DIETARY DIVERSITY, DIET QUALITY AND NUTRIENT ADEQUACY OF DDIETS OF WOMEN OF REPRODUCTIVE AGE IN SOUTH EAST NIGERIA

BY

GERTRUDE NNEKA, ONYEJI

B.Sc. Nutrition and Dietetics (UNN), M.Sc. Human Nutrition (Ibadan)

MATRICULATION NUMBER 49718

A THESIS IN THE DEPARTMENT OF HUMAN NUTRITION SUBMITTED TO THE FACULTY OF PUBLIC HEALTH, COLLEGE OF MEDICINE IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY OF THE UNIVERSITY OF IBADAN.

JULY, 2015

ABSTRACT

Malnutrition remains a public health problem among women of reproductive age in developing countries. The quality of diets is known to be related to dietary diversity and favorable nutritional status. Diet in developing world is predominantly starchy staples with few animal products. Information on dietary intakes, patterns and diet quality for women across Nigeria are limited. This study was conducted to assess Dietary Diversity (DD), Diet Quality (DQ) and Nutrient Adequacy (NA) of diets of Women of Reproductive Age (WRA) in South East Nigeria (SEN).

This study was a descriptive cross-sectional design with four-stage sampling technique used to select 1,200 WRA from three of the five States in SEN. Three Local Government Areas (LGA) were randomly selected from the three senatorial districts in each state. From the nine LGA, 36 rural and 18 urban communities were randomly picked from which the respondents were selected using systematic random sampling method. A pre-tested semi-structured interviewer-administered questionnaire was used to collect data on demographic and socio-economic characteristics. Two non-consecutive 24-hour diet recall, weight and height measurements were conducted. Dietary diversity was determined using a 14 food-group dietary diversity tool and the overall score was categorised as follows: low, 1-4; average, 5-9; high, 10-14. Diet quality was determined using diet quality index-international scale (DQI-I) comprising of: 'Variety' (20%), 'Adequacy' (40%), 'Moderation' (30%), and 'Overall-Balance' (10%). Twenty-four-hour dietary recall was analysed using adapted Total Dietary Assessment (TDA) Software. Nutrient Adequacy Ratio (NAR) was derived for energy and 11 nutrients by dividing the nutrient intake of each woman by her recommended Dietary Allowance (RDA). Data were analysed using descriptive statistics, ANOVA, t-test, and Pearson's correlation at p=0.05 level of significance.

Mean age of WRA was 28.2±5.6 years and BMI was 26.8±4.8 kg/m^2. Most (96.3%) WRA were married, 41.7% were traders while, 54.9% completed secondary school education. About 39.3% of the women were overweight while 21.5% and 0.8% were obese and underweight, respectively. Overall, Dietary Diversity Score (DDS) was 7.0±1.8 and 7.6% had low, 84.6% had average, and

7.8% had high scores. The DDS in the three States were similar, however, significantly higher in the urban (7.0±2.5) than rural (6.9±2.4) sector. Overall, DQ was 58.8±8.1, the total variety (9.5±3.1) and overall-balance (2.0±1.8) component was poor, adequacy (23.8±4.7) was average and moderation (25.0±3.7) was high in the study area. There was no significant difference between DQ in the urban (59.3±7.4) and rural (58.3±7.5) communities. Nutrient Adequacy Ratio for energy (80.5%), protein (83.0%), iron (39.2%) and zinc (72.7%) was adequate in the region while NAR for calcium (3.8%) and vitamin C (16.9%) was inadequate. There was a significant correlation between dietary diversity and diet quality (r=0.48, $p < 0.05$).

The Dietary Diversity Score and Diet Quality indicate average diversity and quality in dietary intake. Nutrient adequacy ratio however, suggested excess intake of energy and protein which may predispose to obesity and its associated complications. Nutrition education and dietary diversification among women of reproductive age are recommended in South East Nigeria.

Keywords: Dietary diversity, Diet quality, Nutrient adequacy, Women of reproductive age

Word count: 490

ACKNOWLEDGEMENTS

I am grateful to God Almighty for His protection and guidance through this programme and in this project. I give Him all the glory. I want to specially thank Him for his provision, support, health and strength given to me to complete this doctorate program

My sincere appreciation goes to the Head of Human Nutrition Department Dr (Mrs) Grace Fadipin and all the lecturers at the Department of Human Nutrition, University of Ibadan for providing me with all that I needed to fulfill my academic goals in Ph.D Human Nutrition. My sincere appreciation especially goes to Dr Adepoju, and Dr (Mrs) Folake O. Samuel for their assistance in making this research worthwhile.

My sincere gratitude goes to my supervisor, Dr. R. A. Sanusi whose prompt attention, patience, encouragement, scholarly suggestions and advice led to successful completion of this project. May God bless you and reward your labour in Jesus name.

My profound gratitude goes to Dr (Mrs) B. O. Ogunba, Dr (Mrs) Mercy Ifeanacho and Ms Priscilia Nwonu whose supports in numerous ways have contributed immensely to the success of this project. It is my pleasure to acknowledge all the field assistants: Onyebuchi Ochi, Nwadinma Obinna, Judith Onuoha, Nneka Enereulor, Igwe Ifeanyi Chukwu, Obinna Onodu, Kenechukwu Onodu, Emmanuel O Balogun, Emeka Nwodo, Paul Agu, Uchenna Ike, Alex Oluwafemi, Attah Tobechukwu, Akubue Francis and Attah Ujunwa.

To Mr Ignatius Ugwu, who was my pilot throughout the months of field work, I say a big thank you. I appreciate Miss Ebere Onodu,, Mr Chika Ugwu, Mr Okechukwu Nsude, Mr Nnamdi Nwodoh, Mr. Jideofor Ignatius and Mr. Emeka Udealor for their help in Data entry.

I truly appreciate Dr. Mrs Olivia Afam-Anene, Dr (Mrs) Nneka Mefor for facilitating my entry into the States and local government areas and their selfless help as co-supervisors on the field. I appreciate my sister Mrs M.N Ugwu who took care of my team and I when we visited her state.

I cannot forget to appreciate these wonderful people that facilitated my entry into the communities: Mrs. Anuforo P. O, Mr. Osuji Solomon, Mrs. Ijeoma Ododo, Mr. Oji L. U, Mr. Okoye Rapheal, Mrs. Oforedu (Blessed Memory), and Director Ezinne

To my precious mother, I am immensely grateful for pushing me to do this programme and for all your prayers. I use this opportunity to express my appreciation and gratitude, thank you so much. To my siblings, extended family members, in-laws, friends and colleagues, I thank you for your prayers and encouragement which went a long way in contributing to the success of this project.

Ejike Ugwu, thank you so much for your contribution in statistical analysis of this study. To my friends Miss. Badejo Catherine, Miss. Ekerette Nkereuwem, Ms Priscilla C Nwonu Mrs. Juliana Okpe, Mrs. Chika Onah, Mrs. Ngozi Muoghalu;. I am grateful for your ideas, contribution and friendship. The prayer and support of the Alumonas, Abahs, Nwachukwus, Awopetus, Egbujos, Oladimejis and Olayiwolas is also acknowledged.

To my loving and understanding children- Ekene, Victor, Amara and Emeka, You are wonderful. You will achieve the plan and purpose of God for your life.

My sincere and profound gratitude goes to my Darling husband Professor Cyprian Ogbonna Onyeji for his moral support, financial assistance and encouragement throughout the period of my study. May God bless you mightily in Jesus' name.

CERTIFICATION

I certify that this work was carried out by Gertrude Nneka Onyeji in the Department of Human Nutrition, Faculty of Public Health, College of Medicine, University of Ibadan, under my supervision

……………………………………….

SUPERVISOR

Dr. R, A. Sanusi
MB, BS (Lagos), M. Sc. (Nutr.), Ph.D
Reader/Associate professor
Department of Human Nutrition
University of Ibadan, Ibadan.

DEDICATION

This work is dedicated to God Almighty, my Shield, my Buckler, my Defence and Provider who made this work to be successful.

to my beloved husband, Professor Cyprian Ogbonna Onyeji (OON)

And

to my wonderful mother, Mrs Ann Nwada Onodu

TABLE OF CONTENTS

TABLES

FIGURES

LIST OF ABBREVATIONS AND ACRONYMS

AACC	American Association of Cereal Chemist
AGDHA	Australian Government Department of Health and Agency
BMI	Body Mass Index
DRI	Dietary Reference Intake
FAO	Food Agricultural Organization
NCFCDPHP	National Center for Chronic Disease Prevention and Health Promotion
NFCNS	Nigerian Food Consumption and Nutrition Survey.
NHS	National Health Service
RDA	Recommended Dietary Allowance
SCOWT	Stunted Children and Overweight Mothers
TDA	Total Dietary Assessment
UNDP	United Nations Development Programme
USDA	United States Department of Agriculture
WHO	World Health Organization
UI/UCH	University of Ibadan/University College Hospital

CHAPTER ONE

INTRODUCTION

1.1 Background

Diet is important in the lives of people, because it is the source of energy and other nutrients needed for survival, growth, development and maintenance of body tissues (McGinnis and Foege, 1993). In nutrition science, the adequacy of a food/diet was and is still based on the ability of the food to have a balance of the six key nutrients (United States Department of Agriculture (USDA), 2010). An adequate diet contains all the nutrients in the right proportions, and is also consumed in sufficient quantity (USDA, 2010). The quality of a diet is determined by the extent to which it meets the demands for nutrients and other health promoting components. Adequate or optimal diet promotes good health, longevity, and reduces the risk of diet-related chronic diseases.

An 'unbalanced' diet is a risk factor for several chronic diseases, among which are obesity, stroke, cancer, and type 2 diabetes mellitus. These diseases contribute to premature deaths, restrict life quality and lead to enormous costs on health systems. Thus, health policy is strongly motivated by the need to monitor the population's diet and, when necessary, to help improve dietary status by providing nutrition information and education. Unfavourable health outcomes usually occur in situations where diets do not contain adequate nutrients for optimal health, either deficiency or excess of one or more of its components (Thiele, Mensink, and Beitz, 2004). Seasonality, location with its climate and agricultural practices are among factors that affect food availability in any locality. Individual and household access to food has been shown to be affected by demographic and socio-economic factors, accounting for variations in diet quality (Bernal and Lorenzana, 2003; Sanusi, 2010).

Malnutrition cannot be reduced by mere intake of food but by the consumption of high quality diet. Deficits in macro-nutrients intakes may result in Protein-Energy Malnutrition (Hillbruner and Egan, 2008). Deficiency diseases may also include iron deficiency anemia, iodine deficiency disorders, zinc and vitamin-A deficiencies (Maziya-Dixon, Akinyele, Oguntona, Nokoe, Sanusi and Harris, 2004). Furthermore, excessive nutrients intake may result in obesity, and cardiovascular diseases and the associated metabolic syndrome (Azadbakht, Mirmiran, Esmaillzadeh, Azizi and Azizi, 2006).

Food Variety and Nutrient Requirement

Throughout the world people eat a variety of foods based on custom, culture, areas and region they live in. The traditional dishes are usually based on locally produced foods, and the dishes of a certain culture will usually include many of the same ingredients. The ultimate choice of food by the consumer however is a personal one and it could be a function of production, availability and income. Nurses and health educators also have some influence on the choice of food. In most parts of Nigeria, as in most parts of Africa, the poor economy, socio-cultural factors, geographic location and distribution of food have combined to limit the food choices of families (Fleck, 1976; Ogunba, 2002).

All people need variety of foods to meet requirements for nutrients, and the value of diverse diets has long been recognized as a key element of high quality diet (Shimbo, Kimura, Imai, Yasumoto, Yamamoto, Kawamura, *et al.*, 1994, Slattery, Berry and Caan, 1997, Hatloy, Torheim and shaug, 1998; Arimond and Ruel, 2004). Several studies of disease-specific and of general health and survival demonstrate that a varied diet confers advantage (Wahlqvist, Lo and Myers, 1989; Hodgson, Hsu-Hage and Wahlqvist, 1994; Kant, Schatzkin, and Ziegler, 1995; Hsu-Hage and Wahlqvist, 1996).

In rural Africa, wild foods provide diversity of vitamins, and minerals in diet, they are also important during food shortage (Harris and Mohammed, 2003). Increasing the variety of foods across and within food groups is recommended in most dietary guidelines (U.S Department of Agriculture Human Nutrition Information Service (USDAHNIS, 1992)) as well as internationally (World Health Organiztion 1996), because it is thought to ensure adequate intake of nutrients and promote good health.

To meet the requirement for essential nutrients, a variety of foods from all food groups need to be selected. Wise selection of foods from the different food group is necessary and this necessitates dietary diversity. Lack of dietary diversity is a particularly serious problem among poor populations from the developing world because their diets are predominantly based on starchy staples which often include little or no animal products and few fresh fruits and vegetables (Arimond *et al.*, 2004). These plant-based diets tend to be low in a number of micronutrients, and the micronutrients they contain are often in a form that is not easily absorbed. For vulnerable infants and young children, the problem is particularly critical because they need energy and nutrient-dense foods to grow and develop both physically and mentally, and to live a healthy life (Arimond *et al.*, 2004). The nutritional quality of local diets remains low for most people and access to adequate food is not always secure for the poor. No single food by itself (except breast milk) provides all the nutrients in the right proportion that will promote growth and maintain life (Food and Agriculture Organization, 2008). To achieve good nutrition therefore, it is necessary to consume as wide variety of foods as possible from the age of 6 months.

Dietary Diversity Assessment

A number of indices have been adopted in assessing dietary diversity. Two of the indices are, Food Variety Score (FVS) and Dietary Diversity Score (DDS). Food Variety Score refers to the mean number of different food items consumed (Styen, Nel, Nantel, Kennedy and Labadarios, 2006), while Dietary Diversity Score consist of a simple count of food groups that an individual or a household consumes over a reference period (Kennedy, Pedro, Seghieri, Nante and Brouwer, 2007; Sarafzadegan, Azadbakht, Mohammadifard, Esmaillzadeh, Safavi, Sajadi *et al.*, 2009). Dietary Diversity Score is considered to be a better determinant of nutrient adequacy than Food Variety Score. Increasing the number of food groups has a greater impact on dietary quality than increasing the number of individual foods in the diet (Ruel, 2003).

Different food group classification system exists based on the objectives for the assessment of dietary intake. In developing countries, single food or food group counts have been the most popular measurement approaches for dietary diversity, probably because of their simplicity. These range from five food groups (Kant, Schatzkin, Harris, Ziegler and Block, 1993; Mirmiran, 2005), ten (Kennedy *et al.*, 2007), twelve (Swindale and Bilinsky, 2005) and Sixteen (Food and Agriculture Organization (FAO, 2007)) food groups. The current FAO guidelines for measuring household and individual dietary diversity recommends the use of sixteen food groups for household and fourteen food groups for individual dietary diversity assessment (FAO, 2007). Different reference periods have been used in determining the dietary diversity scores; these include 24- hour dietary recall (Shatenstein, Kergoat and Reid, 2004); a two-day recall (Mirmiran, Azadbakht, Esmaillzadeh and Azizi, 2004); three-day recall (Savy, Martin-Prével, Danel, Traissac, Dabiré, and Delpeuch, 2008) and weekly recall (Clasen, Charlton, Gobotswang and Holmboe-Ottsesen, 2005).

The major focus of work in the area of dietary assessment in recent years has been to measure diet quality from diverse perspectives and in a comprehensive manner (Kim, Haines, Siega-Riz and Popkin, 2003). The Diet Quality Index-International (DQI-I) has been used for global monitoring and exploration of diet quality across countries. Assessment of diet quality across diverse countries at different stages of the nutrition transition is especially valuable because it will provide information on dietary issues related to that transition. The Diet Quality Index-International focuses on concerns related not only to chronic diseases but also to problems of undernutrition, thus providing a global tool for monitoring 'healthfulness' of diet and for exploring aspects of diet quality related to the nutrition transition.

The DQI-I according to Kim *et al.*, (2003) focuses on four major aspects of a high-quality diet, i.e. variety, adequacy, moderation, and overall balance. Under each of these components there are specific components of diet to be assessed. These distinctive components help users to readily identify aspects of the diet that mostly need improvement. Scores for each component are summarized in each of the four main categories, and the scores for all four components/ aspects are summed, resulting in the total DQI-I score, ranging from 0 to 100.

1.2 Statement of the problem.

In resource-poor environments across the world, low quality monotonous diets are the norm: when grain-based or tuber-based staple foods dominate and diets lack vegetables, fruits, and animal-source foods, risk for a variety of micronutrient deficiencies is high (Kennedy and Meyers, 2005). Nutritional problems are common in poor populations, since their diets are predominantly based on starchy staples (Styen *et al.*, 2006) and these plant-based diets are low in micronutrient contents, high in phytate and dietary fibre which inhibits the absorption of some micronutrients (Lopez, Leenhardt and Remesy, 2004). Those most likely to suffer from deficiencies include infants and young children, adolescent girls and women of reproductive age.

Studies have consistently shown that women, particularly in the rural areas have poor nutrient intakes (Mozie, 2000; Ene-Obong, Enugu and Uwaegbute, 2001; Maziya-Dixon, Akinyele, Oguntona, Nokoe, Sanusi and Harris, 2004). Heavy workload, poor education, and quality of diet are major causes of malnutrition among rural women. Between 5 to 20% of African women have low Body Mass Index (BMI) as a result of chronic hunger, thus providing evidence of maternal malnutrition (Lartey, 2008). The causes include inadequate food intake, poor quality of diets, frequent infections and short inter-pregnancy intervals (Farid, Abdul and Fawzy, 2010).

The consequence of poor maternal nutritional status is reflected in low pregnancy weight gain, high maternal morbidity and mortality. The prevalence of chronic energy deficiency as measured by the Body Mass Index (BMI) of women of reproductive age was 12% (Maziya-Dixon *et al.*, 2004). Chronic energy deficiency has serious implications for morbidity and low productivity of women, and is associated with high prevalence of low birth weight and consequently high infant mortality.

Many Children in food secure households are still underweight or stunted because of inappropriate infant feeding and care practices, poor access to health services, or poor sanitation (Akinyele, 2005). Nutritional deficiencies contribute to high rates of disability, morbidity and mortality in Nigeria especially among infants and young children. 'Poverty', which is central to malnutrition, affects about 80% of Nigerian population, weakening productivity and capacity of children to learn properly in school. According to World Health Organization, 2006), one out of 6 infants is born with low birth-weight. One out of 4 pre-school children suffers from undernutrition. Ten million children die every day before the age of 5 and 1 out of 2 deaths is attributable to undernutrition. Maziya-Dixon *et al.*, (2004) found that stunting, underweight; vitamin and mineral deficiency are still major problems in Nigeria. A study of the nutritional status of school children in Enugu State reported that 27.7%, 25.5% and 29.9% were stunted, wasted and underweight, respectively (Ene-Obong and Ejekwu, 2007).

1.3 Justification of the study

Malnutrition and micronutrient deficiencies continue to be a significant public health problem in developing countries among women of reproductive age, infants and children (Maziya-Dixon *et al.*, 2004). Hillbruner and Egan (2008) in their study reported that some of the causative factors are inadequate food intake, poor diet quality and frequent infections. Poor quality diets result in micronutrient deficiencies and predispose to noncommunicable diseases like diabetes, obesity, cancer, cardiovascular diseases. In children, poor quality diets result in inadequate nutrient intake causing poor growth and impaired cognitive development (Azadbakht, *et al.*, 2006).

The quality of diets has been shown to be directly related to dietary diversity and favorable nutritional status (Styen *et al.*, 2006). Dietary Diversity is a key requirement for healthy diets (Ruel, 2002), and historically it has been suggested to be nutrient adequacy (Krebs-Smith, Smiciklas-Wright, Gutherie, and Krebs-Smith, 1987). Dietary guidelines recommend consumption from a number of core food groups to ensure adequate intake of nutrients to promote good health and prevent noncommunicable chronic diseases (Kant, *et al.*, 1993). A number of dietary recommendations intended for reducing the risk of various chronic diseases have advocated a varied diet (National Research Council, 1998; U.S Department of Health and Human services, 1988; U.S Department of Agriculture, Nutrition and your health, 1990). Well-nourished people learn better, produce more and can effectively fight off diseases (Obaid, 2004).

One approach to assessing the quality of the total diet is to evaluate it for the extent of dietary variety (Kant *et al.*, 1993). It provides a measure of quality of the total diet and also correlates positively with nutritional adequacy (Krebs *et al.*, 1987). Importance of dietary variety is based on several studies that have shown that diverse diets are accompanied by positive health outcomes (Wahlqvist *et al.*, 1989).

In developing countries, very little information is available on women's micronutrient status, but even with limited data, it is clear that poor micronutrient status among women is a global problem, and is more severe for poor women (Kennedy and Meyers, 2005). Very few developing countries have information on micronutrient intakes of women of reproductive age (Arimond, Wiesmann, Becquey, Carriquiry, Daniels, Deitchler *et al.*, 2010). Also comparable information about dietary intakes, dietary patterns and diet quality for women across Nigeria is scarce and fragmented (Oyunga-Ogubi *et al.*, 2009). This could be as a result of the cost and complexity of quantitative dietary intake data collection. Problems such as lack of animal source foods, fruits, vegetables and sub-groups particularly at risk of nutrient inadequacy have not been adequately studied (Hamrick and Counts, 2008). Several studies of dietary diversity had been carried out in developed countries; fewer data exist to support the contribution of dietary diversity to health in developing countries (Johns, 2001). Very few studies are available in Nigeria that assessed diet diversity, quality and nutrient adequacy of women of reproductive age. It is therefore necessary to fill the information gap in this area by conducting further research.

