your home? | Yes<br>If No **Skip To Part 2** |
| | The next questions are about all the physical activity you did in the **last 7 days** as part of your paid or unpaid work. This does not include traveling to and from work. | |
| 2 | During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, heavy construction, or climbing up stairs **as part of your work**? Think about only those physical activities that you did for at least 10 minutes at a time. | …….**days per week**<br>Non: **Skip to question 4** |
| 3 | How much time did you usually spend on one of those days doing **vigorous** physical activities as part of your work? | ……**hours per day**<br>……..**minutes per day** |
| 4 | Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads **as part of your work**? Please do not include walking. | ……**days per week**<br>Non: **Skip to question 6** |
| 5 | How much time did you usually spend on one of those days doing **moderate** physical activities as part of your work? | ……**hours per day**<br>……**minutes per day** |
| 6 | During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **as part of your work**? Please do not count any walking you did to travel to or from work. | ……..**days per week**<br>Non: **Skip To Part 2** |
| 7 | How much time did you usually spend on one of those days **walking** as part of your work? | ……**hours per day**<br>……**minutes per day** |

**International Physical Activity Questionnaire (Contd.)**

| | | |
|---|---|---|
| **PART 2: Transportation Physical Activity**<br>These questions are about how you travelled from place to place, including to places like work, stores, movies, and so on. | | |
| 8 | During the **last 7 days**, on how many days did you **travel in a motor vehicle** like a train, bus, car, or tram? | ……**days per week**<br>Non: **Skip To Question 10** |
| 9 | How much time did you usually spend on one of those days **traveling** in a train, bus, car, tram, or other kind of motor vehicle? | …..**hours per day**<br>…..**minutes per day** |
| 10 | Now think only about the **bicycling** and **walking** you might have done to travel to and from work, to do errands, or to go from place to place.<br><br>During the **last 7 days**, on how many days did you **bicycle** for at least 10 minutes at a time to go **from place to place**? | ……**days per week**<br>Non: **Skip To Question 12** |
| 11 | How much time did you usually spend on one of those days to **bicycle** from place to place? | ……**hours per day**<br>……**minutes per day** |
| 12 | During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**? | ……**days per week**<br>Non: **Skip to Part 3** |
| 13 | How much time did you usually spend on one of those days **walking** from place to place? | ……**hours per day**<br>……**minutes per day** |
| | | |
| **PART 3: Housework, House Maintenance, and Caring for Family**<br>This section is about some of the physical activities you might have done in the **last 7 days** in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family. | | |
| 14 | During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, chopping wood, shoveling snow, or digging **in the garden or yard**? | ……**days per week**<br>Non: **Skip to question 16** |
| 15 | How much time did you usually spend on one of those days doing **vigorous** physical activities in the garden or yard? | ….**hours per day**<br>…..**minutes per day** |
| 16 | Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, sweeping, washing windows, and raking **in the garden or yard**? | ……**days per week**<br>Non: **Skip to question 18** |
| 17 | How much time did you usually spend on one of those days doing **moderate** physical activities in the garden or yard? | ……**hours per day**<br>……**minutes per day** |

**International Physical Activity Questionnaire (Contd.)**

| | | |
|---|---|---|
| 18 | Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, washing windows, scrubbing floors and sweeping **inside your home**? | ……**days per week**<br>Non: **Skip to PART 4** |
| 19 | How much time did you usually spend on one of those days doing **moderate** physical activities inside your home? | …..**hours per day**<br>……**minutes per day** |
| **PART 4: Recreation, Sport, and Leisure-Time Physical Activity:** This section is about all the physical activities that you did in the **last 7 days** solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned. | | |
| 20 | Not counting any walking you have already mentioned, during the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**? | ……**days per week**<br>Non: **Skip to question 22** |
| 21 | How much time did you usually spend on one of those days **walking** in your leisure time? | ….**hours per day**<br>…..**minutes per day** |
| 22 | Think about only those physical activities that you did for at least 10 minutes at a time.<br><br>During the **last 7 days**, on how many days did you do **vigorous** physical activities like aerobics, running, fast bicycling, or fast swimming **in your leisure time**? | ……**days per week**<br>Non: **Skip to question 24** |
| 23 | How much time did you usually spend on one of those days doing **vigorous** physical activities in your leisure time? | ….**hours per day**<br>…..**minutes per day** |
| 24 | Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis **in your leisure time**? | ……**days per week**<br>Non: **Skip to question 26** |
| 25 | How much time did you usually spend on one of those days doing **moderate** physical activities in your leisure time? | …..**hours per day**<br>……**minutes per day** |

**SECTION D: ANTHROPOMETRIC MEASUREMENTS**

| S/N | Measurement | a. | 1st Reading | b. | 2nd Reading | Average |
|---|---|---|---|---|---|---|
| 1 | Weight (Kg) | | | | | |
| 2 | Height (cm) | | | | | |
| 3 | Waist Circumference (cm) | | | | | |
| 4 | Hip circumference (cm) | | | | | |
| | BMI | | | | | |
| | Waist/Hip Ratio | | | | | |

**SECTION E: BLOOD PRESSURE MEASUREMENTS**

| S/N | Blood Pressure | a. | 1st Reading | b. | 2nd Reading | Mean BP |
|---|---|---|---|---|---|---|
| 1 | Systolic BP (mmHg) | | | | | |
| 2 | Diastolic BP (mmHg) | | | | | |
| | Status | | | | | |

**Appendix II: Translated Questionnaire (Ibibio Language)**

**DEPARTMENT OF HUMAN NUTRITION**
**FACULTY OF PUBLIC HEALTH**
**UNIVERSITY OF IBADAN**

***Mbuume Udomo Idaha* Nkpadiaha ke Ndidia, Usiiñe Idem, Udọñọ Ubom ye Udọñọ ñkoñ ñkoñ Iyiib ke otu Ikpọ Awo ke *Akwa Ibom ye Cross River Sted, Nigeria***

**Se Ubañake Fien** **Ibad Mbịmme…….…………..**

| S/N | Anyịñ: | | Udʌk utañiko: ……………….. |
|---|---|---|---|
| 1 | Idʌñ: | | |
| 2 | Senitoral Distrik mfo: | | |
| 3 | Sted: | | |

**Ikpeghe A: Mbọk baak nnene nnene ibọọrọ Awọttọ Ibad awo mme Awana Ndubeghe (√))**

**Etop abañake Iwuod Ufọk**

| **4 Awoñwaan /Awodeen……………** | **5) Isua emaña………………** | **6) Ukpa ufọk…………** |
|---|---|---|

| **7). Akpan Ubọkutom** | **8). Idaha ifiọkñwed** | **7) Ewana ye Iwuod Ufọk** |
|---|---|---|
| Anam utom kọfmen/Anam utom kọfmen (7) | Ñkaña (1) | idem (1) |
| Anam ubọk utom/Mbubeghe Abọhọ Unen (6) | Usʌk Praimari (2) | Añwaan (2) |
| Anam utom ufọk usiak ifia/Anam ñkaña utom (5) | Akwueñe/Ama Praimari (3) | Ayịn (3) |
| Utom Utọiñwañ/Utom Ukọiyak (4) | Usʌk Sekọndri (4) | Nditọeka (4) |
| Ntək mbubeghe (3) | Akwueñe/Ama Sekọndri (5) | Sia Mfen…… |
| Awo Adinieghe Se anam kaña (2) | Ufọkñwed ntaifiọk (6) | |
| Mfen (1) | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 10. **Awo-ñwaan/ Awodeen…...** | | 11. Isua Emana……. | 12. Sted Nte Ato………… | | 13. Ubon…………… | | |
| 14 | Edu Ubono | Cristian (1) | Islam (2) | Ubono Obod (3) | Mfen (4) | | |
| 15 | Idaha ke Ndọ | Adọ ndọ (1) | Uwuọñọ Ndọ (2) | Udiaña Ndọ (3) | Ebekpa (4) | Añwaankpa (5) | Abọikpa/ akparawa (6) |
| 16 | Idaha ke Ñwed | Ufọkñwed Ntaifiọk (1) | Akwueñe/ Ama Sekọndri (2) | UsΛk Sekọndri (3) | Akwueñe/ Ama Praimari (4) | UsΛk Praimari (5) | Ñkaña (6) |
| 17 | Akpan Ubọkutom | Anam utom kọfmen/Anam utom kọfmen (1) | Anam ubọk utom/Mbubegh e (2) | Utom Utọiñwañ/Ut om ukọiyak (3) | Anam utom ufọk usiak ifia/Anam ñkaña utom (4) | | |
| | | Ntək Mbubeghe (5) | Akama Ufọk (6) | Awo Adinieghe se anam kaña (7) | Mfen (8) | | |
| 18 | AkΛk se ufọk keed enam ke afiọñ (₦) | ≤10,000 (1) | 10,001 - 20,000 (2) | 20,001 - 50,000 (3) | 50,001 - 100,000 (4) | >100,00 (5) | |
| 19 | Utọ Itie ndΛñ | Ufọk Isọñ (5) | Ubeed Ufọk 2-3 (4) | AdΛñ Ikpọọñ Ufọk (3) | Ubeed Ufọk (2) | Ufọk Ñkanya/Ufọk Ntan (1) | |
| 20 | Akpan Itie Udadikañ | Nginikañ PHCN (5) | PHCN/ Utuenikañ Edatta adañ eto edektri (4) | PHCN Ikpọọñ (3) | Adañ ikañ (2) | Ikañ Kandle (1) | |
| 21 | Akpan Ikañ se kama etem Ndidia | Akas/ Afịm Utem Ndidia (4) | Usan Edektri (3) | Karasịn stof (2) | Ifiak/Ndueto/Mbi oeto (1) | | |
| 22 | Akpan Itie Mmọọñ | Mmọọñ esañukwak (5) | Mmọọñ esañukwak (4) | Ube Mmọọñ (3) | Mmọọñ Edịm (2) | Mmọọñ Inyañ/ Mmọọñ Idịm (1) | |
| 23 | Akapan UsΛñ Eduọñọke Mbio | Akoono Mbio (5) | Insinetọ/Ñ kpọ Ufọp Mbio (4) | Itie Uduọñọ Mbio Ediọọñọke (3) | Ubuuk Mbio/ Uduọñọ Mbio ke Ikọd (2) | Uduọñọ Mbio ke Ufeghe ndiọọñ/Idịm (1) | |
| 24 | Akpan UsΛñ Eduọñọke Uduañ/Ifuọ | Nto Mbakara (5) | Ube Ukaikọd (4) | Nto IdΛñ (3) | Ikọd (2) | Idịm/Inyañ (1) | |

**IKPEGHE B: UDOMO NKPADIAHA KE NDIDIA (Ndidia Usen ke se Etoyo)**

| S/N (a) | Ndidia/Mmịn (b) | Se Ibaña Ndidia or Mmịn (c) | Itie nte Edat (d) | Ini (e) | Udomo se Edia (f) | Ukem Udob (g) |
|---|---|---|---|---|---|---|
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| Nte ndidia akedo ñkaña (Ii/Iyo<br>Akpedo iyo, nsinam yak mmidoho<br>ñkaña………………………….. | | | Amaaben ibọk-ndidia/sọplịmen nte keed? (Ii/Iyo).<br>Akpedo ii, wọt……………………. | | | |