1.4 Research Questions

1. How diverse is the diet of mothers in the South-East Nigeria?
2. How adequate is the energy and selected nutrients of mothers in the South-East of Nigeria?
3. What is the quality of diet of mothers in the South-East of Nigeria?
4. What is the prevalence of overweight and obesity in mothers of the South East Nigeria
5. What is the prevalence of wasting, stunting and underweight among the under five children in the South Eastern states of Nigeria.

1.5 Objectives of the study

The general objective of the study was to assess the dietary diversity**,** diet quality and nutrient adequacy of diets of women of reproductive age in south-East Nigeria.

The specific objectives of the study were to:

1. assess nutrient intake using multiple 24hr diet recall
2. assess dietary diversity using FAO (2007) criteria
3. assess diet quality using Diet Quality Index International protocol.
4. Assess the prevalence of overweight and obesity of mothers using body mass index.
5. Determine prevalence of wasting, stunting and underweight among the under-5 children.
6. determine relationship between dietary diversity, diet quality and nutrient adequacy

1.6 Null hypotheses

1 There is no relationship between nutrient adequacy and diet diversity

2 There is no relationship between nutrient adequacy and diet quality

3 There is no relationship between diet quality and diet diversity

4 There is no relationship between diet quality and body mass index

CHAPTER TWO

LITERATURE REVIEW

2.1 Measures of diet quality

Dietary Diversity (DD) can be defined as the number of different foods or food groups consumed over a given reference period (Krebs-Smith *et al.*, 1987; Löwik, Hulshof, and Brussaard, 1999; Ruel, 2002; Ruel, 2003; Steyn, Bradshaw, Norman, Joubert, Schneider and Steyn, 2005). It is usually measured by summing the number of foods or food groups consumed over a reference period (Krebs-Smith *et al.*, 1987; Löwik *et al.*, 1999 and Ruel, 2002,). The reference period usually ranges from one to three days, but seven days is also often used, and periods of up to 15 days have been reported (Drewnowski and Popkin, 1997). Dietary diversity has been consistently linked with diet quality. It is widely recognized as being a key dimension of diet quality and is reflected in food-based dietary guidelines. With the current recognition that dietary factors are associated with increased risks of chronic diseases, dietary recommendations promote increased dietary diversity along with reducing intake of selected nutrients such as fat, refined sugars and salt.

Dietary quality (DQ) - reflects nutrient adequacy, the more recent concern in developed countries as well as in countries in transition (or soon to be in transition) regarding over nutrition and excess intake of certain nutrients and foods has led to a global shift in the definition of dietary quality to include both concepts of nutrient deficiency and over nutrition (WHO, 1996; US Department of Agriculture Human Nutrition Information Service (USDAHNIS), 1992; Chinese Nutrition Society 1990). Diet quality can be assessed based on compliance with dietary guidelines or recommendations for health, such as those formulated by World Health Organization for the prevention of diet-related chronic diseases (World Health Organization, 2003; Huijbregts, Feskens, Rasanen, Fidanza, Alberti-Fidanza and Nissinen, 1997).

Dietary variety, a term often used in the literature, is considered as synonymous to dietary diversity.

Nutrient adequacy - refers to a diet that meets requirements for energy and all essential nutrients (Ruel, 2002; Ruel, 2003).

2.2 Dietary diversity

Dietary diversity through food groups is particularly important as different food groups have unique nutrients associated with them and different foods within each food groups provide more of some nutrients than others (Azadbakht, Mirmiran and Azizi, 2005; Drewnoski and Darmon, 2005), hence, eating a variety of foods from each group may provide all nutrients in that group (Mirmiran *et al.*, 2004). In addition, nutrients from different food sources can interact to help with the absorption of other nutrients (e.g., protein from meat increases iron absorption both from the meat and from the vegetable sources). Each of these nutrients has a particular role to play in health and well-being and together, they provide all the necessary ingredients to meet the body's needs.

Sanusi (2010) in his study in Nigeria, reported DDS of 5.81. Also Savy, Martin-Prével, Sawadogo, Kameli and Delpeuch (2005, 2006) reported a DDS of 5.1 ±1.7 and 3.8±1.5 respectively. In developing countries, particularly in Africa, a relationship between dietary diversity scores and individuals' nutritional status has already been shown several times (Onyango, Koskia and Tucker, 1998; Tarini *et al.*, 1999; Hatloy, Halland, Diarra and Oshaug, 2000; Arimond and Ruel, 2002),

Maternal malnutrition is acknowledged as a major predisposing factor for morbidity and mortality in African women (Lartey, 2008), notably caused by inadequate food intake, poor diet quality and frequent infections (Sanusi, 2010). Several authors therefore argue that, quality of diets is directly correlated to dietary diversity and inversely related to malnutrition (Azadbakht *et al.*, 2005; Styen *et al.*, 2006). Great interest has also been paid to a balanced and diversified diet, especially in relation to problems caused by nutritional deficiencies and their consequences (WHO, 1996). It has been clearly stated that a non-diversified diet can have negative consequences on individuals' health, development and well-being mainly by reducing physical capacities and resistance to infection; and also by impairing cognitive development, reproductive and even social capacities (Underwood, 1998). In developing countries, the nutritional status of populations in urban areas is generally better than those in rural areas. One of the explanations for this difference is based on a more diversified diet in urban areas (Popkin and Bisgrove, 1988). Ruel (2002) reported that lack of dietary diversity is a challenge for rural communities in developing countries. Their diets are mainly starchy staples with inadequate animal products, fresh fruits and vegetables (Ruel, Minote and Smith, 2004). A more diverse diet is one key to combat this trend and to healthier lives (Frison, Francesco and Fanzo, 2004) though access to more diverse foods sometimes leads to diets higher in fats, and can result in other health problems (Drewnowski and Popkin, 1997). Rashid, Smith and Rahman (2006) reported that many studies focus on determinants of dietary energy consumption (or dietary quantity), at the expense of dietary quality and diversity. This study will therefore focus on determinants of dietary diversity and diet quality given the fact that studies on dietary diversity and diet quality are few in Nigeria.

.

2.3 Measurements of dietary diversity

Questionnaire is the major tool for determining Dietary Diversity Score (DDS). The diet diversity questionnaire is the major tool for determining the dietary diversity scores for both individuals and household (Food Agriculture Organization (FAO), 2007). The questionnaire provides a more rapid, user-friendly and Cost-effective approach to measure changes in dietary quality at the household and individual level. Dietary diversity is a qualitative measure of food consumption that reflects household access to a wide variety of foods, and is also a proxy of the nutrient adequacy of the diet for individuals.

Diet diversity is measured in two ways namely: at the individual level and at the household level (Swindale and Bilinsky, 2005; FAO, 2007). The household dietary diversity score (HDDS) is meant to reflect in a snapshot form, the economic ability of a household to consume a variety of foods. Studies have shown that an increase in dietary diversity is associated with socio-economic status and household food security (household energy availability) (Hoddinot and Yohannes, 2002; Hatloy, Halland, Diarra and Oshaug, 2000). The individual dietary diversity score (IDDS) aims to capture nutrient adequacy (FAO, 2007).

The questionnaire used for measuring household and individual dietary diversity is adapted from the FANTA Household DD Questionnaire and expanded version (Fanta, 2006) and the questionnaire used for women in Demographic and health surveys (DDS). According to FAO (2007), the questionnaire, when used at individual level is appropriate for any individual above the age of three years. The questionnaire consists of three sections namely: food groups, examples of food items within that food groups, and 'yes/no' options. Thus, depending on whether or not any food item from the group was consumed, a yes or no option is recorded in the space provided (Swindale and Bilinsky, 2005 and FAO, 2007).

Many studies on several different age groups have shown that an increase in individual dietary diversity score is related to increased nutrient adequacy of the diet (Hatloy *et al.,* 1998; Ruel *et al.,* 2000; Ogle, Hung and Tuyet, 2001; Foote, Murphy, Wilkens, Basiotis and Andrea, 2004; Steyn *et al.,* 2006; FANTA, 2006; Kennedy *et al.,* 2007). The decision on which level to collect information depends in part on the purpose and objectives of the survey. If assessment of the nutrient adequacy of the diet is of primary concern, it would be best to collect information at the individual level by choosing one or two target individuals per household (FAO, 2007). Another important consideration for the choice between household and individual is the frequency of meals/snacks purchased and consumed outside the home. If meals/snacks are purchased and consumed outside of the home on a regular basis by one or more family members, administering the questionnaire at the individual level is more appropriate as it is not possible to accurately capture meals/snacks purchased and eaten outside the home at the level of the household (FAO, 2007).

2.4 Food group classifications

Food groups may be classified based on the major nutrient content (fatty foods, starchy foods, protein foods); the role of the foodstuffs in human nutrition (energy foods, protective foods, body-building foods); individual nutrients (carbohydrates, fats, vitamins, protein); or commercial value (cereals, roots and tubers, nuts and seeds, fruits, leafy vegetables) (King and Burgess, 1993). Dietary Guidelines for Americans (2010) provide information about food plans. According to them, there are five groups consisting of vegetables, fruits, grains, dairy and protein group (which includes meat, poultry, fish and nuts).

Food groups may also be classified based on the objectives for the assessment of dietary intake. In a study assessing whether Dietary Diversity Score (DDS) is a useful indicator of micronutrient intake in non-breast-feeding Filipino children, the DDS was calculated for each child using a set of 10 food groups consisting of cereals and tubers, meat, poultry and fish, dairy, eggs, pulses and nuts, vitamin A-rich fruits and vegetables, other fruit, other vegetables, oils and fats, and other (Kennedy *et al.*, 2007). Swindale *et al.,* (2005) used up to twelve food groups while Food and Agriculture Organization (FAO) (2002) used sixteen food groups. FAO (2007) recommended the use of sixteen and fourteen food groups for household dietary diversity score (HDDS) and individual dietary diversity score (IDDS) respectively.

Table 2.1: Food Groups Used for Individual and Household Dietary Diversity Assessments

Question Number	Food group	
1	CEREALS	All cereal, grains and cereal based products including bread, noodles, biscuits, cookies or any other foods made from millet, sorghum, maize, rice, wheat.
2	VITAMIN A RICH VEGETABLES AND TUBERS	These include pumpkin, carrots, squash, or sweet potatoes that are orange inside + other locally available vitamin-A rich vegetables(e.g.sweet pepper)
3	WHITE TUBERS AND ROOTS	These include white potatoes, white yams, cassava, or cocoyam, water yam and foods made from these roots and tubers.
4	DARK GREEN LEAFY VEGETABLES	Dark green/leafy vegetables, pumpkin leaves, water leaves, green, cassava leaves.
5	OTHER VEGETABLES	Examples include onions, garden egg, green peas, green beans, cabbage, okra etc.
6	VITAMIN A RICH FRUITS	Ripe mangoes, cantaloupe, dried apricots, dried peaches pawpaw, star apple+other locally available vitamin A-rich fruits
7	OTHER FRUITS	These include citrus fruits (oranges, grapes, lemon etc) banana, pears, pineapple and other fruits, including wild fruits
8	ORGAN MEAT (IRONRICH)	liver, kidney, heart or other organ meats or blood-based foods
9	FLESH MEATS	beef, pork, lamb, goat, rabbit, wild game, chicken, duck, or other birds.
10	EGGS	Egg.
11	FISH	Fresh or dried fish or shellfish.
12	LEGUMES, NUTS AND SEEDS	Beans, peas, lentils, nuts including groundnuts, seeds including melon seeds etc or foods made from these.
13	MILK AND MILK PRODUCTS	milk, cheese, yogurt, fura nunu or other milk products
14	OILS AND FATS	oil, fats margarine or butter added to food or used for cooking
15	SWEETS	sugar, honey, sweetened soda or sugary foods such as chocolates, sweets or candies
16	SPICES, CONDIMENTS, BEVERAGES	spices(black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages.

The first fourteen food groups are used for the individual dietary diversity assessments while the whole sixteen food groups are used for the household dietary assessment (FAO, 2007).

2.5 Nutritional properties of some food groups

The method of classification for the various foods that humans consume based on the nutritional properties and the position of the plant or animal food product in the hierarchy of plant or animal Kingdom is known as food group (Davidson, 2006). Eating certain quantities of foods from the different categories is recommended by most guides to healthy eating as one of the most important ways to achieve a healthy lifestyle through diets (Jeanene, Fogli, Johanna, Edward, Marjorie, Lisa, and Paul, 2006), because it is thought to ensure adequate intake of essential nutrient said to promote good health (Ruel, 2003).

.

2.5.1 Cereals roots and tubers

Foods in this group come from grains (cereals) like wheat, oats, rice, rye, barley, millet and corn sometimes inclusive of potatoes and other starches, . It is often the largest category in nutrition guides (Australian Government Department of Health and Agency (AGDHA), 2011; United States Department of Agriculture (USDA), 2011). The grains can be eaten whole, ground into flour to make a variety of cereal foods like bread, pasta and noodles, or made into ready-to-eat breakfast cereals. The nutrients provided by the foods in this group include carbohydrates, protein, fibre and a wide range of vitamins and minerals including folate, thiamine, riboflavin, niacin and iron (Delzenne, Fayomi and Delisle, 2005; Sadiq, Tahir, Khan, Shabir and Butt, 2008).

Wholemeal or wholegrain varieties provide more fibre, vitamins and minerals. However, most grains contain considerable amount of phytic acid, a natural chelator that lowers the absorption of trace elements such as iron, zinc as well as calcium or magnesium (Lopez *et al.*, 2004). Some foods in this group may have fibre, vitamins and minerals added during processing. Dietary fibres are non cellulosic polysaccharides present in cereals (2-8%) and are mostly arabinoxylans, beta glucans, pectins, arabinogalactans, lignin and cellulose. Naturally, they are classified under unavailable carbohydrates and have beneficial effects in alleviating disease symptoms such as diabetes, atherosclerosis and colon cancer. For instance, the oat brain contains beta-glucan which has been proven beneficial in the treatment of diabetes and cardiovascular diseases (Sadiq *et al.*, 2008). Dietary fibre has various mechanisms in the management of metabolic syndrome, including its ability to control body weight through its effect on satiety, modulation of glucose homeostasis/insulin sensitivity and to positively affect factors implicated in cardiovascular diseases (Delzenne *et al.*, 2005).

A wide range of plants are grown for their edible tubers, but five species together account for almost 90% of the total world production. These are cassava, sweet potato, yams, Irish potato and taro; all of these except, cassava contain storage proteins (Ene-Obong, Odoh and Ikwuagwu, 2003). In general, tubers are rich in starch, and are often considered solely as source of carbohydrate. They do contain protein which varies in amount from 1-2% dry weight in cassava to almost 10% dry weight in yam bean, though their protein content is usually substantially lower than those of seeds (Shewry, 2003).

Carbohydrates, apart from supplying energy in form of glucose to the body, is also said to be involved in regulation of immune system, cellular signaling, cell malignancy, anti- infection responses, host-pathogen interactions etc (Tharanathan, 2002). Orange fleshed sweet potatoes is an efficacious of pro-vitamin A (Low, 2008).

2.5.2 Fruits and Vegetables

Fruits are the sweet-tasting seed-bearing parts of plants, or occasionally sweet parts of plants which do not bear seeds. These include apples, oranges, plums, bananas, berries and lemons etc., and are sometimes categorized with vegetables. Fruits are typically in medium-sized category in nutrition guides, though occasionally a small one (AGDHA, 2011; NHS, 2011; USDA, 2011). They are usually good source of vitamins, especially the water soluble ones. Vegetables come from many different parts of plants such as the leaves, roots, tubers, flowers, stems, seeds and shoots. Some vegetables like tomatoes and pumpkin are the fruit of the plant, but are included in this group because they are used as vegetables. Most vegetables are good sources of many vitamins. It has been suggested that a diet which includes vegetables rich in vitamins A and C, together with vegetables like broccoli, cauliflower, cabbage and Brussels sprouts from the cruciferous family can help to prevent certain types of cancer (Scott, Galicia-Connolly, Adams, Surette, Vohra and Yager, 2012).

A vegetable is not considered a grain, fruit, nut, spice, or herb (Heimendigher and Van Dayn, 1995). For example, the stem, root, flower, etc., may be eaten as vegetables. Vegetables contain many vitamins and minerals; however, different vegetables contain different spreads, so it is important to eat a wide variety of types (Heimendigher and Van Dayn, 1995). For instance green vegetables typically contain pro-vitamin A, dark orange and dark green vegetables contain vitamin C, and vegetables like broccoli and related plants contain iron and calcium. Vegetables are very low in fats and calories, but ingredient s added in preparation can often add these. Capsicum, broccoli, cauliflower, cabbage and tomatoes are high in vitamin C. Dark green and orange vegetables like spinach, broccoli, carrots and pumpkin are high in vitamin A. Vegetables are a good source of vitamins, minerals, dietary fibre and carbohydrate. Green vegetables are also good source of folate (Bailey, Dodd, Gache, Dwyer, McDowell and Yetley, 2010).

The polyphenol contents of fruits and vegetables such as flavonoids is said to have strong antioxidant properties, thus epidemiological evidences present that increased intake of fruits and vegetables can significantly reduce the risk of cardiovascular diseases (CVD) (Ruel and Coullard, 2007). Juices belong to this group but they have much lower fibre content than fruit.

2.5.3 Dairy

Dairy products are produced from the milk of mammals, most usually but not exclusively cattle. Milk, yoghurt and firm cheeses are the three important foods in this group (Jensen, Hagerty and McMahon, 2008). There is a wide choice of these foods available. Choices of milk and yoghurt can be made on the basis of fat content, type of sweetener and flavourings used. Milks can be fresh, dried, evaporated or long-life. Cheeses can also be reduced in fat. Milk and its derivative products are a rich source of dietary calcium, but also provide protein, phosphorus, Vitamin A, Vitamin D, Riboflavin, and Vitamin B_{12} (Miller, Jarvis and McBean, 2001).

Many dairy products are high in saturated fat and cholesterol compared to vegetables, fruits and whole grains, which is why skimmed products are available as an alternative (Jensen *et al.*, 2008). The milk, yoghurt and cheese group can increase the fat content of diet if full cream products are chosen. For most people, five years and over, the best choices are low fat milk, yoghurt and cheese. For children under five years of age, full cream varieties are recommended because low fat diets are not suitable (Jensen *et al.*, 2008). For adults, three cups of dairy products are recommended per day. Some people with special needs, including the frail elderly and people who may need to regain weight after illness, will benefit from the full cream choices (Clark, 2005).

2.5.4 Meat, Fish, Poultry and Eggs

There is a wide variety of foods in this group; Meats, poultry, and fish. These include beef, chicken, pork, salmon, tuna, shrimp, and eggs. The foods in this group are good sources of protein, iron, niacin and vitamin B_{12} (Food and Agriculture Organization/World Health Organisation (FAO/WHO, 1998). Within this group, lean red meats are a particularly good source of iron and zinc. The iron in animal foods is more easily absorbed by the body than the iron in plant foods. Vitamin C, found in fruit and vegetables, will assist the body to absorb iron from plant foods. Two consecutive cross-sectional studies(Oyunga-Ogubi *et al.*, 2009) using 24-hour recalls revealed a decrease in Vitamin A intake due to decrease consumption of offal, decreased protein, vitamin D, and vitamin B_{12} due to the decreased consumption of meat and fish. Calcium consumption was lower as a result of decreased intakes of calcium (Serra-Majem, Ribas, Perez-Rodrigo, Garcia-Closas, Pena-Quintana and Aranceta, 2007).

Egg is an important source of nutrients, containing all of the proteins, lipids, vitamins, minerals and growth factors as well as a number of defense factors to protect against bacterial and viral infections (Brown, 1998). Several biological activities have now been associated with egg components, including novel antimicrobial activities, anti-adhesive properties, immune-modulators, anticancer, antihypertensive activities, nutrient bioavailability and functional lipids; highlighting the importance of egg and egg components in human health, disease prevention and treatment (Kovacs-Nolan, Phillips and Mine, 2005).

Fish, egg yolk and organ meat are good natural sources of Vitamin D. Epidemiological studies link fish consumption to lower rates of neurological diseases. Fish contains high level of Omega-3 polyunsaturated fatty acids (PUFA) (Orr and Bazinet, 2008). Fish consumption is also beneficial to visual functions as it is believed that diet- induced deficiency in omega-3 fatty acids are well known to alter photoreceptor function. Ngugen, Vingrys and Bui (2008) in assessing the broader functional changes in a diversity of retinal neurons in Sprague- Dawley rats fed with either Omega – 3 sufficient or deficient diets for five weeks before conception concluded that increasing dietary Omega- 3 has beneficial effects across the retina, with the greatest improvement occurring in ganglion cell function.

2.5.5 Dietary Fiber

Fiber refers to certain types of carbohydrates that our body cannot digest. These carbohydrates pass through the intestinal tract intact and help to move waste out of the body (Greger, 2000).

Dietary fibre or sometimes called roughage and ruffage are the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine, with complete or partial fermentation in the large intestine (American Association of Cereal Chemists (AACC), 2001). Chemically, dietary fibre consists of non-starch polysaccharides such as arabinoxylans, cellulose, and many other plant components such as resistant starch, resistant dextrins, inulin, lignin, waxes, chitins, pectins, beta-glucans, and oligosaccharides (United State Department of Agriculture (USDA, 2005)). A novel position has been adopted by the USDA to include functional fibres as isolated fibre sources that may be included in the diet (USDA, 2005). The term "fibre" is something of a misnomer, since many types of so-called dietary fiber are not actually fibrous. Dietary fibres promote beneficial physiologic effects including laxation, and/or blood cholesterol attenuation, and/or blood glucose attenuation.