**IKPEGHE C: Udomo Utom Uneññe Idem: Mbịme abañake Usiiñe Idem ke Afịd Unadod**

**Ikpeghe 1: Utom-Abañake usiiñe Idem**

| | | |
|---|---|---|
| 1 | Amenie utom/Amenam utom idaha ami ubenne fien akpọñ ufọk mfo? | Ii<br>**Akpedo iyo, bọhọ ka ikpeghe ọyọhọ 2** |
| 2 | Ke usen itiaba aboyokeko, usen afañ ke afo akenam akpọsọñ utom usiiñe idem nte ubenne udob ñkpọ, udọk isọñ, udọọk enyọñ, utem ikọd/uwaak mbiod nte keed uto utom mfo? | **…usen ifañ ke udua**<br>**Ibaha: bọhọ ka mbịme ayọhọ 4** |
| 3 | Ufañ ini ifañ ke afo asidat ke usen keed ke otu mme usen ado anam akpọsọñ utom nte keed ke utom mfo? | **…….awa ifañ ke usen**<br>**……..minịk ifañ ke usen** |
| 4 | Ke akpatre usen itiaba aboyokeko, usen ifañ ke afo akenam idaha idaha utom nte ubeen mbiomo nte keed ke otu utom afo anamma? Mbọk ku sịn adisaña isañ. | **……mme ifañ usen ke udua**<br>**Ibaha: bọhọ ka mbịme ayọhọ 6** |
| 5 | Ufañ ini ifañ ke afo akesidat ke usen ke otu mme usen ado anam idaha idaha utom nte keed ke otu utom mfo? | **…… awa ifañ ke usen**<br>**……..minịk ifañ ke usen** |
| 6 | Ke akpatre usen itiaba aboyokeko, usen ifañ ke akesaña isañ ayọhọ minịk 10 akañ keed nte keed ke utom mfo? Mbọk ku bat isañ afo akesaña akaa utom,asana anyọñ usịn. | **……usen ifañ ke udua**<br>**Ibaha: bọhọ ka mbịme ayọhọ 2** |
| 7 | Ufañ ini ifañ ke afo akesidat ke usen ke otu mme usen ado asaña isañ nte keed ke utom mfo? | **……awa ifañ ke usen**<br><br>**……minịk ifañ ke usen** |
| **IKPEGHE 2: Uka Isañ Awanake Usiiñe Idem Isañ** | | |
| 8 | Ke akpatre usen itiaba aboyokeko, usen ifañ ke afo akesaña ke ñkpọ isañ nte tren, bọs, mmoto/tren, tasi, keke, mmasịn aka isañ? | **……usen ifañ ke udua**<br>**Ibaha: bọhọ ka mbịme ayọhọ 10** |
| 9 | Ufañ ini ifañ ke afo akesidat ke usen ke otu mme usen ado asaña ke tren, bọs, mmoto, tren, tasi, keke, enañukwak/ñkpọ isañ mfen aka isañ? | **…..awa ifañ ke usen**<br>**…..minịk ifañ ke usen** |
| 10 | Ke akpatre usen itiaba aboyokeko, akañ ifañ ke afo akewat enañukwa ayọhọ minịk 10 ini keed aka itie mme itie? | **……usen ifañ ke udua**<br>**Ibaha: Bọhọ ka mbịme ayọhọ 12** |
| 11 | Ufañ ini ifañ ke afo akesidat awat enañukwa ke usen ke otu mme usen ado aka itie mme itie? | **……. awa ifañ ke udua**<br>**….minịk ifañ ke usen** |
| 12 | Ke akpatre usen itiaba aboyokeko, usen ifañ ke afo akedat minịk 10 asaña akañ keed aka itie mme itie? | **……usen ifañ ke udua**<br>**Ibaha: Bọhọ ka ikpghe ọyọhọ 3** |
| 13 | Ufañ ini ifañ ke afo akesidat ke usen ke otu mme usen ado asaña aka itie mme itie | **…… awa ifañ ke usen**<br>**…… minịk ifañ ke usen** |

| | | |
|---|---|---|
| **IKPEGHE 3: Utomufọk, Ukama Ufọk, mme Editʌm Ufọk Ñkama** | | |
| 14 | Ke akpatre usen itiaba aboyokeko, usen ifañ ke afo akenam ọkpọsọñ utom nte udịppe udob ñkpọ, ukpeghe eto, ukoono sno/udọk isọñ? | **……usen ifañ ke udua**<br><br>**Ibaha: Bọhọ ka mbịme 16** |
| 15 | Ufañ ini ifañ ke afo akesidat ke usen ke otu mme usen ado anam ọkpọsọñ utom ke iñwañ? | **…. awa ifañ ke usen**<br>**….. minịk ifañ ke usen** |
| 16 | Ke akpatre usen itiaba aboyokeko, usen ifañ ke afo akenam idaha idaha utom nte udịppe nyakka ñkpọ, ukwọk isọñ, uyet mme windo, ukpaad mbiod/mbio, uyet isọñ mme ukwọk esịd ubeed mfo? | **…… usen ifañ ke udua**<br>**Ibaha: Bọhọ ka mbịme 18** |
| 17 | Ufañ ini ifañ ke afo akesidat ke usen ke otu mme usen ado anam idaha idaha utom ke iñwañ/esịd ufọk mfo? | **…… awa ifañ ke usen**<br>**….minịk ifañ ke usen** |
| **IKPEGHE 4: Ubre Mbre, Mbre, mme Ini nduọk Adudu** | | |
| 18 | Ke akpatre usen itiaba aboyokeko, usen ifañ ke afo akesaña minịk 10 akañ keed ke ini nduọk adudu mfo ke aboyoke se amaakesiasiak? | **….. usen ifañ ke udua**<br>**Ibaha: Bọhọ ka mbịme 22** |
| 19 | Ufañ ini ifañ ke afo akesidat ke usen ke otu mme usen ado asaña ke ini nduọk adudu mfo? | **….. awa ifañ ke usen**<br>**….minịk ifañ ke usen** |
| 20 | Ke akpatre usen itiaba aboyokeko, usen ifañ ke afo akenam ọkpọsọñ utom nte uneeñe-idem, ufeghe itọk, uwat enañukwak nsọb, uwọk ewọk nsọb ke ini nduọk adudu mfo? | **….. usen ifañ ke udua**<br>**Ibaha: Bọhọ ka mbịme 24** |
| 21 | Ufañ ini ifañ ke afo akesidat ke usen ke otu mme usen ado anam ọkpọsọñ utom ke ini nduọk adudu mfo? | **…..awa ifañ ke usen**<br>**….minịk ifañ ke usen** |
| 22 | Ke akpatre usen itiaba aboyokeko, usen ifañ ke afo akenam idaha idaha utom nte uwat enañukwak ke udomo ini, uwọk ewọk ke udomo ini, ubre tenis ke udomo ke ini nduọk adudu mfo? | **….usen ifañ ke udua**<br>**Ibaha: Bọhọ ka ikpeghe ọyọhọ 5** |
| 23 | Ufañ ini ifañ ke afo akesidat ke usen ke otu mme usen ado anam idaha idaha utom ke ini nduọk adudu mfo? | **…..awa ifañ ke usen**<br>**….minịk ifañ ke usen** |