There are two main components of dietary fibres: soluble and insoluble fibre. Soluble fiber dissolves in water. It is readily fermented in the colon into gases and physiologically active byproducts, and can be prebiotic and/or viscous. Soluble fibres tend to slow the movement of food through the system. Food sources of dietary fibre are often divided according to whether they provide (predominantly) soluble or insoluble fibre. Plant foods contain both types of fibre in varying degrees, according to the plant's characteristics. Examples of foods with soluble fibres are legumes (peas, soybeans, lupins and other beans) oats, rye, chia, barley, some fruits and fruit juices (including prune juice, plums, berries, ripe bananas, and the insides of apples and pears), certain vegetables such as broccoli, carrots, and Jerusalem artichokes,root tubers,root vegetables such as sweet potatoes and onions (skins of these are sources of insoluble fibre also),psyllium seed husk (a mucilage soluble fiber) and flax seeds nuts, with almonds being the highest in dietary fibre(Alvarado, Pacheco-Delahaye and Hevia, 2001).

Insoluble fibre does not dissolve in water. It can be metabolically inert and provide bulking or prebiotic, metabolically fermenting in the large intestine. Bulking fibres absorb water as they move through the digestive system, easing defecation (USDA, 2005). Fermentable insoluble fibres mildly promote stool regularity, although not to the extent that bulking fibres do, but they can be readily fermented in the colon into gases and physiologically active byproducts. Insoluble fibres tend to accelerate the movement of food through the system. Sources of insoluble fibre include whole grain foods wheat and cornbran legumes such as beans and pea nuts and seeds,potato skins,lignans vegetables such as green beans, cauliflower, zucchini (courgette), celery, and nopal, some fruits including avocado, and unripe bananas the skins of some fruits, including kiwifruit,grapes and tomatoes (Alvarado *et al.*, 2001).

Dietary fibres have three primary mechanisms: bulking, viscosity and fermentation (Gallaher and Daniel, 2006). They can change the nature of the content of the gastrointestinal tract, and to change how other nutrients and chemicals are absorbed through bulking and viscosity (USDA, 2005; Eastwood and Kritchevsky, 2005). Some types of soluble fibers bind to bile acids in the small intestine, making them less likely to enter the body. This in turn lowers cholesterol levels in the blood which may reduce the risk of cardiovascular disease (Anderson and Whitaker, 2009). Viscous soluble fibres may also attenuate the absorption of sugar, reduce sugar response after eating normalise blood lipid levels, and once fermented in the colon, produce short-chain fatty acids as byproducts with wide-ranging physiological activities.

Disadvantages of diets high in fibre is the potential for significant intestinal gas production and bloating. Constipation can occur if insufficient fluid is consumed with a high-fiber diet. Dietary fiber is not yet formally proposed as an essential macro-nutrient, but is nevertheless regarded as important for the diet. Regulatory authorities in many developed countries recommend increase in fiber intake (USDA, 2005; Eastwood and Kritchevsky 2005; Jones, Turnbaugh, Hamady, Yatsunenko, Cantarel, Duncan, *et al.*, 2008).

Fiber does not bind to minerals and vitamins and therefore does not restrict their absorption, but rather evidence exists that fermentable fiber sources improve absorption of minerals, especially calcium (Greger *et al.*, 1999; Raschka and Daniel, 2005; Scholz-Ahrens and Schrezenmeir, 2007). Some plant foods can reduce the absorption of minerals and vitamins like calcium, zinc, vitamin C, and magnesium, but this is caused by the presence of phytate (which is also thought to have important health benefits), not by fiber (Scholz-Ahrens and Schrezenmeir, 2007).

Diets that are low in fiber have been shown to cause problems such as constipation and hemorrhoids and to increase the risk for certain types of cancers such as colon cancer (Hsieh, 2005). Diets high in fiber; however, have been shown to decrease risks for heart disease, obesity, and they help lower cholesterol. Foods high in fiber include fruits, vegetables, and whole grain products. Diets naturally high in fiber can be considered to bring about several main physiological consequences:

- helps prevent constipation
- reduces the risk of colon cancer
- improvement in gastrointestinal health
- improvement in glucose tolerance and insulin response
- reduction of hyperlipidemia, hypertension, and other coronary heart disease risk factors
- reduction in the risk of developing some cancers
- increase satiety and hence some degree of weight management.

A study of 388,000 adults ages 50 to 71 for nine years found that the highest consumers of fiber were 22% less likely to die over this period (Park, Subar, Hollenbeck and Schatzkin, 2011). In addition to lower risk of death from heart disease, adequate consumption of fibre-containing foods, especially grains, was also associated with reduced incidence of infectious and respiratory illnesses, particularly among males, and reduced risk of cancer-related death.

Fibre contributes less energy (measured in Calories or kilojoules) than sugars and starches because it cannot be fully absorbed by the body. Sugars and starches provide 4 Calories per gramme, and the human body has specific enzymes to break them down into glucose, fructose, and galactose, which can then be absorbed by the body. The human body lacks enzymes to break down fibre (Eastwood and Morris, 1992). Insoluble fibre is not metabolized by the body, so the body cannot absorb it and is said to contribute zero Calories per gramme (Stacewicz-Sapuntzakis, Bowen, Hussain, Damayanti-Wood and Farnsworth, 2001). Soluble fibre is partially fermented, with the degree of fermentability varying with the type of fibre, and contributes some energy when broken down and absorbed by the body. Dietitians have not reached a consensus on how much energy is actually absorbed, but some approximate around 2 Calories (8.5 kilojoules) per gramme of soluble fibre. Regardless of the type of fibre, the body absorbs fewer than 4 Calories (16.7 kilojoules) per gramme of fibre, which can create inconsistencies for actual product nutrition labels. In some countries, fibre is not listed on nutrition labels, and is considered zero Calories/gramme when the food's total Calories are computed. In other countries all fiber must be listed, and is considered 4.0 Calories per gramme when the food's total Calories are computed (because chemically fibre is a type of carbohydrate and other carbohydrates contribute 4.0 Calories per gramme). In the US, soluble fibre must be counted as 4 Calories per gramme, but insoluble fiber may be (and usually is) treated as zero Calories per gram and not mentioned on the label (Wong, Kim, Dufner-Beattie, Petris,, Andrews and Eide, 2006).

Current recommendations from the United States National Academy of Sciences, Institute of Medicine, suggest that adults should consume 20–35 grams of dietary fibre per day, but the average American's daily intake of dietary fibre is only 12–18 grammes (Scholz-Ahrens and Schrezenmeir, 2007).

2.5.6 Empty calories

Empty calories also known as a discretionary calorie, has the same energy content as any other calorie but lacks many accompanying nutrients such as vitamins, dietary minerals, antioxidants, amino acids, or dietary fiber (Angeloni, Leoncini, Malaguti, 2009). It is casual dietary terminology, and a measure of the digestible energy present in high-energy foods with little nutritional value. Examples are typically processed carbohydrates and ethanol (alcohol), and to some extent fats (Centre for Disease Control (CDC), 2011).

All people require certain essential nutrients; sedentary individuals and those eating less to lose weight may suffer malnutrition if they eat food supplying empty calories but not enough nutrients. People who engage in heavy physical activity need calories as fuel, which can be supplied by empty calories in addition to foods with essential nutrients, but caloric intake must be balanced with activity to maintain a proper body weight (Centers for Disease Control (CDC), 2013).

Eating a variety of nutritious foods every day protects against chronic illness and helps to maintain a healthy immune system (Dietary Guidelines for Americans, 2005). The following foods are often considered to contain mostly empty calories and may lead to weight gain: Cake, cookies, sweets, candy, ice cream, soft drinks, fruit-flavored beverages and gelatin and other foods containing added sugars (including High-fructose corn syrup, HFCS) Margarine or shortening, and other fats and oils (although some consumption of fats is essential to health), Beer, wine, and other alcoholic beverages (USDA, 2011). An excess intake of fat and a deficient intake of vitamins, minerals and trace elements are associated with the development of chronic diseases (Thiele *et al.*, 2003). To ensure that intakes meet recommended guidelines, public health organizations and dietitians need to develop practical educational strategies for making adequate food choices (Thiele *et al.*, 2003).

2.6 Diet Quality

The major focus of work in the area of dietary assessment in recent years has been to measure diet quality from diverse perspectives and in a comprehensive manner. Many suggest that a composite measure of diet is a preferred alternative to a single nutrient or food as a measure of diet quality (Kant, 1996; Gerber, 2001). WHO (1996) recommended that developing countries also should start implementing measures of dietary quality that capture both problems of nutrient deficiency and dietary excess and over nutrition. This is in recognition of the accelerated pace at which the nutrition transition is taking place in developing countries as a result of rapid economic development and urbanization.

Savy, Martin-Prével, Sawadogo, Kameli, and Delpeuch (2005) in their study in Burkina Faso demonstrated a link between dietary quality and adult women's nutritional status. In their study, they reported that those women who clearly had lower dietary scores were those who also had the worst nutritional status. Washi and Ageib (2010) in their study in Saudi Arabia found that poor diet quality and food habits are related to impaired nutritional status in 13- to 18-year-old adolescents in Jeddah. Malhotra and Passi (2007) on the study of diet quality and nutritional status of rural adolescent girl beneficiaries of Integrated Child Development Services (ICDS) in north India also revealed not only a high incidence of under-nutrition but also an inadequate energy/micronutrient intake among the beneficiaries of adolescent girl scheme.

James, Nelson, Ralph and Leather (1997) and Martikainen, Joutsenniemi, martelin, Kestila, Pirkola and Koskinen (2005) suggested that dietary factors may help explain some of the observed social inequities in health. The more affluent population subgroups are not only healthier and slimmer, but they also consume higher-quality diets than do the poor (Drewnowski and Darmon, 2005). Diet quality is affected not only by age and sex, but also by occupation, education, and income levels (Galobardes, Morabia and Bernstein, 2001; Groth, Fagt and Brondsted, 2001; Turrell, Hewitt, Patterson and Oldenburg, 2003) which are the conventional indexes of socioeconomic status (SES) or social class (Krieger, Williams and Moss, 1997). The different socioeconomic indicators appear to have similar, although independent, effects on nutrition and diet (Galobardes *et al.*, 2001; Groth *et al.*, 2001; Turrell *et al.*,2003 and Lallukka, Laaksonen, Rahkonen, Roos and Lahelma, 2007), Higher values of the Healthy Eating Index (Loughley, Basiotis, Zizza and Dinkins, 2004), Diet Quality Index (Patterson, Haines and Popkin, 1994), dietary variety (Worsley, Blashe and Crawford, 2003) and diversity scores (Kant and Braubard, 2007) and other diet-quality measures have all been associated with higher SES (Lallukka *et al.*, 2007, Dynesen, Haraldsdottir, Holm and Astrup, 2003; Robinson, Crozier, Borland, Hammond, Barker and Inskip, 2004; Kushi, Folsom, Jacobs, Luepker, Elmer and Blackburn, 1998; Shimakawa, Sorlie and Carpenter, 1994; Parker, Murphy and Wilkens, 2005).

The same positive relationship with SES was observed for dietary patterns (Martikainen *et al.*, 2005; Barker, McClean, Thompson and Reid, 1990). Similarly, studies of household food purchases, a proxy for food consumption found a positive relation between household SES and the quality (Turrell, *et al.*, 2003; Huot, Paradis, Receveur and Ledoux, 2004) and variety (Thiele *et al.*, 2003) of purchased diets. Direct Diets of lower SES groups were also characterized by more added fats (Groth *et al.*, 2001; Hupkens, Knibbe and Drop, 1997; VanRossum, van de, Witteman, Grobbee and Mackenbach., 2000; Hulshof, Lowik and Kok, 1991; Linseisen, Bergstrom and Gafa, 2002), although only a few studies distinguished between animal fats and vegetable fats. A study in France showed that children of semi-skilled and unskilled workers consumed significantly more sweets, bread, potatoes, cereals, and deli meats than did children from the upper SES group (Rolland-Cachera and Bellisle, 1986). In the United States, children and adolescents from low SES households consumed less fruit and vegetables (Xie, Gilliland, Li and Rockett, 2003; Neumark-Sztainer, Story, Hannan and Croll, 2002) and a more limited variety of produce (Kirby, Baranowski, Reynolds and Binkley, 1995). Children from families with lower education levels had the lowest fruit intakes and the highest consumption of sweetened beverages (Cullen, Ash, Warneke and de Moor, 2002).

As a result of paucity of studies on diet quality in Nigeria, this study will contribute to knowledge in understanding relevant factors that determine diet quality

2.6.1 Measurement of diet quality

Some of the dietary quality indices are:

1. **The Diet Quality Index- International (DQI-I):** This measures four major aspects of a high-quality, healthy diet (variety, adequacy, moderation and overall balance), covering nutritional concerns of both developed and developing countries. The DQI-I focuses on concerns related not only to chronic diseases but also to problems of under nutrition, thus providing a global tool for monitoring healthfulness of diet and for exploring aspects of diet quality related to the nutrition transition (Kim *et al.,* 2003). For calculation of dietary quality score using the method of Kim *et al.*, (2003) known as Diet Quality Index-International (DQI-I), five food groups are used. Namely grains, vegetables, meat/poultry/fish/egg, fruits and dairy and beans

2. **Healthy Eating Index (HEI):** The Healthy Eating Index (HEI) is a measure of diet quality based on nutrients and foods. It assesses adherence to US Food Guide Pyramid and Dietary Guidelines for Americans (Kennedy, Ohls, Carlson and Fleming, 1995). USDA's primary use of the HEI is to monitor the diet quality of the U.S. population and the low-income subpopulation.

3. Alternative Healthy Eating Index: In contrast to HEI, Alternative Healthy Eating Index (AHEI) acknowledges benefits of unsaturated oils, distinguishes quality within food groups, and excludes potato and its products from vegetable group (McCullough, Feskanich, Stampfer, Giovannucci, Rimm, *et al.*, 2002, Fung, Hu, McCullough, Newby, Willett and Holmes, 2006). It assesses whether Alternative Healthy Eating Index (AHEI) predicts disease risk better than Healthy Eating Index (HEI).

4. Diet Quality Index (DQI): Measures quality of diet that can reflect the risk of major diet-related chronic diseases based on nutrients: total fat, saturated fat, cholesterol, Protein, Ca, Na, serving from two food groups: vegetables and fruits, grains (Patterson, 1994, Seymour, Calle, Flagg, Coates, Ford and Thun, 2003).

5. Dietary Diversity Score (DDS): This measures dietary diversity by simple count of food groups consumed over a reference period (Swindale and Blinsky, 2005).

6. Healthy Food Index (HFI): This measures food intake patterns on basis of food recommendation. The health value of food is derived from the positions of such foods in the food guide pyramid, a guide to healthy eating in most national recommendations (Drescher, Thiele and Mensink, 2007).

7. Healthy Diet Indicator: This measure the quality of diet based on WHO recommendations for preventing chronic diseases (Huijbregts, *et al.*, 1997).
Measures of dietary quality range from simple indicators such as the percentage of energy from animal sources (Allen, Black, Backstrand, Pelto, Ely, Molina and Chavez, 1991) to complex indices that combine both nutrient and food components (Patterson *et al.*, 1994; Kennedy *et al.*, 1995; Haines, Siega-Riz, and Popkin 1999).

2.6.2 Tools for measuring Diet Quality

Food frequency questionnaire (FFQ) and 24-hour diet recall questionnaire are the main tools for determining diet quality (Murphy, 1996; Trichopoulou, Kouris-Blazos, Wahlqvist, Gnardellis, Lagiou, Polychronopoulos, *et al.*, 1995).

2.7 Nutrient Adequacy

Micronutrient deficiencies have been referred to as "hidden hunger" (WHO, 2005). Micronutrient deficiencies are observed to be extremely widespread, probably more so than malnutrition as assessed by inadequacy of energy intake or by anthropometry (Mason and Bassuk, 2001). It has been recognized that a diet rich in energy but lacking other essential components can lead to heart disease, diabetes, cancer and obesity (Frison *et al.*, 2004). These conditions are no longer associated only with affluence; they are on the increase among poorer people in developing countries, especially urban dwellers (Frison *et al.*, 2004). Lack of nutrients, aside from lack of energy, has profound effects economically as well as impacts on health and behaviour. One out of 3 people in the world are affected by one or multiple micronutrient deficiencies (WHO, 2006) and are, as a consequence, more susceptible to infection, birth defects and impaired physical and psycho-intellectual development. Increasing obesity levels and the attendant increase risk of non- communicable diseases, especially diabetes, are now global problems (WHO, 1996; Popkin, *et al.*, 1998 and

Mann, 2002). Micronutrient deficiencies of international interest include vitamin A, iron, iodine and zinc.

Different surveys of nutritional assessment in Nigeria reveal low intakes of protein, energy, iron, calcium, zinc, thiamin, and riboflavin in almost all age groups and in both sexes (Igbedioh, 1993; Ene-Obong *et al.*, 2003). The Nigerian Food Consumption and Nutrition data showed that 29.5% of children had marginal vitamin A deficiency, while 13% of mothers and 19.2% of pregnant women were at risk of vitamin A deficiency. The study also showed that 20% of the children were both iron and zinc deficient, while 14.5%, 8% and 4% had mild, moderate and severe iodine deficiencies (Maziya-Dixon et *al.*, 2004). The adolescents study showed that despite adequate intakes of vitamin A, 40% of male and 32% of female adolescents had low plasma concentration of vitamin A (Ene-Obong *et al.*, 2003).

Many people in the developing world are abandoning traditional diets that are rich in fibre and grain for diets that include increased levels of sugars, oils, and animal fats. Traditional eating patterns of various cultures around the world have been associated with reduced risk for chronic diseases (Willett, 1994; Willett, Sacks and Trichopoulou, 1995). The role of diet in the etiology of most non-communicable diseases is well established. Non-communicable diseases are linked to high consumption of energy dense foods made of animal origin and of foods processed or prepared with added fat, sugar and salt. The shifts towards highly refined foods and towards meat and dairy products containing high levels of saturated fats, (i.e. the nutrition transition), now increasingly evident in middle income and lower-income countries, have, together with reduced energy expenditure, contributed to rises in the incidence of obesity and non-communicable diseases (NCCDs) (Popkin, 2001). Chronic non-communicable diseases are defined as diseases or conditions that occur in, or are known to affect, individuals over an extensive period of time and for which there are no known causative agents that are transmitted from one affected individual to another. These conditions have been associated with excessive consumption of one or more nutrients. They include diabetes, hypertension, obesity, cardiovascular disease (CVD), cancers, osteoporosis and dental disease. WHO estimated in 1997 that, non-communicable diseases would become the principal global causes of morbidity and mortality (WHO, 1996; Farid *et al.*, 2010).

Non-Communicable Chronic Diseases (NCCDs) accounted for 60% of global deaths and 47% of the global burden of disease (WHO, 2005). It is expected that by

2020, NCCD will account for 73% of deaths and 60% of disease burden (Shetty, 2002). According to Schmidhuber and Shetty (2005), NCCDs account for at least 40% of all deaths in developing countries and represent an even greater proportion of loss of disability adjusted life years (DALYs). In Africa, they constitute 23% of all deaths (WHO, 2005). They constitute an immense and growing global health problem imposing additional economic and health burden on developing countries. In Europe and North America, fat and sugar account for more than half the caloric intake, and consumption of refined grains has largely replaced that of whole grains (in USA, 98% of wheat flour is refined) (Allison, Zannolli and Narayan, 1999). It is widely accepted that chronic non-communicable diseases are largely due to preventable and modifiable risk factors such as obesity, lack of exercise, unhealthy diet, tobacco use and inappropriate use of alcohol (Hirsch and Peng, 1996). Diet and nutrition is a major modifiable determinant of chronic non communicable diseases, with scientific evidence (Shetty, 2002).

Urbanization is a major risk factor in the non-communicable diseases epidemic. Studies have shown that urbanization leads to dietary changes towards adoption of 'western diet', which is high in animal proteins, fat and sugar (Drewnowski and Popkin, 1997). A westernized lifestyle consisting of cheap and readily available processed foods coupled with reduced physical activity have created an epidemic of over-nutrition resulting in overweight/obesity. It is now emerging that this diet is the cause of many of the diseases we encounter today (WHO, 2005). Recent studies suggest that nutrition related chronic diseases are increasingly becoming a major health threat, particularly in those regions in rapid nutrition transition (Murray and Lopez, 1996). In a "nutrition transition", the consumption of foods high in fats and sweeteners is increasing throughout the developing world, while the share of cereals is declining; intake of fruits and vegetables remains inadequate (Popkin, 1998). These poor quality diets are associated with rising rates of overweight, obesity and diet-related chronic diseases, like heart disease, diabetes and some cancers. More people now die of heart disease in developing countries than in developed, and the problem is becoming more serious among the poor (WHO, 2005). Another element of nutrition transition is the increasing importation of foods from the industrialized world. As a result, traditional diets featuring grains and vegetables are giving way to meals high in fat and sugar. As poor countries become more prosperous, they acquire some of the benefits along with some of the problems of industrialized nations. Both food insecurity and nutrition transition are characterized by the simplification of diets leading to a reduction in the consumption of diverse, nutritionally-rich and functionally-healthy plant foods (John and Eyzaguirre, 2006). Major dietary change includes a large increase in the consumption of fat and added sugar in the diet, often a marked increase in animal food products contrasted with a fall in total cereal intake and fibre.

2.7.1 Macronutrients

Macronutrients are nutrients that provide calories or energy. Nutrients are substances needed for growth, metabolism, and for other body functions. Since "macro" means large, macronutrients are nutrients needed in large amounts. There are three macronutrients: Carbohydrate, Protein, Fat, while each of these macronutrients provides calories, the amount of calories that each one provides varies (Greger, 2000).

Carbohydrate provides 4 calories per gram; Protein provides 4 calories per gram, Fat provides 9 calories per gram. Besides carbohydrate, protein, and fat the only other substance that provides calories is alcohol. Alcohol provides 7 calories per gram. Alcohol, however, is not a macronutrient because we do not need it for survival. Although macronutrients are very important they are not the only things that we need for survival. Our bodies also need water (6-8 glasses a day) and micronutrients.