**Appendix III: Letter of Introduction**


**DEPARTMENT OF HUMAN NUTRITION**
**FACULTY OF PUBLIC HEALTH**
**COLLEGE OF MEDICINE**
**UNIVERSITY OF IBADAN**
**IBADAN, NIGERIA**

+234-8022995251
+234-8133067711
nutrition-dept@mail.ui.edu.ng


25th September, 2018

**TO WHOM IT MAY CONCERN**

This is to certify that Ekerette Nkereuwem Ndaeyo: Matric No: 105260 is a PhD student in the Department of Human Nutrition, Faculty of Public Health, College of Medicine, University of Ibadan and is currently undertaking a project titled, **"Associations of Diet Quality and Physical Activity with Prevalence of Obesity and Hypertension among Adults in Akwa Ibom and Cross River States of Nigeria".**

I will appreciate your support for her to be able to collect the data for this project.

Thank you.

**Dr. O. T. Adepoju**
Acting Head of Department

**Vision:** To be a world class department of Human Nutrition for Academic Excellence geared towards promoting good nutrition for optimal health
**Mission:** (i) To expand nutrition knowledge through provision of excellent conditions for learning, research and innovation. (ii) To produce graduates with sufficient knowledge [illegible]

## Appendix IV: Ethical Approval for the Study

**INSTITUTE FOR ADVANCED MEDICAL RESEARCH AND TRAINING (IAMRAT)**
**College of Medicine, University of Ibadan, Ibadan, Nigeria.**

Director: **Prof. Catherine O. Falade**, MBBS (Ib), M.Sc., FMCP, FWACP
Tel: 0803 326 4593, 0802 360 9151
e-mail: cfalade@comui.edu.ng lillyfunke@yahoo.com

UI/UCH EC Registration Number: **NHREC/05/01/2008a**

NOTICE OF FULL APPROVAL AFTER FULL COMMITTEE REVIEW

**Re: Diet Quality, Physical Activity, Prevalence of Obesity and Hypertension among Adults in Akwa Ibom and Cross River States, Nigeria**

UI/UCH Ethics Committee assigned number: UI/EC/21/0098

Name of Principal Investigator: **Nkereuwem N. Ekerette**

Address of Principal Investigator: Department of Human Nutrition and Dietetics
College of Medicine
University of Ibadan, Ibadan

Date of receipt of valid application: 18/03/2021

Date of meeting when final determination on ethical approval was made: **N /A**

This is to inform you that the research described in the submitted protocol, the consent forms, and other participant information materials have been reviewed and *given full approval by the UI/UCH Ethics Committee.*

This approval dates from **20/04/2021 to 19/04/2022.** If there is delay in starting the research, please inform the UI/UCH Ethics Committee so that the dates of approval can be adjusted accordingly. Note that no participant accrual or activity related to this research may be conducted outside of these dates. *All informed consent forms used in this study must carry the* UI/UCH EC *assigned number and duration of* UI/UCH EC *approval of the study.* It is expected that you submit your annual report as well as an annual request for the project renewal to the UI/UCH EC at least four weeks before the expiration of this approval in order to avoid disruption of your research.

*The National Code for Health Research Ethics requires you to comply with all institutional guidelines, rules and regulations and with the tenets of the Code including ensuring that all adverse events are reported promptly to the* UI/UCH EC. *No changes are permitted in the research without prior approval by the* UI/UCH EC *except in circumstances outlined in the Code. The* UI/UCH EC *reserves the right to conduct compliance visit to your research site without previous notification.*

UI/UCH EC
APR 2021
APPROVED
COLLEGE OF MEDICINE, U.I.

---------------------------------------
**Professor Catherine O. Falade**
Director, IAMRAT
Chairperson, UI/UCH Research Ethics Committee
E-mail: uiuchec@gmail.com

Research Units • Genetics & Bioethics • Malaria • Environmental Sciences • Epidemiology Research & Service • Behavioural & Social Sciences • Pharmaceutical Sciences • Cancer Research & Services • HIV/AIDS

**Appendix V: Informed Consent Form**

**DEPARTMENT OF HUMAN NUTRITION**
**FACULTY OF PUBLIC HEALTH**
**UNIVERSITY OF IBADAN**

***Questionnaire on Assessment of***
***Diet Quality, Physical Activity, Obesity and Hypertension among Adults in Akwa Ibom and Cross River States, Nigeria***

**INFORMED CONSENT FORM**

IRB Research approval number: UI/EC/21/0098
This approval will elapse on: 19/04/2021

**Title of the research:** Diet Quality, Physical Activity, Obesity and Hypertension among Adults in Akwa Ibom and Cross River States, Nigeria.

**Names and affiliation of researcher: Ekerette, Nkereuwem Ndaeyo** of the Department of Human Nutrition and Dietetics, Faculty of Public Health, University of Ibadan.

**Sponsor(s) of research:** Self (Ekerette, Nkereuwem Ndaeyo)

**Purpose(s) of research:** This research is conducted to evaluate the associations between diet quality, physical activity, obesity and hypertension.

**Information to be obtained during the study**
The following information will be obtained during the course of this research:

1. You will be interviewed to provide information on food intakes. And so, you will be requested to recall and report all foods and beverages consumed over the immediate past 24 hours, as well as the time and place of consumption for each food and beverage. You will also be required to recall and report detailed descriptions of each dietary item consumed, and estimate the quantity of each foods eaten using any selected portion estimation method.

2. You will be expected to recall and report all physical activities undertaken, including the number of days and the duration in which each activity was undertaken within the past seven days.

3. Measurements will be taken for your weight, height, waist circumference and hip circumference using appropriate tools.

4. Blood pressure measurements will also be obtained using a conventional mercury-in-glass sphygmomanometer.

**Expected duration of research and of participants' involvement:** This study is expected to last for a maximum of six (6) months. You will be contacted once during the study. An interview session is expected to last between 60 minutes to 1 hour 30 minutes.

**Risk(s):** No procedures for this study is associated with any known risk. Nevertheless, you could be exposed to accidents where the study tools and equipment are not handled with care. Where that happens, the investigator will take full responsibility for all treatments.

**Costs of joining the research:** No cost will be incurred by the reason of participating in this study, except the time that will be involved in the whole procedures.

**Benefit(s):** This research is conducted to evaluate the quality of dietary intakes, physical activity, obesity and hypertension among adults. It is expected that the findings from the study will be used to formulate policies that improve the general well-being of adults in the study locations. Study participants will also be informed of their body weight and blood pressure status and where there is need for intervention, such participants will be directed to the appropriate institutions to receive help.

**Confidentiality:** Information collected in the course of this study will not be linked to you in anyway and your name or any identifier will not be used in any publication or reports from this study.

**Voluntariness:** Your participation in this research is entirely voluntary. You have the right to not to take part in the study or to discontinue at any point in time in the course of the study. However, it will be appreciated if you give full participation in the study.

**Alternatives to participation:** There will be no adverse consequences if you choose not to participate in this study.

**Due inducement(s):** Participation in this research will not attract any inducement in monetary terms. However, each participant will be appreciated with a token (a bar of toilet soap) at the end of each interview.

**Consequences of participants' decision to withdraw from research and procedure for orderly termination of participation:** You have the option to stop participating in the study at any point in time during the course of this research if you so desire. However, please be informed that some of the information collected about you before you opted out may have been edited or used in reports writing and publications. These can no longer be removed. The researcher, on the other hand, have promised to do all possible to accommodate your requests.

**Modality of providing treatments and action(s) to be taken in case of injury or adverse event(s):** The researcher will be fully responsible for all medical treatments for any physical injuries sustained during the course of this study.

**What happens to research participants and communities when the research is over:** The researcher will notify you of her findings in a timely manner. You will be informed of any information that may have an impact on your continued involvement or your health during the course of this study

**Statement about sharing of benefits among researchers and whether this includes or exclude research participants:** Any material items acquired as a result of this research, whether through donation or purchase, will be owned by the researcher. There are no current or future plans to contact participants about such material benefits.

**Any apparent or potential conflict of interest:** There is no indication for any conflict of interest in this research.

**Statement of person obtaining informed consent:**
I've made adequate explanations about this study to____________________________and have given sufficient information to the participant about the possible risks and benefits, to enable him/her make informed decision.
DATE:_______________________SIGNATURE:______________________________
NAME: ________________________________________________

**Statement of person giving consent:**
I read the research description and had it translated into a language I can understand. I've also had a satisfactory discussion with the doctor. I am aware that my participation is entirely voluntary. I know enough about the research study's purpose, methods, risks, and benefits to decide whether or not I want to participate. I understand that I have the right to withdraw from this study at any time. I have a copy of this consent form and additional information sheet that I will keep.

DATE:_____________________SIGNATURE:___________________________________
NAME: _______________________________________________
WITNESS' SIGNATURE (if applicable): ____________________________
WITNESS' NAME (if applicable): ________________________________________

**Contact address:** Department of Human Nutrition and Dietetics, Faculty of Public Health, University of Ibadan.
**e-mail:** nekerette@gmail.com

This research has been approved by the Ethics Committee of the University of Ibadan and the Chairman of this Committee can be contacted at Biode Building, Room 210, 2nd Floor, Institute for Advanced Medical Research and Training, College of Medicine, University of Ibadan, E-mail: uiuchirc@yahoo.com and uiuchec@gmail.com

**Appendix VI: Sample Size Calculation**

**A. Diet quality**

Applying the formula,

$$n = \frac{z^2 \times pq}{d^2}$$

where;

**n** represents the minimum sample size;

**$z^2$** the normal deviate corresponding to the desired confidence interval = 1.96

**p** the proportion of elements in the study population with key attribute being measured = the 5.7% of under nutrition in South South Nigeria (NPC and ICF, 2019).

**q** unaffected population = 1-p = 0.943

**d** the desired degree of accuracy = 2.75% (0.0275)

$$\frac{1.96^2 \times 0.057 \times 0.943}{0.0275^2}$$

$$= 273$$

Adjusting to account for a 10% attrition rate, it was calculated to be 27 + 273 = 300.

A. Physical activity

Applying the formula,

$$n = \frac{z^2 \times pq}{d^2}$$

where;

**n** represents the minimum sample size;

**$z^2$** the normal deviate corresponding to the desired confidence interval = 1.96

**p** the proportion of elements in the study population with key attribute being measured = the 22.0% of physical inactivity (Oyeyemi *et al.*, 2018).

**q** unaffected population = 1-p = 0.78

**d** the desired degree of accuracy = 2.75% (0.0275)

$$\frac{1.96^2 \times 0.22 \times 0.78}{0.0275^2}$$

$$= 872$$

Adjusting to account for a 10% attrition rate, it was calculated to be 87 + 872 = 959.

**B. Obesity**

Applying the formula,

$$n = \frac{z^2 \times pq}{d^2}$$

where;

**n** represents the minimum sample size;

**$z^2$** the normal deviate corresponding to the desired confidence interval = 1.96

**p** the proportion of elements in the study population with key attribute being measured = 22.2% prevalence of obesity among adult Nigerians (Chukwuonye *et al.*, 2013).

**q** unaffected population = 1-p = 0.0778

**d** the desired degree of accuracy = 2.75% (0.0275)

$$\frac{1.96^2 \times 0.222 \times 0.778}{0.0275^2}$$

$$= 877$$

Adjusting to account for a 10% attrition rate, it was calculated to be 88 + 877 = 965.

**C. Hypertension:**

Applying the formula,

$$n = \frac{z^2 \times pq}{d^2}$$

where;

**n** represents the minimum sample size;

**$z^2$** the normal deviate corresponding to the desired confidence interval = 1.96

**p** the proportion of elements in the study population with key attribute being measured = a 44.9% prevalence of hypertension among adult Nigerians (Murthy *et al.*, 2013).

**q** unaffected population = 1-p = 0.449

**d** the desired degree of accuracy = 2.75% (0.0275)

$$\frac{1.96^2 \times 0.449 \times 0.551}{0.0275^2}$$

$$= 1257$$

Adjusting to account for a 10% attrition rate, it was calculated to be 126 + 1257 = 1383.