Micronutrients are nutrients that our bodies need in smaller amounts, and include vitamins and minerals.

a. Carbohydrates

Carbohydrates are the macronutrient that we need in the largest amounts. According to the Dietary Reference Intakes published by the USDA (2010), 45% - 65% of calories should come from carbohydrate. We need this amount of carbohydrate because:

• Carbohydrates are the body's main source of fuel.
• Carbohydrates are easily used by the body for energy.
• All of the tissues and cells in our body can use glucose for energy.
• Carbohydrates are needed for the central nervous system, the kidneys, the brain, the muscles (including the heart) to function properly.
• Carbohydrates can be stored in the muscles and liver and later used for energy.
• Carbohydrates are important in intestinal health and waste elimination.

• Carbohydrates are mainly found in starchy foods (like grain and potatoes), fruits, milk, and yogurt. Other foods like vegetables, beans, nuts, seeds and cottage cheese contain carbohydrates, but in lesser amounts (Leung, 2007).

b. Protein

According to the Dietary Reference Intakes published by the USDA (2010) 10% - 35% of calories should come from protein. Most Americans get plenty of protein, and easily meet this need by consuming a balanced diet. Escott-stump (2008) enumerated that we need protein for:

• Growth (especially important for children, teens, and pregnant women)
• Tissue repair
• Immune function
• Making essential hormones and enzymes
• Energy when carbohydrate is not available
• Preserving lean muscle mass

Protein is found in meats, poultry, fish, meat substitutes, cheese, milk, nuts, legumes, and in smaller quantities in starchy foods and vegetables. When we eat these types of foods, our body breaks down the protein that they contain into amino acids (the building blocks of proteins). Some amino acids are essential which means that we need to get them from our diet, and others are nonessential which means that our body can make them. Protein that comes from animal sources contains all of the essential amino acids that we need. Plant sources of protein, on the other hand, do not contain all of the essential amino acids (Woolf, Fu and Basu, 2011).

Proteins are essential nutrients needed by human body for growth and maintenance (Hermann, 2013). They are one of the major building blocks of body tissue, and can also serve as a fuel source. As fuel, proteins provide 4 kcal per gramme, just like carbohydrates, and unlike lipids, which contain 9 kcal per gramme. Aside from water, proteins are the most abundant kind of molecules in the body. Protein can be found in all cells of the body and is the major structural component of all cells in the body, especially muscle (Hermann, 2013; Food and Nutrition Board (FNB), 2005). This also includes body organs, hair and skin. Proteins also are utilized in membranes, such as glycoproteins. When broken down into amino acids, they are used as precursors to nucleic acid, co-enzymes, hormones, immune response, cellular repair and molecules essential for life and it is needed to form blood cells (Nutrition Working

Group of the International Olympic Committee 2003; FNB, 2005). In nutrition, proteins are broken down in the stomach during digestion by enzymes known as proteases into smaller polypeptides to provide amino acids for the body (Genton, Melzer and Pichard, 2010).

Amino acids can be divided into three categories: essential amino acids, non-essential amino acids and conditional amino acids. Essential amino acids cannot be made by the body in sufficient amount and must be supplied by food. Non-essential amino acids are made by the body from essential amino acids or in the normal breakdown of proteins. Conditional amino acids are usually not essential, except in times of illness, stress or for someone challenged with a lifelong medical condition (Food and nutrition board, 2005).

Essential amino acids are leucine, isoleucine, valine, lysine, threonine, tryptophan, methionine, phenylalanine and histidine. Non-essential amino acids include alanine, asparagine, aspartic acid and glutamic acid. Conditional amino acids include arginine, cysteine, glutamine, glycine,serine, and tyrosine (USDA, 2010).They are found in animal sources such as meats, milk, fish and eggs, as well as in plant sources such as whole grains, pulses, legumes, soy, fruits, nuts and seeds. Vegetarians and vegans can get enough essential amino acids by eating a variety of plant proteins (USDA, 2010).

A wide range of foods are sources of proteins. The best combination of protein sources depends on the region of the world, access, cost, amino acid types and nutrition balance, as well as acquired tastes. Some foods are high in certain amino acids, but their digestibility and the anti-nutritional factors present in these foods make them of limited value in human nutrition, hence, one must consider digestibility and secondary nutrition profile such as calories, cholesterol, vitamins and essential mineral density of the protein source (Vernon and Peter, 1994). Worldwide, plant protein foods contribute over 60 percent of the per capita supply of protein on average. In North America, animal-derived foods contribute about 70 percent of protein sources.Meat, eggs and fish are sources of complete protein. Milk and milk-derived foods are also good sources of protein (Steinke, 1992).

Whole grains and cereals are another source of proteins. However, these tend to be limiting in the amino acid lysine or threonine, which are available in other vegetarian sources and meats. Examples of food staples and cereal sources of protein, each with a concentration greater than 7 percent, are (in no particular order) buckwheat, oats, rye, millet, maize (corn), rice, wheat, spaghetti, burger, sorghum, amaranth, and quinoa (Oyunga-Ogubi *et al.*, 2009).

Vegetarian sources of proteins include legumes, nuts, seeds and fruits. Legumes, some of which are called pulses in certain parts of the world, have higher concentrations of amino acids and are more complete sources of protein than whole grains and cereals. Examples of vegetarian foods with protein concentrations greater than 7 percent include soybeans, lentils, kidney beans, white beans, mung beans, chickpeas, cowpeas, lima beans, pigeon peas, lupines, wing beans, almonds, Brazil nuts, cashews, pecans, walnuts, cotton seeds, pumpkin seeds, sesame seeds, and soya seeds (Vernon and Peter, 1994).

Food staples that are poor sources of protein include roots and tubers such as yams, cassava and sweet potato. Plantains, another major staple, are also poor source of essential amino acids. Fruits, while rich in other essential nutrients, are poor source of amino acids per 100 gram consumed. The protein content in roots, tubers and fruits is between 0 and 2 percent. Food staples with low protein content must be complemented with foods with complete, quality protein content for a healthy life; particularly in children, for proper development (Hermann, 2013; Latham, 1997).

c. Fats and oils

Fats consist of a wide group of compounds that are generally soluble in organic solvents and generally insoluble in water (Ralet, Saulnier and Thibault, 1993). Chemically, fats are triglycerides, triesters of glycerol and any of several fatty acids. Fats may be either solid or liquid at room temperature, depending on their structure and composition. Fats and oils include cooking oil, butter, margarine and shortening. The food pyramid advises that fats be consumed sparingly (Samaha, Iqbi and Seshadri, 2003).

There are four major types of fats:

- Monounsaturated fats
- Polyunsaturated fats
- Saturated fats
- Trans fats

Monounsaturated and polyunsaturated fats are known as the "good fats" because they are good for the heart, cholesterol, and overall health (Siri-Tarino, Sun, Hu and Krauss, 2010). Bad fats increase cholesterol and risk of certain diseases, while good fats protect the heart and support overall health. In fact, good fats—such as omega-3 fats—are essential to physical and emotional health. Saturated and Trans fats are known as the “bad fats” because they increase the risk of disease and elevate cholesterol level in the blood. Appearance-wise, saturated and Trans fats tend to be solid at room temperature (e.g butter or traditional stick margarine), while monounsaturated and polyunsaturated fats tend to be liquid (e.g Olive or corn oil). Healthy sources of fat can be found in fish, nuts, and certain fruits and vegetables e.g.avocados.

Saturated fat is fat that consists of triglycerides containing only saturated fatty acids. Saturated fatty acids have no double bonds between the individual carbon atoms of the fatty acid chain. That is, the chain of carbon atoms is fully "saturated" with hydrogen atoms (Siri-Tarino *et al.,* 2010). There are many kinds of naturally occurring saturated fatty acids, which differ mainly in number of carbon atoms, from 3 carbons (propionic acid) to 36 (hexatriacontanoic acid) (World Health Organization/ Food and Agriculture Organization (WHO/FAO) Expert Consultation, 2003).

Various fats contain different proportions of saturated and unsaturated fat. Examples of foods containing a high proportion of saturated fat include animal fats such as cream, cheese, butter, and ghee; suet, tallow, lard, and fatty meats; as well as certain vegetable products such as coconut oil, cottonseed oil, palm kernel oil, chocolate, and many prepared foods (Darwin, 2011).While nutrition labels regularly combine them, the saturated fatty acids appear in different proportions among food groups. Lauric and myristic acids are most commonly found in "tropical" oils (e.g., palm kernel, coconut) and dairy products. The saturated fat in meat, eggs, chocolate, and nuts is primarily the triglycerides of palmitic and stearic acids (WHO/FAO, 2003).

Since the 1950s, it has been commonly believed that consumption of foods containing high amounts of saturated fatty acids (including meat fats, milk fat, butter, lard, coconut oil, palm oil, and palm kernel oil) is potentially less healthy than consuming fats with a lower proportion of saturated fatty acids. Sources of lower saturated fat but higher proportions of unsaturated fatty acids include olive oil, peanut oil, canola oil, avocados, safflower, corn, soy, and cottonseed oils (WHO/FAO, 2003).There are strong, consistent, and graded relationships between saturated fat intake, blood cholesterol levels, and the mass occurrence of cardiovascular disease(D’Elia, Barba, Cappuccio and Strazzullo, 2011). Abnormal blood lipid levels, that is high total cholesterol, high levels of triglycerides, high levels of low-density lipoprotein (LDL, "bad" cholesterol) or low levels of high-density lipoprotein (HDL, "good" cholesterol) cholesterol all increase the risk of heart disease and stroke (Hooper, Summerbell, Thompson, Sills, Roberts, Moore and Smith, 2011).

In 2003, the World Health Organization (WHO) and Food and Agriculture Organization (FAO) expert consultation report concluded that "intake of saturated fatty acids is directly related to cardiovascular risk. The traditional target is to restrict the intake of saturated fatty acids to less than 10% of daily energy intake and less than 7% for high-risk groups. If populations are consuming less than 10%, they should not increase that level of intake. Within these limits, intake of foods rich in myristic and palmitic acids should be replaced by fats with a lower content of these particular fatty acids. In developing countries, however, where energy intake for some population groups may be inadequate, energy expenditure is high and body fat stores are low (BMI <18.5 kg/m^2). The amount and quality of fat supply has to be considered keeping in mind the need to meet energy requirements. Specific sources of saturated fat, such as coconut and palm oil, provide low-cost energy and may be an important source of energy for the poor "WHO/FAO Expert Consultation (2003).

Meta-analyses have found a significant relationship between saturated fat and serum cholesterol levels (Clarke, Frost, Collins, Appleby, Peto, 1997). High total cholesterol levels, which may be caused by many factors, are associated with an increased risk of cardiovascular disease (Bucher, Griffith and Guyatt, 1999). However, other indicators measuring cholesterol such as high total/HDL cholesterol ratio are more predictive than total serum cholesterol (Bucher, *et al.*, 1999). In a study of myocardial infarction in 52 countries, the ApoB/ApoA1 (Apolipoproteins B/ Apolipoproteins AI) (related to LDL and HDL, respectively) ratio was the strongest predictor of CVD among all risk factors (European Society of Cardiology (ESC), 2007). There are other pathways involving obesity, triglyceride levels, insulin sensitivity, endothelial function, and thrombogenicity, among others, that play a role in CVD, although it seems, in the absence of an adverse blood lipid profile, the other known risk factors have only a weak atherogenic effect (ESC, 2007). Different saturated fatty acids have differing effects on various lipid levels (ESC, 2007).

Most ingested cholesterol is esterified, and esterified cholesterol is poorly absorbed. The body also compensates for any absorption of additional cholesterol by reducing cholesterol synthesis (John, Sorokin and Thompson, 2007). For these reasons, cholesterol intake in food has little, if any, effect on total body cholesterol content or concentrations of cholesterol in the blood. Cholesterol is recycled. The liver excretes it in a non-esterified form (via bile) into the digestive tract. Typically about 50% of the excreted cholesterol is reabsorbed by the small bowel back into the bloodstream. Some plants make cholesterol in very small amounts. Plants manufacture phytosterols (substances chemically similar to cholesterol produced within plants), which can compete with cholesterol for reabsorption in the intestinal tract, thus potentially reducing cholesterol reabsorption (USDA, 2011). When intestinal lining cells absorb phytosterols, in place of cholesterol, they usually excrete the phytosterol molecules back into the GI tract, an important protective mechanism (John *et al.*, 2007).

All foods containing animal fat contain cholesterol to varying extents. Major dietary sources of cholesterol include cheese, egg yolks, beef, pork, poultry, fish, and shrimp (Centre for Disease Control, (CDC), 2013). Human breast milk also contains significant quantities of cholesterol. From a dietary perspective, cholesterol is not found in significant amounts in plant sources (William, 2003). Biosynthesis of cholesterol is directly regulated by the cholesterol levels present, though the homeostatic mechanisms involved are only partly understood (Espenshade and Hughes, 2007). A higher intake from food leads to a net decrease in endogenous production; whereas lower intake from food has the opposite effect. Abnormally low levels of cholesterol are termed hypocholesterolemia. Research into the causes of this state is relatively limited, but some studies suggest a link with depression, cancer, and cerebral hemorrhage (Foote *et al.*, 2004). In general, the low cholesterol levels seem to be a consequence, rather than a cause, of an underlying illness. A genetic defect in cholesterol synthesis causes Smith-Lemli-Opitz syndrome, which is often associated with low plasma cholesterol levels (Lewington, Whitlock, Clarke, Sherliker, Emberson, Halsey, Qizilbash, Peto and Collins, 2007).

The consumption of saturated fat is generally considered a risk factor for dyslipidemia, which in turn is a risk factor for some types of cardiovascular disease (Christopher and Patrick, 2007). A meta-analysis published in 2003 found a significant positive relationship in both control and cohort studies between saturated fat and breast cancer. However two subsequent reviews have found weak or insignificant associations of saturated fat intake and breast cancer risk, and note the prevalence of confounding factors (Freedman, Kipnis, Schatzkin and Potischman, 2008). Also a systematic literature review published by the World Cancer Research Fund and the American Institute for Cancer Research in 2007 found limited but consistent evidence for a positive relationship between animal fat and colorectal cancer (ESC, 2007). Huncharek and Kupelnick (2001) in a meta-analysis of eight observational studies found a statistically significant positive relationship between saturated fat and ovarian cancer. Some researchers also have indicated that serum myristic acid (Männistö, Pietinen and Virtanen, 2003) and palmitic acid and dietary myristic and palmitic saturated fatty acids and serum palmitic combined with alpha-tocopherol supplementation are associated with increased risk of prostate cancer in a dose-dependent manner. These associations may, however, reflect differences in intake or metabolism of these fatty acids between the pre-cancer cases and controls, rather than being an actual cause (Crowe, Allen and Appleby, 2008).

Mounting evidence indicates that the amount and type of fat in the diet can have important effects on bone health. Most of this evidence is derived from animal studies. The data from one study indicated that bone mineral density is negatively associated with saturated fat intake, and that men may be particularly vulnerable (Crowe, *et al.*, 2008).

2.7.2 Micronutrients

Micronutrients are those nutrients we require in relatively small quantities (Weisburger, 2000). They are vitamins and minerals, and are required in milligram and microgram amounts.

a. Mineral

Major minerals are the ones that the body requires in amounts of at least 100 milligrams per day. They are sodium, potassium, chloride, phosphorus, calcium, magnesium and sulfur. The minerals that the body requires in amounts less than 100 milligrams per day are referred to as trace minerals (Weisenberger, 2014). They are chromium, copper, fluoride, iodine, iron, manganese, molybdenum, selenium and zinc. Minerals do not contain carbon, and are not destroyed by heat or light. Unlike other nutrients, minerals are in their simplest chemical form. Minerals are elements.Whether found in bone, seashells, cast iron pots or the soil, they are they same as the minerals in our food and our bodies. The mineral content of plant foods varies with the soil content and the maturation of the plant.

i. Iron

Iron, one of the most abundant metals on earth, is essential to most forms of life and to normal human physiology. Iron is an integral part of many proteins and enzymes that maintain good health. In humans, iron is an essential component of proteins involved in oxygen transport (Dallman, 1986). It is also essential for the regulation of cell growth and differentiation (Bothwell, Charlton, Cook and Finch, 1979; Andrews, 1999).

There are two forms of dietary iron: haeme and nonhaeme. Haeme iron is derived from haemoglobin, the protein in red blood cells that delivers oxygen to cells. Haeme iron is found in animal foods that originally contained haemoglobin. A deficiency of iron limits oxygen delivery to cells, resulting in fatigue, poor work performance, and decreased immunity (Haas and Brownlie, 2001; Bhaskaram, 2001). On the other hand, excess amount of iron can result in toxicity and even death (Corbett, 1995). Almost two-thirds of iron in the body is found in haemoglobin, the protein in red blood cells that carries oxygen to tissues. Smaller amount of iron is found in myoglobin, a protein that helps supply oxygen to muscle; and in enzymes that assist biochemical reactions. Iron is also found in proteins that store iron for future needs and that transport iron in the blood. Iron stores are regulated by intestinal iron absorption (Miret, Simpson and McKie, 2003).

Iron absorption refers to the amount of dietary iron that the body obtains and uses from food. Healthy adults absorb about 10% to 15% of dietary iron, but individual absorption is influenced by several factors (Bothwell *et al.*, 1979; Monson, 1988; Hallberg, Hulten and Gramatkovski, 1997; Sandberg, 2002; Miret *et al.*, 2003; Uzel and Conrad, 1998 and Davidsson, 2003). Storage levels of iron have the greatest influence on iron absorption. Iron absorption increases when body stores are low. When iron stores are high, absorption decreases to help protect against toxic effects of iron overload (Bothwell *et al.*, 1979). Iron absorption is also influenced by the type of dietary iron consumed. Absorption of haeme iron from meat proteins is efficient. Absorption of haeme iron ranges from 15% to 35%, and is not significantly affected by diet (Monson, 1988). In contrast, 2% to 20% of non-haeme iron in plant foods such as rice, maize, black beans, soybeans and wheat is absorbed (Tapiero, 2011). Non-haeme iron absorption is significantly influenced by various food components (Bothwell *et al.*, 1979; Monson, 1988; Hallberg et al., 1997; Uzel and Conrad, 1998; Sandberg, 2002; Davidsson, 2003).

Meat proteins and vitamin C improve the absorption of non-haeme iron (Siegenberg, Baynes, Bothwell, Macfarlane, Lamparelli, Car *et al.*, 1991; Hunt, 1994). Tannins (found in tea), calcium, polyphenols, and phytates (found in legumes and whole grains) can decrease absorption of nonheme iron (Brune, Rossander and Hallberg, 1989; Hallberg, Brune, Erlandsson, Sandberg and Rossander-Hutlen, 1991; Cook, Reddy, Burri and Hurrell, 1997; Minihane and Fairweather-Tair, 1998; Samman, Sandstrom, Toft, Bukhave, Jensen, Sorensen and Hansen, 2001). Some proteins found in soybeans also inhibit non-haeme iron absorption (Lynch, Dassenko, Cook, Juillerat and Hurrell, 1994). It is most important to include foods that enhance non-haeme iron absorption when daily iron intake is less than recommended, when iron losses are high (which may occur with heavy menstrual losses), when iron requirements are high (as in pregnancy), and when only vegetarian non-haeme sources of iron are consumed.

ii. Sodium

Sodium occurs naturally in most foods. The most common form of sodium is sodium chloride, which is table salt. Sodium chloride (table salt, NaCl) is vital for good nutrition. Sodium ions facilitate transmission of electrical signals in the nervous system and regulate the water balance between body cells and body fluids (Mayo Clinic Staff, 2011). Milk, beets, and celery also naturally contain sodium, as does drinking water; although the amount varies depending on the source, Sodium is also added to various food products. Some of these added forms are monosodium glutamate, sodium nitrite, sodium saccharin, baking soda (sodium bicarbonate), and sodium benzoate (Dietary Reference Intakes (DRI), 2005). These are found in items such as Worcestershire sauce, soy sauce, onion salt, garlic salt, and bouillon cubes. Processed meats, such as bacon, sausage, ham, canned soups and vegetables are examples of foods that contain added sodium. Fast foods are generally very high in sodium. It is estimated that one out of three Americans who will develop high blood pressure, a high-sodium diet may be to blame (Haines, 2001). Cardiovascular diseases are the leading cause of death worldwide, and high blood pressure is a major risk factor. In some people, sodium increases blood pressure because it holds excess fluid in the body, creating an added burden on the heart. Salt Austrialia, (2011) reported that too much sodium in the diet may also have other harmful health effects, including increased risk for stroke, heart failure, osteoporosis, and stomach cancer and kidney disease.

iii. Calcium

Calcium is a mineral found in many foods. The body needs calcium to maintain strong bones and to carry out many important functions. Approximately 99 percent of the body's calcium is stored in the bones and teeth (Dietary Supplement Fact, 2011), where it supports their structure and hardness. The body also needs calcium for muscles to move and for nerves to carry messages between the brain and every part of the body (Heaney and Rafferty, 2001). In addition, calcium is used to help blood vessels move blood throughout the body and to help release hormones and enzymes that affect almost every function in the human body (Food and Nutrition Board, 2005). By eating a variety of foods such as; Milk, yogurt, and cheese the recommended amount of Calcium can be met. Non-dairy sources include vegetables such as Chinese cabbage, kale, and broccoli. Spinach provides calcium, but its bioavailability is poor. Most grains do not have high amounts of calcium unless they are fortified; however, they contribute calcium to the diet because they contain small amounts of calcium and people consume them frequently.

Not all calcium consumed is actually absorbed in the gut. Humans absorb about 30% of the calcium in foods, but this varies depending upon the type of food consumed, age, intake of vitamin D, presence of Calcium antagonists like Pytate and Oxalate etc.