**Appendix VII: Estimated Sample Sizes for Study Locations**

| **Akwa Ibom State** | | | **Cross River State** | | |
|---|---|---|---|---|---|
| **Senatorial District** | **LGA** | **Community/Sector/ Number** | **SD** | **LGA** | **Community/Sector/ Number** |
| AK North East | Itu (135) | Afaha Ube/Urban/47 | CR North | Ogoja (104) | Ishibori/Urban/38 |
| | | Ikot Abiyak/Rural/50 | | | Nyakom/Rural/50 |
| | | Akon Itam/Rural/38 | | | Okende/Rural/54 |
| | Uyo (155) | Ikot Ebido/Urban/54 | | Bekwarra (91) | Abuchichie/Urban/34 |
| | | Ikot Oku Ikono/Rurual/57 | | | Afrike I/Rural/43 |
| | | Ifa Atai/Rural/44 | | | Ukpa/Rural/48 |
| AK North West | Ikot Ekpene (131) | Ikot Obong Edung/Urban/46 | CR Central | Ikom (104) | Adijinkpor/Urban/38 |
| | | Ikot Abia Idem/Rural/40 | | | Akparabong/Rural/54 |
| | | Ikot Ediet/Rural/45 | | | Yawende/Rural/50 |
| | Essien Udim (104) | Ikot Oku Etim/Urban/36 | | Etung (91) | Effaraya/Urban/34 |
| | | Ukana Ikot Ntuen/Rural/33 | | | Etomi/Rural/44 |
| | | Ukana Mboho/Rural/35 | | | Ajassor/Rural/47 |
| AK South | Eket (139) | Ikot Ebok/Urban/49 | CR South | Calabar South (122) | Asukwo Edem/Urban/45 |
| | | Ikot Ibiok/Rural/43 | | | Anantigha/Rural/35 |
| | | Ebana/Rural/47 | | | Ikot Idang/Rural/42 |
| | Onna (108) | Ndoneyo/Urban/38 | | Akpabuyo (97) | Ikot Offiong Mbai/Urban/36 |
| | | Mkpaeto/Rural/36 | | | Ikot Oyom/Rural/30 |
| | | Atiamkpat/Rural/34 | | | Esuk Mba/Rural/31 |

**Appendix: VIII: List of Foods Consumed in the Study Communities**

| S/N | Soups and sauces |
|---|---|
| 1 | Editan soup, cooked with okro |
| 2 | Editan soup, (plain) |
| 3 | Editan soup (cooked with water leaf) |
| 4 | Afang soup, (Afang, cooked with waterleaf) |
| 5 | Afang soup, (Afang, cooked with groundnut) |
| 6 | Afang soup, cooked with seasame seeds |
| 7 | Afang soup, cooked with melon |
| 8 | Afang etighe (Afang, cooked with okro) |
| 9 | Afang Abak (Afang, cooked with banga) |
| 10 | Edikang Ikong soup |
| 11 | Okro Soup (cooked with vegetable) |
| 12 | Okro soup (cooked with Atama) |
| 13 | Efere otong (Okro, cooked with okpno and vegetables) |
| 14 | White soup, thickened with pounded yam |
| 15 | White soup (thickened with unripe ground paw paw |
| 16 | Achi Soup |
| 17 | Bitter leave soup (cooked with waterleaf) |
| 18 | Bitter leave soup (cooked with melon) |
| 19 | Bitter leave soup (cooked with melon and waterleaf) |
| 20 | African salad (Abacha) |
| 21 | Goatmeat pepper soup |
| 22 | Chickin pepper soup |
| 23 | Fresh fish pepper soup |
| 24 | Abak Atama |
| 25 | Efere Mpkafere (Oha soup) |
| 26 | Beniseed soup |
| 27 | Groundnut soup |
| 28 | Up and down soup (light sauce thickened with garri) |
| 29 | Palm oil sauce |
| 30 | Tomatoe stew |

| S/N | Starchy Roots and tubers |
|---|---|
| 1 | Ufofob ukom (Unripe plantain, roasted) |
| 2 | Unripe plantain (boiled) |
| 3 | |
| 4 | Unripe plantain pottage (plantain, peeled, cut into tiny cubes, cooked with vegetables, dry fish, crayfish, seasonings and palm oil) |
| 5 | Plantain and beans jollof (unripe plantain, peeled, cut into small cubes, boiled and cooked with beans pottage) |
| 6 | Ripe plantain, fried |
| 7 | Ripe plantain, boiled |
| 8 | Ripe plantain, roasted |
| 9 | Yam (boiled) |
| 10 | Ufofob udia (yam, roasted) |

| | |
|---|---|
| 11 | Yam (fried) |
| 12 | Yam and beans mixture (yam, peeled, cut, cooked with beans pottage) |
| 13 | Pounded yam |
| 14 | Iwuk udia (yam pottage) |
| 15 | Oto mboro (unripe babana, peeled, grated, cut into droppings, cooked with dry fish, seasonings, cray fish, palm oil and vegetables) |
| 16 | Banana and beans mixture (unripe unripe banana, peeled, cut into small cubes, boiled and cooked with beans pottage) |
| 17 | Utetem mboro (unripe banana, boiled) |
| 18 | Ekpang nkukwo (cocoyam, peeled, grated, wrapped in tender cocyam leaves, cooked with dry fish, cray fish, palm oil, seasonings and vegetables) |
| 19 | Usung Ikpong (pounded cocoyam) |
| 20 | Asimeka (cocoyam, boiled) |
| 21 | Ayan ekpang ikpong (Cocoyam, peeled, grated, wrapped in fresh banana leaf, steamed) |
| 22 | Oto ebre (wateryam, peeled, grated, cut into droppings, cooked with dry fish, cray fish, palm oil, seasonings and vegetables) |
| 23 | Garri |
| 24 | Fufu |
| 25 | Edita iwa (fresh cassave, peeled, boiled, sliced and soaked) |
| 26 | Asa Iwa (cassava, peeled, grated, wrapped in tender cocoyam leaves, cooked with seasonings, dry fish, craysish, palm oil, and vegetables) |
| 27 | Ayan ekpang iwa (cassava, peeled, grated, wrapped in fresh banana leaf, steamed) |
| 28 | Anem ye okoti (sweet yam, peeled, cut, cooked with beans pottage) |
| 29 | Anem (sweet yam, boiled) |
| 30 | ufofob anem (sweet yam, roasted) |
| 31 | Sweet potatoe(boiled) |
| 32 | sweet potatoe (fried) |