Age and life stage: Net calcium absorption is as high as 60% in infants and young children, who need substantial amounts of the mineral to build bone (National Institutes of Health, 1994; Committee Review of Dietary Reference Intakes, 2010). Absorption decreases to 15%–20% in adulthood (though it is increased during pregnancy) and continues to decrease as people age; compared with younger adults, recommended calcium intakes are higher for females older than 50 years and for both males and females older than 70 years (Heaney, Recker, Stegman and Moy, 1989; National Institutes of Health, 1994; Committee Review of Dietary Reference Intakes, 2010).

Vitamin D intake: This nutrient, obtained from food and produced by skin when exposed to sunlight of sufficient intensity, improves calcium absorption (Committee Review of Dietary Reference Intakes, 2010).

Other components in food: Phytic acid and oxalic acid, found naturally in some plants, bind to calcium and can inhibit its absorption. Foods with high levels of oxalic acid include spinach, collard greens, sweet potatoes, rhubarb, and beans. Among the foods high in phytic acid are fiber-containing whole-grain products and wheat bran, beans, seeds, nuts, and soy isolates. The extent to which these factors affect calcium absorption varies. Research shows, for example, that eating spinach and milk at the same time reduces absorption of the calcium in milk. In contrast, wheat products (with the exception of wheat bran) do not appear to lower calcium absorption (Weaver and Heaney, 1991). For people who eat a variety of foods, these interactions probably have little or no nutritional consequence and, furthermore, are accounted for in the overall calcium DRIs. Some absorbed calcium is eliminated from the body in urine, faeces, and sweat. This amount is affected by such factors as the following:

Sodium and protein intakes: High sodium intake increases urinary calcium excretion (Heaney, 1996; Weaver, Proulx and Heaney, 1999). High protein intake also increases calcium excretion and was therefore thought to negatively affect calcium status (Heaney, 1996; Weaver *et al,* 1999). However, more recent research suggests that high protein intake also increases intestinal calcium absorption, effectively offsetting its effect on calcium excretion, so whole body calcium retention remains unchanged (Kerstetter, O'Brien, Caseria, Wall and Insogna, 2005).

Caffeine intake: This stimulant in coffee and tea can modestly increase calcium excretion and reduce absorption (Barrett-Connor, Chang and Edelstein, 1994). One cup of regular brewed coffee, for example, causes a loss of only 2–3 mg of calcium (Heaney, 1996).

Alcohol intake: alcohol intake can affect calcium status by reducing its absorption (Hirsch, 1996) and by inhibiting enzymes in the liver that help convert vitamin D to its active form (U.S. Department of Agriculture Human Nutrition Information Service, 1996). However, the amount of alcohol required to affect calcium status and whether moderate alcohol consumption is helpful or harmful to bone is unknown.

Phosphorus intake: the effect of this mineral on calcium excretion is minimal. Several observational studies suggest that consumption of carbonated soft drinks with high levels of phosphate is associated with reduced bone mass and increased fracture risk. However, the effect is probably due to replacing milk with soda rather than the phosphorus itself (Calvo, 1993; Heaney and Rafferty, 2001).

Fruit and vegetable intakes: metabolic acids produced by diets high in protein and cereal grains increase calcium excretion (Fenton, Eliasziw, Lyon, Tough and Hanley, 2008). Fruits and vegetables, when metabolized, shift the acid/base balance of the body towards the alkaline by producing bicarbonate, which reduces calcium excretion. However, it is unclear if consuming more fruits and vegetables affects bone mineral density. These foods, in addition to reducing calcium excretion, could possibly reduce calcium absorption from the gut and therefore have no net effect on calcium balance. In most people, these factors have little effect on calcium status. The amount of calcium you need each day depends on your age. 1,000 mg is the recommended dietary allowance for Adults 19–50 years.

Insufficient intakes of calcium do not produce obvious symptoms in the short term because the body maintains calcium levels in the blood by taking it from bone. Over the long term, intakes of calcium below recommended levels have health consequences, such as causing low bone mass (osteopenia) and increasing the risks of osteoporosis and bone fractures especially in older individuals (Committee to Review Dietary Reference Intakes for Vitamin D and Calcium, Food and Nutrition Board, Institute of Medicine, 2010).

Symptoms of serious calcium deficiency include numbness and tingling in the fingers, convulsions, and abnormal heart rhythms that can lead to death if not corrected (Dawson-Hughes, Heaney, Holick, Lips, Meunier and Vieth, 2005). These symptoms occur almost always in people with serious health problems or who are undergoing certain medical treatments.

iv. Phosphorus

Phosphorus is an essential macromineral. To be healthy this nutrient must be included in the diet. Phosphorus is the second most abundant mineral nutrient in the body, after calcium (Hirsch and Peng, 1996). This mineral is part of all cells, especially cell membranes, and is essential to bone strength, because it's the main structural component of bones and teeth, as calcium phosphate. Phosphorus is also an important element in energy production. Phosphorus functions in bones and teeth and in cell energy production. The main energy-storage molecule, adenosine triphosphate (ATP) contains phosphorus. It also helps synthesize protein and is part of phospholipids (fat molecules), such as lecithin, which cells use to make membranes (Calvo, 1993).

Dietary sources include almost all foods but the amounts of phosphorus are greater in animal products and high-protein foods like meats, fowl, fish, eggs, and dairy. Nuts, seeds, and many vegetables are rich in phosphorus as well (Hirsch and Peng, 1996). Sodas and other drinks containing phosphoric acid may cause excessive amounts of phosphorus intake, which can interfere with proper calcium metabolism. The optimum calcium to phosphorus ratio is approximately 1:1. Phosphorus deficiency and toxicity are not very predominant; excesses of phosphorus may alter calcium balance, and phosphorus deficiency may lead to energy and metabolic problems (Hirsch and Peng, 1996). Adults need about 800 mg daily.

v. Potassium

The potassium cation is a nutrient necessary for human life and health. Potassium chloride is used as a substitute for table salt by those seeking to reduce sodium intake so as to control hypertension (D'Elia *et al.*, 2011). Epidemiological studies and studies in animals subject to hypertension indicate that diets high in potassium can reduce the risk of hypertension and possibly stroke (by a mechanism independent of blood pressure), and a potassium deficiency combined with an inadequate thiamine intake has produced heart disease in rats (Mann, 2002).

A potassium intake sufficient to support life can in general be guaranteed by eating a variety of foods. Clear cases of potassium deficiency (as defined by symptoms, signs and a below-normal blood level of the element) are rare in healthy individuals. Foods rich in potassium include parsley, dried apricots, dried milk, chocolate, various nuts (especially almonds and pistachios), potatoes, bamboo shoots, bananas, avocados, soybeans, and bran, although it is also present in sufficient quantities in most fruits, vegetables, meat and fish.

Individuals suffering from kidney diseases may suffer adverse health effects from consuming large quantities of dietary potassium. USDA (2010) reported that end stage renal failure patients undergoing therapy by renal dialysis must observe strict dietary limits on potassium intake, as the kidneys control potassium excretion, and build up of blood concentrations of potassium (hyperkalemia) may trigger fatal cardiac arrhythmia. The USDA lists tomato paste, orange juice, beet greens, white beans, potatoes, bananas and many other good dietary sources of potassium, ranked in descending order according to potassium content (USDA, 2010).

There is some debate regarding the optimal amount of dietary potassium. For example, the 2004 guidelines of the Institute of Medicine specify a DRI of 4,700 mg of potassium (100 mEq), though most Americans consume only half that amount per day, which would make them formally deficient as regards this particular recommendation (DRI, 2005). Likewise, in the European Union, in particular in Germany and Italy, insufficient potassium intake is somewhat common (Karger, 2004). Italian researchers reported in a 2011 meta-analysis that a 1.64 g higher daily intake of potassium was associated with a 21% lower risk of stroke (USDA, 2010).

vi. Magnesium

Magnesium (mg) is an activator of numerous enzyme systems which control carbohydrate, fat and electrolyte metabolism, nucleic acid and protein synthesis, and membrane transport and integrity (Figoni, 2010). Metabolic balance studies indicate that certain nutrients and stress conditions increase the need for Mg.

The RDAs for Magnesium are 300 mg for young women and 350 mg for young men (4.5-5 mg/kg/day). The RDAs for 15- to 18-year-old boys and pregnant and lactating women are estimated at 400 and 450 mg respectively (Mozie, 2000). The recommendation for older children is that sufficient Magnesium be consumed to provide for needs during growth. Balance studies, however, indicate that adolescent girls require 6-10 mg/kg/day, while adolescent boys seem to need even more (Seelig, 1981). The RDAs for infants (50-70 mg or 4-10 mg/kg/day) are based on the amounts in human milk and infant formulas and are presumed to provide an infant’s entire need. But, infants may need as much as 15-20 mg/kg/day depending on their rates of growth and composition of their diets (Schmidl and Labuza, 2000). While it is also assumed that infant formulas provide enough Magnesium to meet an infant's need, it is significant that the formula-fed infants studied were barely in Magnesium equilibrium rather than in positive balance necessary for growth (Seelig, 1981). It is noteworthy that although infant formulas contain higher levels of Magnesium than mother milk, plasma Magnesium levels of bottle-fed infants were lower than breast-fed (Schmidl and Labuza, 2000).

The RDAs for Mg may not be optimal for most people. Attempts to redefine Mg requirements should take into account factors known to increase the need for Mg, such as excesses of some nutrients and of stress. Thus, studies conducted in metabolic units may yield misleading results because subjects are protected from uncontrolled dietary and stress factors. The Recommended Dietary Allowances (RDA) for adults is 300-400 mg per day (Seelig, 1981).

A Mg deficiency that is severe enough to result in low plasma levels is marked by well-known symptoms, such as convulsions and cardiac arrhythmia. Marginal deficiencies are associated with a variety of other acute and chronic disorders (Wacker, 1980). Adequate protein intake is necessary for optimal Mg retention. Schmidl and Labuza (2000) in their study found that when protein intake was increased from low to normal levels in young and adolescent boys and in girls and women on diets marginal in Mg, improved Mg retention was observed. Diets containing sufficient Mg for growth and development (10-16 mg/kg/day) resulted in positive balances regardless of the protein intake (Shrewy, 2003; Schmidl and Labuza, 2000). High Mg intakes also improve nitrogen (N) balance in persons consuming a high protein diet. High intakes of sugar also appear to increase the need for Mg (Lopez *et al.*, 2004; Schmidl and Labuza, 2000). The urinary excretion of Mg more than doubled in young men after ingesting 100g of glucose.

Alcohol consumed with or without food increases Mg requirements. Even moderate alcohol consumption increases the urinary excretion of Mg (Lopez *et al.*, 2004; Schmidl and Labuza, 2000). Poor diet and urinary loss during alcoholism contribute to severe Mg depletion. This was one of the first clinically recognized conditions involving a Mg deficit (Lopez et al., 2004; Schmidl and Labuza, 2000).

High levels of fat in the intestinal lumen derived from fatty food ingestion or intestinal dysfunction, such as steatorrhea or short bowel, interfere with Mg absorption because soaps that are formed from fat and divalent cations like Mg are not absorbed (Lopez *et al.*, 2004; Schmidl and Labuza, 2000).

Stress causes secretion of epinephrine (adrenalin) and corticosteroids and results in Mg loss in animals and in humans (Schmidl and Labuza, 2000). The types of stresses that can increase Mg needs can be physical (exhausting or competitive exercise, extremes of temperature, and accidental or surgical trauma), or psychological (anger, fear, anxiety, overwork and crowding). Subjects exposed to the vicissitudes of life may need more than the RDAs for Mg.

Mg deficiency causes cardiovascular damage, and its administration is therapeutic in cardiac arrhythmia. Its suboptimal supply can have serious immediate and long-term consequences. For example, hyperirritability and convulsions mark acute Mg depletion in experimental animals (Lopez *et al.*, 2004). Similar dysfunctions have been diagnosed in humans with hypomagnesemia (Lopez *et al.*, 2004). Deficiency studies, which create less severe deficiencies but impose them for longer periods, cause myocardial necrosis and lesions of small arteries (Schmidl and Labuza, 2000).

Epidemiologists have noted the experimental evidence linking Mg deficiency and heart disease and the clinical evidence that Mg is also useful in treating cardiac arrhythmias (Schmidl and Labuza, 2000; Lopez, *et al.*, 2004). The incidence of sudden cardiac death is lower among people living in hard water areas than among those drinking soft water (Lopez, *et al.*, 2004). Hence, the higher Mg levels in hard water have been suggested as a factor that may protect against sudden cardiac deaths.

vii. Zinc

Zinc is one of the essential trace elements and, as such, a member of one of the major subgroups of the micronutrients that have attained such prominence in human nutrition and health (Yamaguchi, Miura, Kikuchi, Celino, Agusa, Tanabe and Miura, 2009). Zinc is ubiquitous in subcellular metabolism. It is, for example, an essential component of the catalytic site or sites of at least one enzyme in every enzyme classification (Fierke, 2000). Altogether, several hundred zinc metalloenzymes have been identified in the plant and animal kingdoms.

Nutritional zinc deficiency has been more thoroughly documented, including the results of a series of randomized controlled studies of dietary zinc supplementation in young children in Denver during the 1970s and 1980s. These indicated the occurrence of growth-limiting zinc deficiency in otherwise apparently normal infants and young children (Hambidge, Krebs and Walravens, 1985; Walravens, Kreb and Hambidge 1983; Walravens, P.A., Hambidge, K.M. & Koepfer, D.M, 1989; Walravens, Hambidge and Koepfer, 1976). These studies have provided one cornerstone for the large number of randomized, double-blinded controlled studies of dietary zinc supplementation that were conducted, primarily in developing countries, in the 1990s (Bhutta, Black, Brown, Gardner, Gore, Hidayat *et al.*, 1999, Brown *et al.*, 1998). The cumulative results of these studies have had a very positive impact in the advancement of appreciation of the public health importance of human zinc deficiency on a global basis (Black, 1998). This work provided clear documentation of the etiological role of zinc in several diseases and clinical circumstances and in disturbances of normal physiology, growth and development. Organ systems known to be affected clinically by severe zinc deficiency states include the epidermal, gastrointestinal, central nervous, immune, skeletal and reproductive systems (Hambidge and Walravens, 1982). The ubiquity and versatility of zinc in subcellular metabolism suggest that zinc deficiency may well result in a generalized impairment of many metabolic functions (Williams, 1989).

The fundamental importance of zinc in cellular growth and differentiation points to the special vulnerability to an inadequate supply of zinc of the rapidly growing embryo, fetus, infant and young child or of the patient mounting an immune response or requiring tissue repair. An appreciation of the extraordinary rapidity with which the effects of dietary zinc restriction of growth and differentiation are manifest in the animal (mammalian) model (Chesters, 1982) correctly showed the special vulnerability to zinc deficiency of cells that are rapidly turning over, notably those of the immune system. However, other organs and systems that are not noted for rapid cell turnover, e.g., the central nervous system (Frederickson, 2003), are also vulnerable to zinc restriction. The pattern of disturbance of zinc-dependent metabolism may well depend on a variety of host and environmental (including other dietary) factors as well as on the severity and acuteness of the zinc deficiency. Hence the human nutrition scientist and clinician are faced with a potentially bewildering range of manifestations of zinc deficiency that are typically difficult to detect and confirm.

Measurements of zinc concentrations in plasma have been shown to be useful in identifying children who are more likely to have a growth response to zinc supplements (Brown, Peerson and Allen, 1999) or diarrhea (Bahl, Bhandari, Hambidge and Ban, 1998). Zinc added to conventional therapy is effective in reducing the duration of acute and persistent diarrhea has been confirmed through pooled analysis of data derived from multiple studies (Bhutta *et al.,* 1999). The severity of the illness may also be reduced. Pooled analyses have also confirmed that zinc supplementation of children at a community level in the developing world results in significant reductions in the incidence and prevalence of diarrhea. Losses of zinc via the intestine are likely to be increased in diarrheal states and may contribute to zinc deficiency and to a vicious cycle.

Pneumonia- Pooled analyses of the results of community zinc supplementation studies in children in developing countries have demonstrated a very substantial and statistically significant reduction in the prevalence of pneumonia (Bhutta *et al.*, 1999).

Other infections- Malaria is among other infections that appear to be reduced by zinc supplementation (Bates, Prentice and Cole, 1993, Black, 1998).

Neuropsychological performance- Evidence of improved brain development attributable to improved zinc status has been derived from studies of activity levels in young children in India (Sazawal, Bentley, Black, Dhingra, George and Bhan, 1996) and Guatemala (Bentley, Caulfield, Ram, Santizo, Hurtado, Rivera, Ruel and Brown, 1997). Neuropsychological performance has been reported to improve with zinc supplementation in young Chinese children (Penland, Sandstead, Alcock, Dayal, Xue-Cun, Jue-Sheng, *et al.,* 1998, Sandstead, Penland, Alcock, Dayal, Chen, Li, Zhoa and Yang, 1998) but only when other micronutrient nutrition is adequate.

Relevance to childhood morbidity and mortality rates- Probably for reasons discussed in the section on the biology of zinc, the effects of zinc deficiency are remarkably diverse and notable for being nonspecific. The latter does not detract from their importance. It has been estimated that the beneficial effects of zinc supplements for diarrhea prevention are of the same magnitude as those achieved by cleaning the water supply and providing quality sanitation. In the case of children under 5 years, the public health benefits of zinc supplementation in the prevention of acute lower respiratory disease and malaria have also been calculated to be superior to any other preventive modalities. These infectious/nutritional diseases are the principal causes of childhood morbidity and mortality globally. The impairment of physical growth and the impairment of neuropsychological development are well-recognized associated features. The sum of recent evidence indicates that the maintenance of optimal zinc nutriture is perhaps the most effective, even if only partial, preventive measure that can be undertaken to decrease morbidity rates in young children in the developing world.

Pregnancy and prenatal development- Studies in the developing world have started to give attention to pregnancy and the effects of maternal zinc status on both prenatal and postnatal development (Caulfield, Zavaleta and Figueroa, 1999a). Early results of these endeavors indicate that poor maternal zinc status in pregnancy can have adverse effects on fetal brain function (Merialdi *et al.*, 1998). In contrast to recent observations in the United States (Goldenberg, Tamura, Neggers, Copper, Johnson, DuBard and Hauth, 1995), the lack of effect of maternal supplementation on fetal growth has been unexplained (Caulfield, Zavaleta and Figueroa, 1999b).

The most obvious factors that have hampered progress in understanding of the prevalence of this micronutrient deficiency have been, and continue to be, the lack of adequate laboratory biomarkers (Hambidge and Krebs, 1995; Underwood, 1998) and the lack of pathognomonic clinical features of zinc deficiency states

b. Vitamins

Vitamins are essential micronutrients the body needs in small amounts for various roles throughout the human body (Bellows and Moore, 2013). For optimal health, it is important to get the vitamins and minerals the body needs either through a balanced, nutritious diet, health supplements, or both. Vitamins are divided into two groups: water-soluble (B-complex vitamins and C vitamins) and fat-soluble vitamins (A, D, E and K). Unlike water-soluble vitamins which are highly soluble need daily or regular replacement in the body, fat-soluble vitamins which are also essential for health are stored in the liver and fatty tissues, and are eliminated much more slowly than water soluble vitamins and do not need to be replaced every day

Vitamin C

The body needs vitamin C, also known as ascorbic acid or ascorbate, to remain in proper working condition (Bellows and Moore, 2013). Vitamin C benefits the body by holding cells together through collagen synthesis; collagen is a connective tissue that holds muscles, bones, and other tissues together. Vitamin C also aids in wound healing, bone and tooth formation, strengthening blood vessel walls, improving immune system function, increasing absorption and utilization of iron, and acting as an antioxidant. An antioxidant can be a vitamin, mineral, or a carotenoid, present in foods, that slows the oxidation process and acts to repair damage to cells of the body. Studies suggest that vitamin C may reduce the risk of certain cancers, heart disease, and cataracts (Bellows and Moore, 2013)

Fat-Soluble Vitamins

The fat-soluble vitamins, A, D, E, and K, are stored in the body for long periods of time and generally pose a greater risk for toxicity when consumed in excess than water-soluble vitamins (Bellows and Moore, 2013; Ene-Obong, Odoh and Ikwuagwu, 2003). Eating a normal, well-balanced diet will not lead to toxicity in otherwise healthy individuals. However, taking vitamin supplements that contain megadoses of vitamins A, D, E and K may lead to toxicity (Bellows and Moore, 2013). The body only needs small amounts of any vitamin. While diseases caused by a lack of fat soluble vitamins are rare in the United States, symptoms of mild deficiency can develop without adequate amounts of vitamins in the diet. Additionally, some health problems may decrease the absorption of fat, and in turn, decrease the absorption of vitamins A, D, E and K (Bellows and Moore, 2013).

i. Vitamin A: Retinol

Vitamin A, also called retinol, has many functions in the body. In addition to helping the eyes adjust to light changes, vitamin A plays an important role in bone growth, tooth development, reproduction, cell division, gene expression, and regulation of the immune system (Bellows and Moore, 2013; FAO/WHO, 1998.). The skin, eyes, and mucous membranes of the mouth, nose, throat and lungs depend on vitamin A to remain moist. Vitamin A is also an important antioxidant that may play a role in the prevention of certain cancers.

Eating a wide variety of foods is the best way to ensure that the body gets enough vitamin A (FAO/WHO, 1998). The retinol, retinal, and retinoic acid forms of vitamin A are supplied primarily by foods of animal origin such as dairy products, fish and liver. Some foods of plant origin contain the antioxidant, beta-carotene, which the body converts to vitamin A. Beta-carotene, comes from fruits and vegetables, especially those that are orange or dark green in color (Ogle, Hung and Tuyet, 2001). Vitamin A sources also include carrots, pumpkin, winter squash, dark green leafy vegetables and apricots, all of which are rich in beta-carotene.