| **S/N** | **Animal Protein Sources** |
|---|---|
| 1 | Beef (boiled) |
| 2 | Beef (fried) |
| 3 | Suya (beef) |
| 4 | Goat meat (boiled) |
| 5 | Chicken (boiled) |
| 6 | Chicken (fried) |
| 7 | Pork |
| 8 | Turkey (fried) |
| 9 | Canda (Ikpa, cow skin) |
| 10 | Egg (fried) |
| 11 | Egg sauce |
| 12 | Egg (boiled) |
| 13 | Farmed iced fish (boiled) |
| 14 | Farmed iced fish (fried) |
| 15 | Fresh fish, (boiled) |
| 16 | Dry fish |
| 17 | Snail |

| | |
|---|---|
| 18 | Oyster |
| 19 | Crab |
| 20 | Periwinkle |
| 21 | Bush meat |

| **S/N** | **Cereals and Products** |
|---|---|
| 1 | White Rice (boiled) |
| 2 | Fried rice |
| 3 | Coconut rice |
| 4 | Jollof rice |
| 5 | Coconut rice |
| 6 | Yellow rice |
| 7 | Rice and beans jollof |
| 8 | Pap (white maize gruel) |
| 9 | Pap (guinea corn and yellow maize gruel) |
| 10 | Pap (millet and yellow maize gruel) |
| 11 | Ekoki (maize pudding, steamed) |
| 12 | Asa ibikpot (fresh corn, pounded, molded, coooked with dry fish, crayfish, palm oil, seasonings and vegetables) |
| 13 | Wheat (paste) |
| 14 | Kunu |
| 15 | Semovita |
| 16 | Custard (cooked into gruel) |
| 17 | Golden morn |
| 18 | Noodles |
| 19 | Spaghetti |
| 20 | Bread |
| 21 | Cornflakes |
| 22 | Biscuit (cabin) |
| 23 | Biscuit (crackers) |
| 24 | sausage (gala) |
| 25 | Meat pie |
| 26 | Fish pie |
| 27 | Cake |
| 28 | Puff puff |
| 29 | Buns |
| 30 | Doughnut |
| 31 | Egg roll |
| 32 | Chin chin |

| **S/N** | **Legumes, Seeds, Nuts and products** |
|---|---|
| 1 | Okoti (beans pottage) |
| 2 | Akara (beans pudding, fried) |
| 3 | Moin moin (beans pudding, steamed) |
| 4 | Groundnut (roated) |
| 5 | Kuli kuli |
| 6 | Tiger nuts |

| | |
|---|---|
| 7 | Tiger nut drink |
| 8 | Soya milk drink |
| 9 | Ukana (African oil bean nut, boiled, peeled, sliced, fermented) |
| 10 | Ipkan (Melon seed, peeled, ground, defatted, mixed with seasonins, molded and smoked) |
| 11 | Bitter kola |
| 12 | Ekpuro (walnut) |
| 13 | Dates |

| S/N | Fruits and Other vegetables |
|---|---|
| 1 | Water melon |
| 2 | Banana |
| 3 | Paw paw |
| 4 | Quava |
| 5 | Orange |
| 6 | lemon |
| 7 | Lime |
| 8 | Grape |
| 9 | Star fruit (Carambola) |
| 10 | Avocado |
| 11 | Pineapple |
| 12 | Apple |
| 13 | Red bush apple |
| 14 | Fruit juice |
| 15 | Cucumber |
| 16 | Carrot |
| 17 | Garden egg |
| 18 | Nkarika (Pepper fruit) |
| 19 | Ndiya (monkey kola) |

| S/N | Milk and Milk drinks |
|---|---|
| 1 | Peak milk (powdered |
| 2 | Dana powdered milk |
| 3 | Peak milk (liquid) |
| 4 | Three crown milk (powdered) |
| 5 | Cowbell powdered milk |
| 6 | Nutri Milk drink |
| 7 | Viju milk drink |
| 8 | Hollandia milk drink |
| 9 | Yoghurt |

| S/N | Alcoholic, Non-alcoholic and Cocoa Beverages |
|---|---|
| 1 | Beer |
| 2 | Dry gin |
| 3 | Palm wine |
| 4 | Coffee |

| | |
|---|---|
| 5 | Lipton tea |
| 6 | Soft drinks |
| 7 | Zobo drink |
| 8 | Malt |
| 9 | Milo |
| 10 | Bournvita |
| 11 | Ovaltine |

| **S/N** | **Sugars and Sweets** |
|---|---|
| 1 | White sugar, granulated |
| 2 | Sugar (white, cube) |
| 3 | Sugar cane |
| 4 | Honey |
| 5 | Sweets |

**Appendix IX: Additional results on Socio-demographic characteristics of respondents**

**Distribution of Respondents in Senatorial Districts and Occupations**

| **Variable** | | **AK N (%)** | **CR N (%)** | **Total N (%)** |
|---|---|---|---|---|
| **Senatorial District** | Akwa Ibom North East | 256 (19.4) | - | - |
| | Akwa Ibom North West | 247 (18.7) | - | - |
| | Akwa Ibom South | 230 (17.4) | - | - |
| | Cross River North | - | 221 (16.7) | - |
| | Cross River Central | - | 241 (18.3) | - |
| | Cross River South | - | 125 (9.5) | - |
| **Primary Occupation** | Civil/Public Servant | 48 (6.5) | 80 (13.6) | 128 (9.7) |
| | Registered Business/Artisan | 178 (24.3) | 78 (13.3) | 256 (19.4) |
| | Farming/Fishing | 180 (24.6) | 233 (39.7) | 413 (31.3) |
| | Home Maker | 4 (0.5) | 7 (1.2) | 11 (0.8) |
| | Not Currently Employed | 63 (8.6) | 82 (14.0) | 145 (11.0) |
| | Others | 3 (0.4) | 2 (0.3) | 5 (0.4) |
| | Total | 733 (100.0) | 587 (100.0) | 1320 (100.0) |