The recommendation for vitamin A intake is expressed as micrograms (mcg) of retinol activity equivalents (RAE). Retinol activity equivalents account for the fact that the body converts only a portion of beta-carotene to retinol. One RAE equals 1 mcg of retinol or 12 mcg of beta-carotene. The Recommended Dietary Allowance (RDA) for vitamin A is 900 mcg/ day for adult males and 700 mcg/day for adult females (Bellows and Moore, 2013; Ogle *et al.*, 2001).Compared to vitamin A, it takes twice the amount of carotene rich foods to meet the body's vitamin A requirements, so one may need to increase consumption of carotene containing plant foods.Recent studies indicate that vitamin A requirements may be increased due to hyperthyroidism, fever, infection, cold, and exposure to excessive amounts of sunlight (Hamrick and Counts, 2008). Those that consume excess alcohol or have renal disease should also increase intake of vitamin A (La Vecchia, Negri, Franceschi, Parazzini, Decarli, 1992).

ii. Vitamin D

Vitamin D helps to form and maintain the teeth and bones, and increases the amount of calcium that the small intestine absorbs. Vitamin D is required for the body's use of calcium and phosphorous. Vitamin D is also important for weight management because it helps the body with metabolism. Good sources of Vitamin D are milk and other vitamin D-fortified dairy products, as well as cod liver oil, fish oil, and oily fish including herring, salmon and sardine.

Symptoms of vitamin D deficiency in growing children include rickets (long, soft bowed legs) and flattening of the back of the skull. Vitamin D deficiency in adults may result in osteomalacia (muscle and bone weakness), and osteoporosis (loss of bone mass) (Bellows and Moore, 2013).

Recently published data introduces a concern that some adults and children may be more prone to developing vitamin D deficiency due to an increase in sunscreen use (Wood, 2000). In addition, those that live in inner cities, wear clothing that covers most of the skin, or live in northern climates where little sun is seen in the winter are also prone to vitamin D deficiency. Since most foods have very low vitamin D levels (unless they are enriched) a deficiency may be more likely to develop without adequate exposure to sunlight. Adding fortified foods to the diet such as milk, and for adults including a supplement, are effective at ensuring adequate vitamin D intake and preventing low vitamin D levels.

Vitamin D deficiency has been associated with increased risk of common cancers, autoimmune diseases, hypertension, and infectious disease (Crowe *et al.*, 2008). In the absence of adequate sun exposure, at least 800 to 1,000 IU of vitamin D3 may be needed to reach the circulating level required to maximize vitamin D's benefits.

These populations may require extra vitamin D in the form of supplements or fortified foods:

- Exclusively breast-fed infants: Human milk only provides 25 IU of vitamin D per liter. All breast-fed and partially breast-fed infants should be given a vitamin D supplement of 400 IU/day
- Dark Skin*:* Those with dark pigmented skin synthesize less vitamin D upon exposure to sunlight compared to those with light pigmented skin.
- Elderly*:* This population has a reduced ability to synthesize vitamin D upon exposure to sunlight, and is also more likely to stay indoors and wear sunscreen which blocks vitamin D synthesis.
- Covered and protected skin*:* Those that cover all of their skin with clothing while outside, and those that wear sunscreen with an SPF factor of 8, block most of the synthesis of vitamin D from sunlight.
- Disease*:* Fat malabsorption syndromes, inflammatory bowel disease (IBD), and obesity are all known to result in a decreased ability to absorb and/or use vitamin D in fat stores.

The Tolerable Upper Intake Level (UL) for vitamin D is set at 100 mcg for people 9 years of age and older (Bellows and Moore, 2013). High doses of vitamin D supplements coupled with large amounts of fortified foods may cause accumulations in the liver and produce signs of poisoning. Signs of vitamin D toxicity include excess calcium in the blood, slowed mental and physical growth, decreased appetite, nausea and vomiting. It is especially important that infants and young children do not consume excess amounts of vitamin D regularly, due to their small body size.

iii. Vitamin E: Tocopherol

Vitamin E benefits the body by acting as an antioxidant, and protecting vitamins A and C, red blood cells, and essential fatty acids from destruction (Bellows and Moore, 2013). Research from decades ago suggested that taking antioxidant supplements, vitamin E in particular, might help prevent heart disease and cancer (Minihane and Fairweather-Tair, 1998; Dietary supplement Fact, 2011). However, newer findings indicate that people who take antioxidant and vitamin E supplements are not better protected against heart disease and cancer than non-supplement users (Weisburger, 2000; Dietary supplement Fact, 2011). Many studies show a link between regularly eating an antioxidant rich diet full of fruits and vegetables, and a lower risk for heart disease, cancer, and several other diseases (Fung *et al.,* 2006; European Society of Cardiology, 2007). Essentially, recent research indicates that to receive the full benefits of antioxidants and phytonutrients in the diet, one should consume these compounds in the form of fruits and vegetables, not as supplements (Ruel and Couillard, 2007; John *et al.*, 2007). Healthy sources of vitamin E include vegetables, fruits, vegetable oils, nuts, seeds, whole grains and fortified cereals

About 60 percent of vitamin E in the diet comes from vegetable oil (soybean, corn, cottonseed, and safflower). This also includes products made with vegetable oil (margarine and salad dressing) (Bellows and Moore, 2013; Linseisen *et al.,* 2002). Vitamin E sources also include fruits and vegetables, whole grains, nuts (almonds and hazelnuts), seeds (soya) and fortified cereals.

The Recommended Dietary Allowance (RDA) for vitamin E is based on the most active and usable form called alpha-tocopherol ((Bellows and Moore, 2013). Food and supplement labels list alpha-tocopherol as the unit International units (IU) not in milligrams (mg) (Bellows and Moore, 2013). One milligram of alpha-tocopherol equals to 1.5 International Units (IU). RDA guidelines state that males and females over the age of 14 should receive 15 mcg of alpha-tocopherol per day (Bellows and Moore, 2013; Linseisen, *et al.,* 2002). Consuming vitamin E in excess of the RDA does not result in any added benefits.

Vitamin E deficiency is rare. Cases of vitamin E deficiency usually only occur in premature infants and in those unable to absorb fats. Since vegetable oils are good sources of vitamin E, people who excessively reduce their total dietary fat may not get enough vitamins E. Vitamin E obtained from food usually does not pose a risk for toxicity. Supplemental vitamin E is not recommended due to lack of evidence supporting any added health benefits. Megadoses of supplemental vitamin E may pose a hazard to people taking blood-thinning medications such as Coumadin (also known as warfarin) and those on statin drugs (Bellows and Moore, 2013: Linseisen et al., 2002).

iv. Vitamin K

Vitamin K is naturally produced by the bacteria in the intestines, and plays an essential role in normal blood clotting, promoting healthy bones and teeth, and helping to produce proteins for blood, bones, and kidneys (Bellows and Moore, 2013). Good food sources of vitamin K are green, leafy-vegetables such as turnip greens, spinach, cauliflower, cabbage and broccoli, and certain vegetables oils including soybean oil, cottonseed oil, canola oil and olive oil. Animal foods, in general, contain limited amounts of vitamin K (Bellows and Moore, 2013).

Without sufficient amounts of vitamin K, hemorrhaging can occur. Vitamin K deficiency may appear in infants or in people who take anticoagulants, such as Coumadin (*warfarin*), or antibiotic drugs. Newborn babies lack the intestinal bacteria to produce vitamin K and need a supplement for the first week. Those on anticoagulant drugs (blood thinners) may become vitamin K deficient, but should not change their vitamin K intake without consulting a physician.

People taking antibiotics may lack vitamin K temporarily because intestinal bacteria are sometimes killed as a result of long-term use of antibiotics. Also, people with chronic diarrhea may have problems absorbing sufficient amounts of vitamin K through the intestine and should consult their physician to determine if supplementation is necessary (Sazawal, Bentley, Black, Dhingra, George and Bhan, 1996). Although no Tolerable Upper Intake Level (UL) has been established for vitamin K, excessive amounts can cause the breakdown of red blood cells and liver damage (Bellows and Moore, 2013; Darwin, 2011). People taking blood-thinning drugs or anticoagulants should moderate their intake of foods with vitamin K, because excess vitamin K can alter blood clotting times. Large doses of vitamin K are not advised.

Water Soluble Vitamin B-Complex

There are eight water-soluble vitamins known as B-complex vitamins: thiamin (vitamin B1), riboflavin (vitamin B2), vitamin B6, vitamin B12, folate, biotin, niacin and pantothenic acid. Vitamin B-complex vitamins are needed for healthy skin, good vision, a healthy nervous system and the formation of red blood cells (Bellows and Moore, 2013; Darwin, 2011).

Enriched grain products, whole grains, and vitamin supplements are good sources of B-complex vitamins.

2.8 Relationship between dietary diversity, diet quality and nutrient adequacy

The more recent concern in developed countries as well as in countries in transition (or soon to be in transition) regarding over nutrition and excess intake of certain nutrients and foods has led to a global shift in the definition of dietary quality to include both concepts of nutrient deficiency and over nutrition (WHO, 1996; USDAHNIS, 1992; CHS, 1990). In the United States, this has led to the incorporation of concepts of diversity, proportionality, and moderation in the definition of dietary quality, following the principles underlying the current Food Guide Pyramid (Haines *et al.*, 1999; Welsh, Davis, and Shaw, 1992). These guidelines recommend that, in addition to including the recommended levels of energy and nutrients, a healthy, high-quality diet limits the amount of fat, saturated fat, cholesterol, sodium, and refined sugars, and incorporates many servings of fruits, vegetables, and whole grain products. In middle- and low-income countries, concerns about avoidance of excess and imbalanced diets are increasingly relevant, as diet-related risk factors for chronic diseases are rapidly becoming prevalent in many populations (WHO/FAO, 2003). However, in the poorest developing countries and the poorest areas of many other countries, nutrient adequacy remains the predominant diet quality concern (particularly when considering the needs of young children) but rarely on adults.

Dietary quality has traditionally been used to reflect nutrient adequacy, thus, commonly used measures of dietary quality have been the nutrient adequacy ratio (NAR) and the mean nutrient adequacy ratio (MAR). The concept was first developed by Madden, Goodman and Guthrie (1976) and has since then been used both in developed and developing countries (Guthrie and Scheer, 1981; Krebs-Smith *et al.*, 1987; Hatloy *et al.*, 1998). The NAR is defined as the ratio of intake of a particular nutrient to its recommended dietary allowance (RDA). The MAR is the average of the NARs, computed by summing the NARs and dividing by the number of nutrients. Each NAR is usually truncated at 100 percent of the RDAs to avoid high consumption levels of some nutrients compensating for low levels of others in the resulting MAR.

Dietary problems may be primarily quantitative in the most underprivileged areas (rural) areas during seasonal food shortages, or urban areas under acute poverty. As a result, the dietary deficiency then appears to be chiefly energy related. However, even in these conditions it has been shown that the problem of dietary diversity is crucial, hence the measurement of dietary quality is essential (Allen *et al.*, 1991). It is important to emphasize that although dietary diversity is often assumed to be a proxy for nutrient adequacy, it is not synonymous to dietary quality and the two terms (diversity and quality) should not be used interchangeably. As noted by Krebs-Smith *et al.*, (1987), confusion in the use of these terms may stem from many nutrition and health benefits that have been attributed to dietary diversity and that are related to the concept of dietary quality. For instance, dietary diversity is often promoted to enhance the chances of achieving an adequate diet, lessen the risks of developing a deficiency or excess of any one nutrient, ensure an appropriate balance of micronutrients as well as energy from fat, and reduce the likelihood of exposure to excessive amounts of contaminants. Diversity however, is but one component of overall dietary quality, and may not in itself ensure achievement of all dietary goals.

A study in Mali by Hatloy *et al.*,(1998) which specifically validated dietary diversity against nutrient adequacy showed that DDS (based on food groups) is a stronger determinant of nutrient adequacy than Food Variety score (FVS)(based on individual foods). Thus in this context, increasing the number of food groups has a greater impact on nutrient adequacy than increasing the number of individual foods in the diet. Ogle *et al.*, (2001) in their study in Viet Nam, which included adult women validated the diversity measures and Dietary Diversity score (DDS) against nutrient intake and nutrient density confirmed a positive association between the two measures of diversity and intake of a variety of nutrients. Women in the highest tercile of FVS were those who had consumed 21 or more different foods in 7 days and had a significantly higher intake of most nutrients studied than those from the lowest tercile, who had consumed 15 or fewer foods. Similarly, women with a food group diversity greater or equal to eight (out of a maximum of 12 groups) had significantly higher nutrient adequacy ratios for energy, protein, niacin, vitamin C, and zinc than women with lower food group diversity. Two other studies that have looked at the association between diversity measures and nutrient intakes confirm positive association between dietary diversity and intake of a variety of nutrients (Onyango *et al.,* 1998; Tarini, Bakari and Delisle, 1999). In an analysis of data from ten poor and middle-income countries, increases in dietary diversity were associated with increased availability of calories (from staples and from non-staple foods) at household level (Hoddinott and Yohannes, 2002). A study in Mali by Hatloy, Torheim and Oshaug, (1998) on dietary diversity and nutrient adequacy documented a significant association between nutrient adequacy (NAR/MAR) and both measures of dietary diversity (FVS and DDS). Two other studies that have looked at the association between diversity measures and nutrient intakes in Nigeria and Kenya, respectively, confirm the positive association between dietary diversity and intake of a variety of nutrients (Tarini, Bakari and Delisle, 1999; Onyango *et al.*, 1998). Only one study, conducted in Ghana and Malawi, documents weak and even in some cases negative associations between diversity and certain nutrients (Ferguson, Gibson, Opare-Obisaw, Osei-Opare, Lamba and Ounpuu, 1993).

Another study in Mali also documented a strong association between dietary diversity and nutritional status, for children aged 6-59 months (Hatløy *et al.,* 2000). It is also important to study the association between proxies of overall dietary quality and nutritional outcomes. In developing countries, this has been the subject of many studies on children (Onyango *et al*., 1998; Hatloy *et al.*, 2000; Arimond and Ruel, 2002).

2.9 BODY MASS INDEX (BMI)

Malnutrition, as measured by anthropometric status, is a powerful risk factor for illness and elevated death rates throughout life. The two types of nutritional problems are under-nutrition and over-nutrition. Under-nutrition means too little food, too little care and too little health. More emphasis should be given not only to food but also to care and health, the reason being that even if children in the age group of 0-2 years are able to get food, they may have mothers who do not have enough time to pay attention to their needs. Similarly, if there is no health-guaranteeing environment, and children suffer from diarrhea diseases, no amount of food will help prevent malnutrition (Duggan, Watkins and Walker, 2008).

Over-nutrition, on the other hand, means either too many calories or the wrong types of calories such as saturated fats or highly processed sugar that lead to obesity, vascular diseases, and so on. Many developing countries have under-nutrition and those in Europe and North America have over- nutrition problems. The prevalence of obesity doubled to 16% and continues to increase (Bennett, Todd and Flately, 1993). Changes in diet and activity patterns are fueling the obesity epidemic (Popkin, 2001).

The epidemic of overweight and obesity inflicts significant disadvantages on both the individual and society, through increased risk of disease and death, health care costs (Must, Spadano, Coakley, Field, Colditz and Dietz, 1999, Allison *et al.*, 1999), reduced social status, educational attainment, and employment opportunities (WHO, 1998). However, the problems of over-nutrition are increasing even in countries where hunger is endemic. Studies have reported significant increases in the prevalence of overweight and obese individuals in developing countries (Popkin *et al.*, 1998 and Mann, 2002; WHO, 2013). There is in-between category with countries like India that still have an enormous amount of under-nutrition and significant over-nutrition problems. In India, for instance, around 50% of its children under the age of five are undernourished or malnourished. But in urban areas, the over-nutrition problem is shooting up, because of the change in lifestyle and food habits.

Protein energy malnutrition (PEM) is called "the silent emergency" whose major victims are children of school age (Pulfrey, 2006). It is declared that PEM "is an accomplice in at least half of the 10.4 million child deaths each year. Furthermore, malnutrition is said to cast long shadows, affecting close to 800 million people - 20% of all people in the developing countries. In other words, 1 out of every 8 people in the world suffers from malnutrition. Food and Agriculture Organization (2008) reported that hunger and malnutrition are killing nearly six million children each year. Many of these children die from a handful of treatable infectious diseases including Diarrhoea, Pneumonia and measles. These children would have survived if their bodies and immune systems had not been weakened by hunger and malnutrition. Hunger and malnutrition are among the root causes of poverty, illiteracy, disease and mortality of millions of people in developing countries (FAO, 2008).

In a very recent study among children and adolescents from Southern Nigeria, it has been shown that the prevalence of overweight, obesity and thinness (underweight) were 11.4%, 2.8%, and 13.0%, respectively (Ene-Obong, Ibeanu, Onuoha and Ejekwu, 2012). This is a dangerous trend since obesity in children is an indicator of adult obesity. It has been shown that 60% of children who are overweight have one additional risk factor for cardiovascular diseases (CVD). In a review of available data in Nigeria, the prevalence of obesity and overweight were found to range between 9.0-9.6% and 18.6-27%, respectively in the urban areas and 3.6-4.6% and 12.6-16.6%, respectively in the rural area, indicating significant urban rural differences. Obesity and overweight were more prevalent among females (6-8% and 14-27%, respectively) than in males (1-2% and 12%, respectively).

Similarly, obesity and overweight were significantly more prevalent among female children (3.7% and 12.9%, respectively) than male children (1.8%-10%, respectively). Obesity and overweight appear to increase with age across all age groups. Obesity, overweight and thinness were more prevalent at age 9 years and 14 years. These periods appear to be very critical for the Nigerian child. Nutritional deficiencies contribute to the high rates of disability, morbidity and mortality in Nigeria especially among infants and young children. Ordinarily, malnutrition stems from lack of food, but the centre of it all is poverty, which affects about 80% of Nigerian population, weakening productivity and capacity of children to learn properly in school. This magnitude of malnutrition deserve urgent attention knowing its consequences as it affects survival and health, education and economy of the nation (Maziya-Dixon *et al.*, 2004).

Under nutrition in Nigeria is a long standing problem which has persisted since the 1960s and whose magnitude is on the increase (Igbedioh, 1993). This is because food consumption, both in quality and quantity, has decreased appreciably, especially with the commencement of some economic policies in the 1980's (Igbedioh, 1993, Bakari, Onyemelukwe, Sani, Aliyu, Hassan and Aliyu, 2007). The economic and political situation in Nigeria has increased stress on family structure (Adekunle, 2005). Nigeria like many other developing countries faces the challenge of providing adequate food supply for its teeming population (FAO/WHO, 2002). "Progress towards reducing the number of hungry people in developing countries by half by 2015 has been very slow and the millennium development Goals (MDGS) on hunger and poverty will not be attained for many decades in sub-Saharan Africa (WHO/FAO, 2003). Also the Nigerian Food Consumption and Nutrition Survey showed that PEM is still very much with us (Maziya-Dixon *et al.*, 2004). National data showed the prevalence of stunting (chronic, longstanding malnutrition), wasting (acute, ongoing malnutrition) and underweight to be 42%, 9% and 25%, respectively among under-

5year old children (Maziya-Dixon *et al.*, 2004). One out of 4 pre-school age children suffer from under nutrition. Ten million children die every day before the age of 5 and 1 out of 2 deaths is attributable to under nutrition (WHO, 2005).

Although there are few data on the prevalence of NCCDs in Nigeria, obesity and diabetes are showing particularly worrying trends not only because they are affecting large proportion of the population but also because they have begun to appear earlier in life (Thiam, Sambe and Lavanga, 2006).

Nigeria is an example of Sub Sahara African (SSA) countries where the double burden of disease is evident (Enwonwu, 2008). This is manifested in the increasing prevalence of lifestyle diseases like diabetes, overweight and obese individuals, as well as the dominance of infectious diseases. Many countries in Africa continue to address public health issues such as immunization, eradication of infectious diseases, and problems of HIV, Non Communicable Diseases (NCDs) such as diabetes, stroke, and hypertension. WHO (2005) reported that chronic diseases, communicable diseases, maternal and perinatal conditions, and nutritional deficiencies will still be the leading causes of death in Nigeria in 2015. In essence, chronic diseases have not displaced acute and infectious diseases; rather there is an ongoing double burden of disease in the country. The Nigerian Federal Ministry of Health has recognized the increasing prevalence of chronic diseases in the country and now has as part of its vision "to reverse the increasing prevalence of non-communicable diseases.

The underlying causes of malnutrition in Nigeria are poverty, inadequate food production, inadequate food intake, ignorance and uneven distribution of food, poor food preservation techniques, improper preparation of foods, food restrictions and taboos, and poor sanitation (Igbedioh, 1993). Malnutrition and related diseases (diarrhoea, measles, anaemia, and gastroenteritis) are the causes of most deaths in infants and young children. Maziya-Dixon *et al.*, (2004) in their study found that stunting, underweight, vitamins and mineral deficiency which indicate protein and energy malnutrition is still a major problem in Nigeria.

An acceleration of malnutrition reduction is needed especially in sub-Sahara Africa, where trends in the child malnutrition, household food insecurity and poverty are all moving in the wrong direction. Reducing the prevalence of child underweight by only 5%, on average could save the lives of 30% of the under-5 children who die annually from hunger-related diseases. In some of the worst affected countries, the prevalence of underweight children among under-five goes up to 45 percent (FAO, 2008). Understanding the relative importance of disease, dietary quantity, and quality in causing malnutrition is therefore of major importance in the designing public policy (Jamison, Leslie.and Musgrove, 2003).

2.9.1 Stunted Children Overweight Mothers (SCOWT)

Stunting (i.e., short stature due to poor living environments) is one of the two most important indices of child well-being in use throughout the world. Stunting was defined as height-for-age < −2 SD of the reference population and maternal overweight as a body mass index (BMI) of > 25 kg m^{-2}. The occurrence of a stunted (undernourished) child in the same household as an overweight (over nourished) mother is termed SCOWT (Garrett and Ruel, 2003). The prevalence of SCOWT is affected by the rates of childhood stunting, which is consistently higher in rural than urban areas, and by the prevalence of maternal overweight, which is currently escalating in rural areas of many countries in the nutrition transition. In addition, the results suggest that SCOWT *is* related to urbanization, although not necessarily urban residence (Garrett *et al.*, 2003). The lack of association of SCOWT in Africa and Asia with urbanization may be because of relatively low levels of urbanization and consequently of the prevalence of factors associated with an urban lifestyle and the nutrition transition in those regions

The timing of stunting is reasonably understood in that most stunting occurs before the age of 3 years, and stunted children usually become stunted adults. The consequences of becoming and remaining stunted are increased risk of morbidity, mortality, delays in motor and mental development, and decreased work capacity (Scrimshaw, Waterlow and Schu¨rch, 1994). In developing countries, 40% of children <5 years of age are stunted. This means that 200 million young children are stunted.

The causes and etiology of stunting are much less understood than are its timing and consequences. In particular, there is little understanding of why and how stunting occurs extensively in environments that are poor and in environments that seem to be improving. In addition, some populations are much more stunted than others (WHO, 1996). This means that an understanding of why and how children become stunted is needed at both the individual and ecological levels.

The rationale for a focus on stunting rather than underweight or wasting as an indicator of child undernutrition is that stunting reflects the cumulative, long-term effects of the numerous insults experienced by children during their intrauterine and preschool years (Martorell, 1995). Many researchers and development practitioners consider it indicative of long-term deprivations at the household level. Stunting and BMI as indicators of longer-term nutritional status make it natural to pair them.

Popkin (2001) showed that there is coexistence of under- and overnutrition not only at the societal but also the household level. The coexistence of under- nutrition and over -nutrition within the same population is referred to as the "double burden of diseases" (WHO, 2003). The resulting problem of double burden, or the co-existence of under- and over nutrition in the same country often in the same household requires a shift in the conceptualization of dietary quality (Ruel, 2002).

CHAPTER THREE

METHODOLOGY

3.1 Study Design- This study is descriptive, cross sectional in design

3.2 Study Locations- This study was carried out in three selected States in the South- East Geo-political Zone of Nigeria. The South - East geopolitical zone is made up of five states namely; Imo, Enugu, Anambra, Ebonyi and Abia and each state is made up of three (3) senatorial zones.These five States were originally part of the Eastern Region in the three-region structure of 1954 (Amakihe, 2013). In 1967, with the creation of twelve federal States, they became part of East Central State (Ajayi, 2007). In 1976, 19 States were created out of the existing 12 States and East Central State was divided into Anambra and Imo States (Rotimi, 1994). On 27th August, 1991 Enugu State was carved out of the old Anambra State, while Abia State was carved out of Imo State. In 1996, Ebonyi State was created by combining portions of Abia and Enugu States. The South-East geo-political zone is the heartland of the Igbo-speaking nationality. The Ibos are among the largest single ethnic groups in Africa. They are based mostly in Southeastern Nigeria constituting about 25% of the population of the country. Administratively, the Ibos make up 100% of the five States of the South-East zone comprising Abia, Anambra, Ebonyi, Enugu and Imo. Igbo land is bothered in the east by Akwa Ibom and Cross River States, in the North by Benue and Kogi States, in the West by Edo and Delta States and in the South by Rivers and Bayelsa States.The Ibos are the only ethnic group in the South-East and Igbo is the only indigenous language spoken there.The dominant religion in the South-East is Christianity, although a certain part of the population practice traditional religion and Islam.

The Igbo are the second largest group of people living in southern Nigeria. They are socially and culturally diverse, consisting of many subgroups. Although they live in scattered groups of villages, they all speak one language. Their main occupations are business, civil servants and farming.

The yam is the staple food of the Igbos. Traditionally, the yam was the food of choice for ceremonial occasions. Nowadays it has been replaced by rice. Other starchy foods include cassava, taro root, maize and plantains. A typical meal includes a starch and a soup or stew, prepared with a vegetable to which pieces of fish, chicken, beef, or goat meat are added.

Table 3.1: Study Locations

State/population	Senatorial Zones	LGAs Selected	Communities	Sample Size		
				Urban	Rural	Total
Imo/ 3,927,563	Orlu	Orlu	Umunna, Amaifeke	44	89	133
			Umulolo			
			Umuokwara			
			Abara Okporo			
			Ubaha Okporo			
	Owerri	Owerri	Douglass	44	90	134
			Douglass/Ikenegbu			
			Shell Camp			
			Irette			
			Egbu			
			Orji			
			Nekede			
	Okigwe	Obowo	Achingali	44	89	133
			Umuariam			
			Okoto			
			Umuda			
			Ohumala			
			Owugh Ohumala			
Enugu/ 3,267,837	Enugu East	Nkwo Nike	Abakpa,	44	89	133
			Thinkers-Corner			
			Ugwuogo			
			Ugbene			
			Ugbo-Chime			
	Enugu North	Nsukka	New Anglican RD	45	89	134
			Odenigwe Lane,			
			Ihe/Owerri			
			Aku Road			
			Orba Road			
			Edem			
	Enugu West	Enugu North	Ogbete	44	89	133
			Ogui			
			New Heaven.			
			Independence-Layout,			
			Asata			
			Garden Avenue			
			Obiagu			
Anambra/ 4,177,828	Anambra North	Awka South Urban	Amawbia	44	90	134
			Awka			
			Umueze Village			
			Ngene Village			
			Amalla Awka			
			Okpuno			
	Anambra South	Aguata	Okpo Ekwulobia	44	89	133
			Agba, Ula			
			Agulu Ezechukwu			
	Anambra Central	Oyi	Achalla-uno	44	89	133
			Nteje			
			Ifite Awkuzu			
			Umuoa Nteje			
			Achalla Agu			
			Ebengwu, Amadi-aba			
			Dusoye			
Grand total				397	803	1200

3.3 Time and Duration of the Study

Data collection was carried out from October 2010 to April, 2011

3.4 Study Population-

Women of reproductive age and their under- 5 children formed the sampling frame in the nine selected local Government Areas.

3.5 Sample size

Using the formula for cross-sectional studies (Frankfort-Nachimas and Nachimas, 1992) the minimum sample size was determined:

$$n = \frac{Z^2pq}{d^2}$$

Where:

n = minimum sample size when sample frame is more than 10,000.

Z = 1.96 the standard normal deviate (or confidence coefficients), which corresponds to the confidence level adopted.

d = 5% degree of accuracy desired (Tolerance error) = estimated proportion of target population to have a particular characteristic such as those estimated to accept the null hypothesis

p = the population of the target population estimated to have a particular characteristic (if there is no reasonable estimate 50% is used).

q = 1-p (50% unaffected population).

Z = 1.96 (i.e. table of confidence coefficients for confidence levels in (Spiegel, 1961)

The estimated proportion of success (of accepting the various null hypotheses) = 50%

Therefore,

$$n = \frac{Z^2\ pq}{d^2} = \frac{1.96^2\ (0.5)(0.5)}{0.05^2}$$

$$= 384$$

The sample size (n) for the study should therefore be three hundred and eighty four (384) citizens. The sample size was increased to 400 subjects per State, for three (3) States making it a total of 1200 subjects.

3.6 Sample Selection

Using table of random numbers of East Central State, Anambra, Enugu, and Imo states were selected for this study. Anambra and Enugu belong to old Anambra State and to moist savanna Agro-ecological zone while Imo belong to Humid Forest agro-ecological zone. In each of the States, the three (3) senatorial districts that make up each State were included totaling nine Senatorial districts. One Local Government area each was selected from each of the three senatorial districts in each State. From the nine local government areas, 36 rural and 18 urban communities were randomly selected. In each of the Local Government Areas, communities were chosen based on population density to represent rural and urban setting in a ratio of 3:1 (267:133) as shown in Table 3.1. At the community level, a house listing of all the eligible households was done first. The eligible households were those with mothers who have under-five old children. Using Systematic random sampling, every third household in the list was chosen for the study (the very first household was selected by using a table of random numbers). Any selected household that was inaccessible during the data collection was replaced with the next eligible household on the list. A total of 1,200 respondents (households) were selected using systematic random sampling technique based on population density to represent rural and urban setting in a ratio of 3:1 (267:133) as shown in Table 3.1. Nigeria is described as 75% rural (Ekong, 2013).

3.7 Inclusion criteria

The study included all women of child-bearing age;

1. who had children under 5 years of age
2. who gave informed consent to participate in the study
3. who were healthy and not on medication
4. who had been resident in that location for the past three years
5. Whose consumption was not affected by ill-health, fasting, national holidays, and festive celebrations

3.8 Quality Control

Research Assistants resident within the states were selected and recruited for fieldwork. The criterion for recruitment was that the person has completed or still undergoing undergraduate training. The investigator organized two days training workshop for field Assistants; the purpose of the training workshop was to standardize procedures in order to ensure precision and accuracy in carrying out anthropometric measurements of women and their under-five children, and also in carrying out the interviews with the women. The interviews were conducted in both English and Ibo (the local dialect).

Validity and reliability of research instruments

As described by Babbie (1986) and De Vaus (1996), there are certain steps that must be taken when constructing an index to ensure its validity and reliability. Validity is the extent to which an index measures the concept it purports to measure. Thus, for validity the following steps were taken:

a. It was ensured that all the questionnaire items belonged together conceptually, that is on 'face value', would measure the concepts, as one understands it. For example, 'type of toilet' does not belong to the location indicator.
b. Each variable in the index was scored in the same direction to allow for fair comparison and combination. In other words, the variables were coded so that a high score indicated better economic status in that aspect, and a low score represented a lesser status.

Reliability is the extent to which the index is consistent in measuring what it claims to measure. A reliable measurement is one where we obtain the same result on repeated occasions; its items are so well constructed that there are no ambiguities in meanings and interpretation such that the measurement, if taken several times will yield very little deviation in the scores obtained on the different occasions. The reliability analysis procedure in Statistical Package for the Social Sciences (SPSS) version 16.0 was used to obtain inter-item correlation among the four composite indicators making up the socio-economic status (SES) index. This provided a measure of overall reliability of the scale (index) as measured by a statistic called 'Cronbach alpha'. This ranges between 0 and 1, the higher the figure, the more reliable the index, and for reliability, it must be at least 0.7. For this study, the questionnaire was administered to a sample of

20 subjects in a location similar to but not part of the study area. The computed alpha was 0.727, thus the SES is reliable.

3.9 Ethical clearance

Ethical clearance to carry out the project was given by University of Ibadan/University College Hospital (UI/UCH) ethics committee, College of Medicine University of Ibadan.

An introductory letter was given to the investigator from the Department of Human Nutrition to the local government chairmen. The local government chairmen handed the investigator over to the nutrition officers who took her to the community heads and ward chairmen. Consent was given to the investigator to carry out the research in the communities and the investigor was introduced to the women. The purpose of the study was explained to the women who gave their consents and also dully filled the informed consent forms. Participants (women) were informed of their freedom to withdraw, or refuse to take part in the study without prejudice.

3.10 Data Collection and research tools

A semi-structured interviewer-administered questionnaire was designed and pre-tested to collect information used for this study. The questionnaire had four sections which included;

a. **Respondent Profile:** This was used to collect information on household identification, household composition and socio-economic characteristics of households. Information from this section included the respondent's name, age, relationship to household head, marital status, household size.

b. **Socio-economic characteristics:** religion, ethnic group, highest educational level attained by both the respondent and head of household, primary occupation of respondent and head of household, primary source of domestic lighting, primary source of water for domestic use, method of refuse disposal, type of toilet, estimated income of respondent and head of household, ownership of house, source of fire for cooking, household equipment.

Socio-economic status: Socio-economic status of household was determined by using level of formal education of respondents and husband, income of respondents and husband, occupation, possessions (house ownership, freezer/fridge, DSTV and car/motorcycle). One mark each was given to each item. Higher scores indicate higher socio-economic status and lower scores indicate lower socio-economic status. They were classified based on their percentile of 25th, 50th and 75th.

c. **Anthropometric Measurements:**

This section was used to collect information on weight and height measurements. **Women**: Heights of women were measured in meters using the stadiometer. Subjects (women) were made to stand and look straight without shoes, with their backs on the stadiometer. Heels, buttocks, shoulders and occipitals were made to touch the stadiometer.

Weights- of women were measured using a sensitive weighing bathroom scale (*Hana,model manufacturer* bathroom scale). Each subject was made to stand erect on the scale with light clothing and without shoes. The readings were taken in kilogrammes (kg). The scale reading was always allowed to return to zero before the subject was asked to stand on it.

Children: Length of children 0-2 years was measured using a length board. Children were placed on the flat board and the knee of the baby pressed down to obtain the actual length of the child with the feet perpendicular to the length board. Children above 3 years were made to stand and look straight without shoes, with their backs on the stadiometer. Heels, buttocks, shoulders and occipitals were made to touch the stadiometer. The measurement was done following standard techniques (WHO, 2008).

Weights- Mothers were weighed then they were reweighed carrying their 0-24 months' old children. The mothers' individual weight was subtracted from the weight of the mothers and their 0-24 months children to obtain the mothers' and children's weight separately. While the weight of children above three years were obtained using sensitive weighing bathroom scale (*Hana* bathroom scale). Each child was made to stand erect on the scale with light clothing and without shoes.

d. Multi-pass, interactive Twenty-Four hours (24-hours) dietary recall technique for the mother: This method was employed to collect information on all foods consumed in the 24 hour preceding the interview. The questionnaire has seven column namely, item number, list of food/drink consumed, description of food or drink consumed, estimates of quantity consumed using volumes,sizes or prices, place where food was consumed, time of consumption, amount actually consumed and weight equivalent. Recall of all foods consumed by the women during the previous 24-hour period was performed on 2 non- consecutive days of the weekdays and weekend.

Each woman involved in the study was asked to recall all the foods, snacks, or other foods she had eaten during these periods regardless of whether the food was eaten in or outside the home. From a practical point of view, the woman was allowed to describe spontaneously her food consumption without trying to get the amount and then prompted to be sure that no meal or snacks was forgotten. Next, the recipe for the dishes was collected from either the person in charge of their preparation or directly from the woman being interviewed. The place and time where the food was consumed were also noted. The amounts consumed by the women were determined using food models, measuring cups, measuring spoons, prices of food items/diets etc. The amount actually taken was determined and converted into weight equivalents. The weight was now fed into the Total Dietary Assessment (TDA) to determine the nutrient intake of the women.

3.11 Data Analyses

a. Measurement of Dietary Diversity Score

Using information collected from the two non-consecutive 24-hour dietary recalls, the dietary diversity was assessed based on the number of food groups consumed over the immediate past 24-hours. A maximum of fourteen food groups was used in assessing the dietary diversity of subjects. A point was awarded to each food group consumed over the reference period, and the sum of all points was calculated for the dietary diversity score for each individual.

Table 3.2: Food groups used for individual and household dietary diversity assessments

1	**Cereals**	All cereal grains and cereals based products including rice, wheat, sorghum, millet, maize, bread, biscuits, cake, noodles, and products made from any of the grains.
2	**Vitamin A vegetables and tubers**	These include carrots, tomato, squash and sweet rice vegetables potatoes that are orange inside, ripe plantain and tubers
3	**White tubers and roots**	These include white potatoes, white yams, cassava, cocoyam, water yam, ona and foods made from these roots, unripe plantain and tubers
4	**Dark green leafy vegetables**	Dark green/leafy vegetables including pumpkin leaves, water leaves, green, orah, uziza leaves, okazi leaves, bitter leaves, garden egg leaves etc.
5	**Other vegetables**	Examples include onions, garden egg, green peas, green beans, cabbage, okra etc.
6	**Vitamin A rich fruits**	Examples include ripe mangoes, pawpaw, and star apple.
7	**Other fruits**	These include citrus fruits (oranges, grapes, lemon etc) banana, pears, pineapple, shawashop etc
8	**Organ meat (iron rich)**	Liver, kidney, heart, offal etc
9	**Flesh meat**	Beef, pork, lamb, goat, rabbit, wild game, chicken, and other birds.
10	**Eggs**	Eggs
11	**Legumes, nuts and seeds**	Beans, peas, lentils, nuts including groundnuts, cashew nuts, seeds including melon seeds, etc.
12	**Fish**	Fresh or dried fish, shell fish.
13	**Milk and milk products**	Milk, cheese, yogurt, ice-cream etc
14	**Oils and fats**	Red palm oils, Oils, fats, margarine or butter added to food or used in cooking
15	**Sweets**	Sugar, honey, sweetened soda and sugary foods such as chocolates, sweets and candies
16	**Spices, Condiments, beverages**	Spices, condiments, coffee, tea, alcoholic and beverages.

The first fourteen food groups were used for the individual dietary diversity assessments while the whole sixteen food groups were used for the household dietary assessment (FAO, 2007).

ii. Classification of Dietary Diversity Terciles: Dietary Diversity terciles were derived from the Fourteen (14) food groups and categorized into low, medium and high dietary diversity. Individual dietary diversity score (IDDS) were then classified based on their position on the scale. The classification is as follows; 1-4 food groups was classified as low, 5-9 as average and 10-14 as high.

b. Measurement of Dietary Quality

For calculation of dietary quality score using the method of Kim *et al*., (2003), five food groups were used. These were cereals/grains, vegetables, meat/poultry/fish/egg, fruits and dairy/beans. The five groups do not include roots and tubers which are the main staple food consumed in the South-East of Nigeria. Hence the food groups were modified to include roots and tubers in the grains group. Therefore the food groups used to calculate diet quality were grains/Roots/Tubers, vegetables, meat/poultry/fish/egg, fruits, dairy and beans'

The dietary quality Index-international (DQI-I) focused on four major aspects of a high-quality diet, i.e. variety, adequacy, moderation and overall balance. Under each of these categories specific components of the diets was assessed. These distinctive categories help users to readily identify aspects of the diet that most needed improvement. Average scores of the five food groups for the two non-consective 24 hour diet recall was used to calculate the diet quality of South-East Nigeria. Scores for each component were summarized in each of the four main categories, and the scores for all four categories were summed, resulting in the total DQI-I score, ranging from 0 to 100 (0 being the poorest and 100 being the highest possible score; see Table 3.5).

i. Variety: This was evaluated in two ways: overall variety and variety within group. Overall variety means inclusion of at least one serving per day from each of the food groups. The scores from these five groups define the maximum overall variety score. Variety within group involved choosing different foods among the protein sources (meat, poultry, fish, dairy, beans and eggs). This was included to illustrate the benefits of including diverse sources of food in the diet even within the same food group. Intake of more than half the serving size per day was considered to be meaningful consumption. A diet that had variety within a similar food group as well as an overall variety was believed to be superior to a diet with a monotonous source.

ii. Adequacy: This category evaluated the intake of dietary elements that must be supplied sufficiently as a precaution against undernutrition and deficiency disorders.

The recommended intake of fruit, vegetables, grains/roots/tubers and fibre was dependent on energy intake. A diet that contains two to four servings of fruit and three to five serving of vegetables, depending on three levels of energy intake 1700 kcal, 2200 kcal and 2700 kcal, was given the highest score of five points (Kim *et al.,* 2003). Daily intakes of six or more, nine or more, and eleven or more servings from the grain group and more than 20, 25 and 30 g of fibre for the three energy intake categories, respectively, met the criteria for the highest score for the grain/root/tubers and fibre components (Kim *et al.*, 2003). Intake of protein was adequate when the proportion of total energy from protein was more than 10 %. The level of intake that defines the highest score for adequacy of iron, calcium and vitamin C was derived from the recommended daily intakes (USDA, 2000) which vary according to age and gender.

Components	**Criteria**
Vegetables group	≥ 3-5 serving/day
Fruit group	≥ 2-4 serving/day
Grains/Roots/Tubers	6-11 serving/day
Fiber	20-30g/day
Protein	10% of energy/day
Iron	100% of RDA (10-30mg/day)
Calcium	100% RDA (1000-1300mg/day)
Vitamin C	100% of RDA (70mg/day)

iii. Moderation. Moderation evaluated the intake of food and nutrients that were related to chronic diseases and that needed restriction. To emphasize the importance of moderation in fat intake, total fat intake in the DQI-I was evaluated using more stringent cut-off values than those found in other dietary indices. Caution for intake of saturated fats was also evaluated on the basis of percentage of energy from saturated fat. Intakes of cholesterol and sodium were examined on the basis of the level of the intakes (Table 3.5).