**Information on Household Head**

| Variable | | AK N (%) | CR N (%) | Total N (%) |
|---|---|---|---|---|
| **Sex of Household Head** | | | | |
| | Male | 520 (70.9) | 413 (70.4) | 933 (70.7) |
| | Female | 213 (29.1) | 174 (29.6) | 387 (29.3) |
| **Age Group of Household Head** | | | | |
| | 20 – 29 | 129 (17.2) | 88 (15.0) | 214 (16.2) |
| | 30 – 39 | 216 (29.5) | 145 (24.7) | 361 (27.3) |
| | 40 – 49 | 186 (25.4) | 142 (24.2) | 328 (24.8) |
| | 50 – 59 | 118 (16.1) | 115 (19.6) | 233 (17.7) |
| | ≥60 | 87 (11.9) | 97 (16.5) | 184 (13.9) |
| **Primary Occupation of Household Head** | | | | |
| | Not Currently Employed | 23 (3.1) | 17 (2.9) | 40 (3.0) |
| | Petty Trading | 131 (17.9) | 73 (12.4) | 204 (15.5) |
| | Farming/Fishing | 85 (11.6) | 272 (46.3) | 357 (27.0) |
| | Company/Casual Worker | 132 (18.0) | 34 (5.8) | 166 (12.6) |
| | Registered Business | 263 (35.9) | 80 (13.6) | 343 (26.0) |
| | Civil/Public Servant | 81 (11.1) | 97 (16.5) | 178 (13.5) |
| | Others | 18 (2.5) | 14 (2.4) | 32 (2.4) |
| **Highest Educational Attainment of Household Head** | | | | |
| | Informal | 130 (17.7) | 127 (21.6) | 257 (19.5) |
| | Some Primary | 353 (48.2) | 219 (37.3) | 572 (43.3) |
| | Complete Primary | 81 (11.1) | 77 (13.1) | 158 (12.0) |
| | Some Secondary | 120 (16.4) | 98 (16.7) | 218 (16.5) |
| | Complete Secondary | 23 (3.1) | 37 (6.3) | 60 (4.5) |
| | Tertiary | 26 (3.5) | 29 (4.9) | 55 (4.2) |
| **Relationship with Household Head** | | | | |
| | Self | 430 (58.7) | 289 (49.2) | 719 (54.5) |
| | Spouse | 162 (22.1) | 137 (23.3) | 299 (22.7) |
| | Child | 111 (15.1) | 125 (21.3) | 236 (17.9) |
| | Sibling | 17 (2.3) | 12 (2.0) | 29 (2.2) |
| | Others | 13 (1.8) | 24 (4.1) | 37 (2.8) |

**Housing Characteristics of Respondents**

| Variable | | AK N (%) | CR N (%) | Total N (%) |
|---|---|---|---|---|
| **Type of Accommodation** | | | | |
| | Wooden House | 8 (1.1) | 30 (5.1) | 38 (2.9) |
| | Thatched/mud House | 28 (3.8) | 34 (5.8) | 62 (4.7) |
| | Single Room(s) | 275 (37.5) | 309 (52.6) | 584 (44.2) |
| | One Bedroom Flat | 74 (10.1) | 67 (11.4) | 141 (10.7) |
| | 2-3 Bedrooms Flat | 203 (27.7) | 135 (23.0) | 338 (25.6) |
| | Duplex/Bungalow | 145 (19.8) | 12 (2.0) | 157 (11.9) |
| **Primary Source of Energy for Lighting** | | | | |
| | Candle wax | 7 (1.0) | 12 (2.0) | 19 (1.4) |
| | Kerosene Lantern | 94 (12.8) | 85 (14.5) | 179 (13.6) |
| | PHCN only | 264 (36.0) | 86 (14.7) | 350 (26.5) |
| | PHCN/Rechargeable Lamp | 76 (10.4) | 207 (35.3) | 283 (21.4) |
| | PHCN/Generating Set | 292 (39.8) | 197 (33.6) | 489 (37.0) |
| **Source of Cooking Fuel** | | | | |
| | Firewood/Saw dust | 335 (45.7) | 374 (63.7) | 709 (53.7) |
| | Kerosene | 233 (31.8) | 136 (23.2) | 369 (28.0) |
| | Electricity | 6 (0.8) | 6 (1.0) | 12 (0.9) |
| | Gas | 159 (21.7) | 71 (12.1) | 230 (17.4) |
| **Primary Source of Water for Household Use** | | | | |
| | River/Stream | 13 (1.8) | 222 (37.8) | 235 (17.8) |
| | Rain Water | 5 (0.7) | 14 (2.4) | 19 (1.4) |
| | Well Water | 4 (0.5) | 72 (12.3) | 76 (5.8) |
| | Borehole Water | 665 (90.7) | 238 (40.5) | 903 (68.4) |
| | Pipe borne Water | 46 (6.3) | 41 (7.0) | 87 (6.6) |
| **Primary method of Refuse Disposal** | | | | |
| | Dumping in Gutter/ Streams | 23 (3.1) | 40 (6.8) | 63 (4.8) |
| | Burying / Bush | 416 (56.8) | 201 (34.2) | 617 (46.7) |
| | popular dump Site | 221 (30.2) | 293 (49.9) | 514 (38.9) |
| | Incinerator | 24 (3.3) | 27 (4.6) | 51 (3.9) |
| | Refuse Collector | 49 (6.7) | 29 (4.4) | 75 (5.7) |
| **Method of Sewage Disposal** | | | | |
| | Streams/River | 0 (0.0) | 8 (1.4) | 8 (0.6) |
| | Bush | 43 (5.9) | 108 (18.4) | 151 (11.4) |
| | Communal Latrine | 2 (0.3) | 29 (4.9) | 31 (2.3) |
| | Pit Latrine | 343 (46.8) | 135 (23.0) | 478 (36.2) |
| | Water Closet | 345 (47.1) | 307 (52.3) | 652 (49.4) |