The 'empty calorie food' component assessed how much a person's energy supply was dependent on low-nutrient density foods, which provided energy but insufficient nutrients. The DQI-I stated that foods such as table sugar, alcohol, honey are empty calorie foods.

iv. Overall balance. This category examined overall balance of diet in terms of proportion of energy sources and fatty acid composition. The detailed cut-off values and corresponding scores are described in (Table 3.6)

Table 3.3: Components of Diet Quality Index-International (DQI-I)

Component	Score ranges	Point	Score criteria
DQI-I, total	0-100		
Variety	0-20		
Overall food group variety	**0-15**	**15**	**≥1 serving from each food group/d**
		12	Any 1 food group missing/d
		9	Any 2 food groups missing/d
		6	Any 3 food groups missing/d
		3	≥ food groups missing/d
		0	None from any food group
Within-group variety from protein source	**0-5**	**5**	**≥3 different sources/d**
		3	2 different sources/d
		1	From 1 source/d
		0	None
Adequacy	**0-40**		
Vegetable	0-5	5	>100% recommendation
		3	50-100% recommendations
		1	<50% recommendations
		0	0% recommendations
Fruit group	**0-5**	**5**	**>100% recommendations**
		3	50-100% recommendations
		1	<50% recommendations
		0	0% recommendations
Grain group	**0-5**	**5**	**>100% recommendations**
		3	50-100% recommendations
		1	<50% recommendations
		0	0% recommendations
Fibre group	0-5	5	**>100% recommendations**
		3	50-100% recommendations
		1	<50% recommendations
		0	0% recommendations
Protein	**0-5**	**5**	**>100% recommendations**
		3	50-100% recommendations
		1	<50% recommendations
		0	0% recommendations
Iron	**0-5**	**5**	**>100% recommendations**
		3	50-100% recommendations
		1	<50% recommendations
Calcium	**0-5**	**5**	**>100% recommendations**
		3	50-100% recommendations
		1	<50% recommendations
		0	0% recommendations
Vitamin C	**0-5**	**5**	**>100% recommendations**
		3	50-100% recommendations
		1	<50% recommendations
		0	0% recommendations
Moderation	**0-30**		
Total fat	**0-6**	**6**	**≤20% of total energy/d**
		3	>20-30% of total energy/d
		0	>30% of total energy/d
Saturated fat	**0-6**	**6**	**≤7% of total energy/d**
		3	>7-10% of total energy/d
		0	>10% of total energy/d
Cholesterol	**0-6**	**6**	**≤300 mg/d**
		3	> 300-400 mg/d
		0	>400 mg/d
Sodium	**0-6**	**6**	**≤2400 mg/d**
		3	>2400-3400 mg/d
		0	>3400 mg/d
Empty calorie food	**0-6**	**6**	**≤3% total energy/d**
		3	> 3-10% total energy/d
		0	>10% total energy/d
Overall balance	**0-10**		
Macronutrient (carbohydrate-protein-fat	**0-6**	**6**	**55-65:10-15:15-25**
		4	52-68:9-16:13-27
		2	50-70:8-17:12-30
		0	Otherwise
Fatty acid ratio	**0-4**	**4**	**p/s=1-1.5; M/S = 1-1.5**
		2	P/S=0.8-1.7; M/S=0.8-1.7
		0	Otherwise

Table from Kim *et al.*, (2003) M/S ratio of MUFA to SFA intakes; P/S, ratio of PUFA to SFA intakes; SFA, saturated fatty acids.

a. Based on 7140kj (1700kcal), 9,240kj (2200 kcal), 11,340kj (2700 kcal.)

b. Iron, calcium and vitamin C was based on recommended daily intakes by (WHO, 1996).

c. Measurement of Nutrient Adequacy: Nutrient intake was determined using Adapted Total Dietary Assessment (TDA) software version 3 (2001) and compared to recommended nutrient intake (RNI) by FAO/WHO (2002). The nutrient adequacy ratio for energy, fat, carbohydrate, protein, Iron, magnesium, zinc, potassium, sodium, phosphorus, calcium and vitamin C were calculated using the formula: nutrient Intake of an individual divided by recommended Dietary Allowance (RNI) for that individual (Madden *et al.*, 1976; Guthrie and Scheer, 1981). Nutrient Adequacy was classified as follows:

(1) Adequate- 80-120%

2) Inadequate

- Mild/moderate- <80%
- Severe- < 60%

(3) Excess- >120%

d. Measurement of BMI: Weights and heights were used to calculate Body Mass Index of mothers using the formular; BMI = $Weight^{kg}/height^2$. The BMI calculated was compared with World Health Organization (2000) standard. The nutritional status of women was classified as follows:

(i) Underweight: < 18.5

(ii) Normal: 18.5 - 24.9

(iii) Overweight: 25- 29.9

(iv)Obesity: 30 - 39.9

(v) Morbid obesity: > 40

e. Assesment of wasting, stunting and underweight in Children

The Z score of children was determined using WHO Anthro (2005), anthropometric data that were provided through the measurement of child's length, and weight in relation to child's age. Three indices of undernutrition were used to quantify the nutritional status of children in the study area. This was done by calculating their Z score with (WHO Anthro, 2005) method and it was compared with the National Center for Health Statistics (NHCHS) reference population international standard Z score where less than -2 SD indicate malnutrition in a child. Children were classified as follows:

(i) Wasting: low weight for height with Z score <-2SD

(ii) Underweight: low weight for age with Z score <-2 SD

(iii) Stunted: low height for age with Z score<-2 SD

ii. Z score analysis

Under- nutrition among children is measured by determining the anthropometric status of the child. There are three types of under-nutrition; first is wasting or insufficient weight for height indicating acute under-nutrition; second is stunting or insufficient height for age indicating chronic under-nutrition; and third, underweight or insufficient weight for age which are determined using Z score.

The Z- score for weight-for –age was used to denote underweight as an overall indicator for malnutrition. Height-for-age was used as an indicator for stunting. Weight-for-height z-score was used an indicator for wasting. The Z-scores were calculated based on the median values of the National Center for Health Statistics (NHCHS) Reference Population. In this study, children who had Z-scores below -2 standard deviations (SD) of the NCHS Reference Population median were considered significantly malnourished. The Z-scores for weight- for- height, height-for-age and weight-for-age were derived using (WHO Anthro, 2005). Other analyses were done using the Statistical Package for the Social Sciences (SPSS) for windows (version 16, 2007).

F. Measurement of Stunted Children Overweight Mothers

Stunting was defined as height-for-age <-2 SD of reference population and maternal overweight as a Body Mass Index >25 kg/m^2. Data of Children 6 to 60 months old and non-pregnant mothers aged 18 years and above were employed for this analysis. The prevalence of stunted children, overweight mothers, (as a percentage of total child-mother pairs) in the South East was measured using Statistical Package for the Social Sciences (SPSS, 2007).

3.12 Independent and Dependent variables

Independent variables were Socio-economic factors (employment status, income level), demographic variables (age, educational level, marital status and family size). Dependent variables were Dietary diversity, dietary quality, nutrient adequacy, BMI.

3.13 Statistical Analysis:

Data analysis

Age, weight, height and two days non-consecutive food intake of the mothers were entered into the computer using TDA package. Standardized sex-specific z-scores and prevalence for height-for-age, weight-for-age and weight-for-height for the children were calculated from weight, height and age measurements of the children with WHO Anthro (2005) software. The z-scores and remaining (unanalyzed) questionnaire data were then transferred into the Statistical Package for the Social Sciences (SPSS) version 16.0, for further analysis of the data, involving appropriate descriptive and inferential statistical methods.

For the descriptive statistics, frequency counts, percentages, means, standard deviation, chi square and charts were used to describe and summarize the questionnaire data. The scores of diet quality and BMI in the different study locations were obtained from TDA. Analysis of variance (ANOVA) procedure was used to determine any significant differences in the dietary diversity, diet quality and BMI in the three states, sectors (urban and rural) and local government areas. In addition, Least Score Difference (LSD) was used to determine any significant differences in the dietary diversity, diet quality and BMI within each of the three states, and nine local governments.

To test the hypotheses, T-test and correlation was used to explore the relationship between the dependent variables (dietary diversity, diet quality and BMI) and independent variables (the demographic variables). Correlation analysis was used to summarize the relationship between two variables. Furthermore, multivariate analysis (regression analysis) was used to predict to what extent the various components of nutrients is significant in explaining the diet quality of individuals and other countries.

CHAPTER FOUR

RESULTS

SECTION A: MATERNAL CHARACTERISTICS

Table 4.1: Mean Age (yrs), weight (kg), height (m) and family size

State		Minimum	Maximum	Mean	SD
Imo state	Age of mother	19.00	45.00	28.69	5.53
	Height of mother	1.45.00	1.85.00	1.59.10	1.92
	Weight of mother	37.00	120.00	66.74	13.67
	Family size	2	15	5.21	1.92
Enugu state	Age of mother	16.00	53.00	28.14	5.57
	Height of mother	1.23.00	1.78.00	1.60.56	0.07
	Weight of mother	44.00	120.00	70.87	12.62
	Family size	3	11	4.79	1.64
Anambra state	Age of mother	15.00	50.00	27.81	5.86
	Height of mother	1.03.00	1.88.00	1.61.56	0.7
	Weight of mother	42.00	121.00	69.73	14.99
	Family size	2	11	5.07	1.71
Total	Age of mother	15.00	50.00	28.22	5.58
	Height of mother	1.45.00	1.88.00	1.60	0.08
	Weight of mother	37.00	121.00	69.11	13.89
	Family Size	2	15	5.02	1.77

SD-standard deviation

The mean age of the respondents was 28.22±5.58 yrs; the mean height and weight were 1.60±0.08m and 69.11±13.89kg, respectively. The minimum family size was 2 and maximum of 15 with a mean of 5.02±1.77 person in the household in the South-East of Nigeria.

Section B: *Socio-economic characteristics of respondents*

Table 4.2: Marital Status, relationship to head of household, ethnic group and religion

MARITAL STATUS	IMO	ENUGU	ANAMBRA	TOTAL
Married	380(95.0)	391(97.8)	385(96.25)	1156(96.3)
Single	12(3.0)	8(2.0)	13(3.25)	33(2.8)
Widowed	4(1.0)	0(0.0)	2(0.5)	6(0.5)
Divorced	4(1.0))	1(0.2)	0(0.0)	5(0.4)
Total	400(100)	400(100)	400(100)	1200(100)
RELATION WITH HEAD OF HOUSEHOLD				
head of household	27(6.75)	8(2.00)	5(1.25)	40(3.33)
Wife	356(89.0)	382(95.5)	382(95.5)	1120(93.34)
daughter	14(3.50)	5(1.25)	12(3.0)	31(2.58)
Others	3(0.75)	5(1.25)	1(0.25)	9(0.75)
Total	400(100)	400(100)	400(100)	1200(100)
RELIGION				
Christianity	400(100)	398(99.5)	396(99.0)	1194(99.5)
Islam	0(0.00)	2(0.50)	1(0.20)	3(0.25)
Traditional religion	0(0.00)	0(0.00)	3(0.80)	3(0.25)
Total	400(100)	400(100)	400(100)	1200(100)
ETHNIC GROUP				
Yoruba	2(0.50)	4(1.00)	0(0.00)	6(0.50)
Ibo	393(98.25)	379(94.8)	398(99.5)	1170(97.50)
Hausa	0(0.00)	4(1.0)	0(0.00)	4(0.30)
Others	5(1.25)	13(3.2)	2(0.50)	20(1.70)
Total	400(100)	400(100)	400(100)	1200(100)

Majority of the women were married (96.3%), 2.8% were single; only a few were widowed (0.5%) or divorced (0.4%). Result shows that majority (97.5%) were Ibos, 0.5% Yorubas, 0.3% Hausas and 1.7% from other tribes. Majority (99.5%) were Christians, 0.25% practiced Islamic religion and 0.25% was traditionalists.

Table 4.3: State of residence, sector and educational level of head of household

Variables	Imo N (%)	Enugu N (%)	Anambra N (%)	Total N (%)
Sector				
Rural	268(67.00)	267(66.80)	268(67.00)	803(66.90)
Urban	132(33.00)	133(33.20)	132(33.00)	397(33.10)
Total	400(100)	400(100)	400(100)	1200(100)
Educational level of head of household				
University degree	71(17.75)	95 (23.75)	55(13.75)	221(18.42)
Polytechnic/diploma	25(6.25)	35(8.75)	18(4.50)	78(6.50)
Secondary completed	225(56.25)	204(51.00)	213(53.25)	642(53.50)
Secondary school not completed	40(10.00)	35(8.75)	50(12.50)	125(10.42)
Primary school	38(9.50)	29(7.25)	57(14.25)	124(10.33)
No formal education	1(0.25)	2(0.50)	7(1.75)	10(0.83)
Total	400(100)	400(100)	400(100)	1200(100)
Educational level of respondent				
University degree	71(17.75)	68(17.00)	42(10.50)	181(15.1)
Polytechnic/diploma	59(14.75)	64(16.00)	39(9.80)	162(13.5)
Secondary completed	227(56.75)	211(52.8)	221(55.20)	659(54.9)
Secondary school not completed	30(7.50)	37(9.2)	67(16.8)	134(11.2)
Primary school	7(1.75)	18(4.50)	29(7.20)	54(4.5)
No formal education	6(1.50)	2(0.50)	2(0.5)	10(0.8)
Total	400(100)	400(100)	400(100)	1200(100)

N (%) = Number (percentage)

The subjects studied were made up of 803(66.9%) from rural and 397(33.1%) from urban. The heads of household that obtained University education were 221 (18.4%) while 78 (6.5%) obtained polytechnic/diploma degree. Majority of the women 642 (53.5%) came from homes where the heads completed secondary school education. One hundred and twenty five (10.4%), 124 (10.3%) and 10 (0.8%) of the subjects came from homes where the heads had not completed secondary school, primary school and no formal education. For the respondents, 181(15.1%) had university education, 162 (13.5%) polytechnic/diploma degree; 659 (54.9%) completed secondary school; 134(11.2%), 54 (4.5%) and10 (0.8%) did not complete secondary school, had primary school education and no formal education.

Table 4.4: Estimated income and occupation

Variables	States			
Income of head of household (₦) (estimated)	**Imo N(%)**	**Enugu N (%)**	**Anambra N (%)**	**Total N (%)**
₦55,000 and above	10(2.5)	40(10.0)	25(6.25)	75(6.25)
₦ 45, 000-54,999	9(2.25)	17(4.25)	6(1.5)	32(2.67)
₦15, 000-44, 999	55(13.75)	103(25.75)	80(20.0)	250(20.83)
₦ 5, 000-14, 999	13(3.25)	63(15.75)	48(12.0)	112(9.33)
Don't know	313(78.25)	177(44.25)	241(60.25)	731(60.92)
Total	**400(100)**	**400(100)**	**400(100)**	**1200(100)**
Income of respondent (₦) (estimated)				
₦ 55,000 and above	4(1.0)	6(1.5)	4(1.0)	14(1.16)
₦ 45, 000-54,999	3(0.75)	9(2.25)	6(1.5)	18(1.5)
₦15, 000-44, 999	56(14.0)	74(18.5)	59(14.75)	189(15.75)
₦ 5, 000-14, 999	84(21.0)	128(32.0)	147(36.75)	359(29.92)
Don't know	149(37.25)	47(11.75)	82(20.5)	278(23.17)
No income	104(26.0)	136(34.0)	102(25.5)	342(28.5)
Total	**400(100)**	**400(100)**	**400(100)**	**1200(100)**
Occupation of head of household				
Farmer	6(1.5)	6(1.5)	10(2.5)	22(1.83)
Trader	175(43.75)	146(36.5)	156(39.0)	477(39.75)
Civil servant	54(13.5)	111(27.75)	64(16.0)	229(19.08)
Artisan	70(17.5)	47(11.75)	67(16.75)	184(15.33)
Religious leader	11(2.75)	8(2.0)	11(2.75)	30(2.52)
Professional*	16(4.0)	30(7.5)	24(6.0)	70(5.83)
Unemployed	7(1.75)	11(2.75)	4(1.0)	22(1.83)
Others	61(15.25)	41(10.25)	64(16.0)	166(13.83)
Total	**400(100)**	**400(100)**	**400(100)**	**1200(100)**
Occupation of respondent				
Farmer	16(4.0)	3(0.75)	8(2.0)	27(2.25)
Trader	177(44.25)	151(37.75)	172(43.0)	500(41.67)
Civil servant	50(12.5)	60(15.0)	62(15.5)	172(14.33)
Artisan	22(5.5)	23(5.75)	18(4.5)	63(5.25)
Religious leader	0(0.0)	0(0.0)	4(1.0)	4(0.33)
Professional*	10(2.5)	4(1.0)	7(1.8)	21(1.75)
Unemployed	81(20.25)	132(33.0)	96(24.0)	309(25.75)
Others	44(11.0)	27(6.75)	33(8.2)	104(8.67)
Total	**400(100)**	**400(100)**	**400(100)**	**1200(100)**

*Doctors, Engineers, Architects, Nurses and others. N=numbers

Up to 731(60.9%) and 278(23.2%) had no idea of the income of head of household and the respondents income, respectively; 26.0% of heads of household and 43.50% of respondents earned between ₦ 5,000 and ₦ 34, 999 while 107(8.9%) of heads of household and 32 (2.7%) of respondents earned ₦ 45,000 above. The predominant occupations included: trading, 477 (39.8%), civil service, 229 (19.1%) and Artisans 184 (15.4%) for the head of households, while respondents were also predominantly traders 500 (41.7%); civil servants, 172 (14.3%) and artisans, 63(5.27%); 309(25.7%) of the respondents were unemployed.

Table 4.5: Source of lighting and water, method of refuse disposal and types of toilet

Variables	Imo N (%)	Enugu N (%)	Anambra N (%)	Total N (%)
Source of lighting				
Lantern/candle	19(4.75)	34(8.5)	27(6.75)	80(6.67)
Generator	57(14.25)	56(14.0)	34(8.5)	147(12.25)
PHCN	324(81.0)	308(77.0)	335(83.75)	967(80.58)
Solar	0(0.0)	2(0.5)	2(0.5)	4(0.33)
Others	0(0.0)	0(0.0)	2(0.5)	2(0.17)
Total	400(100)	400(100)	400(100)	1200(100)
Source of water				
Pond/lake	5(1.25)	3(0.75)	1(0.25)	9(0.8)
Spring/river	10(2.5)	22(5.5)	8(2.0)	40(3.3)
Well	4(1.0)	54(13.5)	12(3.0)	70(5.8)
Bore hole	348(87.0)	102(25.5)	268(67.0)	718(59.8)
Pipe-borne	30(7.5)	198(49.5)	73(18.25)	301(25.1)
Rain water harvest	1(0.25)	7(1.75)	18(4.5)	26(2.2)
Sachet water regularly	2(0.5)	11(2.75)	20(5.0)	33(2.8)
Others	0(0.0)	3(0.75)	0(0.0)	3(0.2)
Total	400(100)	400(100)	400(100)	1200(100)
Method of refuse disposal				
Bush	214(53.5)	76(19.0)	159(39.75)	449(37.42)
Refuse dump	141(35.2)	152(38.0)	176(44.0)	469(39.08)
City services	35(8.8)	162(40.5)	58(14.5)	255(21.25)
Others	10(2.5)	10(2.5)	7(1.75)	27(2.25)
Total	400(100)	400(100)	400(100)	1200(100)
Type of toilet				
Bush/river	12(3.00)	28(7.00)	32(8.00)	72(6.00)
Pit latrine	147(36.75)	89(22.25)	161(40.25)	397(33.08)
Vip latrine	2(0.50)	14(3.50)	6(1.50)	22(1.82)
Water closet	239(59.75)	269(67.25)	200(50.00)	708(59.0)
Other	0(0.00)	0(0.00)	1(0.25)	1(0.10)
Total	400(100)	400(100)	400(100)	1200(100)

PHCN= Power Holding Company of Nigeria; VIP = Ventilated Improved Pit latrine, N = Numbers

Majority of the subjects 967 (80.6) used electricity supplied by Power Holding Company of Nigeria (PHCN) as their primary source of light. Other sources of light in the houses were Generator 147 (12.3%), Lantern/candle 80(6.7) and Solar energy 4 (0.3%). The commonest source of water was Bore-hole 718(59.8%), and Pipe-borne water 301(25.1%). Majority used Refuse dump 469(39.1%), Bush 449(37.4%) and

City Services 225(21.2%). The type of toilets most commonly used were water Closet 708(59.0 %), Pit latrine 397(33.1%) and Bush/River 70(5.8%).

SECTION C: Dietary diversity

Table 4.6: Weekly frequency of consumptions of food groups (%)

Food groups	Imo N (%)	Enugu N (%)	Anambra N(%)	Total N (%)
Cereals	367(91.87)	366(91.5)	371(92.8)	1104(92.0)
Vit A Rich Vegetables	229(57.2)	155(38.8)	187(46.8)	571(47.6)
White tuber	339(84.8)	278(69.5)	327(81.8)	944(78.7)
Dark green vegetables	301(75.2)	142(35.5)	220(55.0)	663(55.2)
Other vegetables	171(42.8)	123(30.8)	100(25.0)	394(32.8)
Vit A fruits	46(11.5)	47(11.8)	33(8.2)	126(10.5)
Other fruits	69(17.2)	66(16.5)	81(20.2)	216(18.0)
Organ meat	18(4.5)	2(0.5)	2(0.5)	22(1.8)
Flesh meat	213(53.2)	228(57.0)	257(64.2)	698(58.2)
Eggs	37(9.2)	19(4.8)	22(5.5)	78(6.5)
Fish	346(86.5)	281(70.2)	292(73.0)	919(76.6)
Legumes and nuts	203(50.8)	237(59.2)	206(51.5)	646(53.8)
Milk products	231(57.8)	181(45.2)	222(55.5)	634(52.8)
Oils and fats	393(98.2)	389(97.2)	394(98.5)	1176(98.0)

N = Numbers

Table 4.6 shows the percentage and the number of subjects from the three States who consumed food items from each of the food groups. One thousand one hundred and four (1104)(92.0%) of the subjects consumed foods from cereal products, 571 (47.6%) from Vitamin A vegetables, 944(78.7%) from white tuber, 663(55.2%) from dark green vegetables, 394(32.8%) from other vegetables, 126(10.5%) from Vitamin A fruits, 216(18.0%) from other fruits, 22(1.8%) from organ meat, 698(58.2%) from flesh meat, 78(6.5%) from egg, 919(76.6%) from fish, 646(53.8%) from legumes and nuts, 638(52.8%) from milk products and 1176(98.0%) ate foods from oils and fats.

Table 4.7: Dietary diversity scores N (%)

	Dietary diversity scores (DDS) in the three states			
DDS	**Imo**	**Enugu**	**Anambra**	**Total**
2	0 (0)	1(0.2)	2(0.5)	3(0.2)
3	5(1.2)	10(2.5)	4(1.0)	19(1.6)
4	24(6.0)	24(6.0)	21(5.2)	69(5.8)
5	51(12.8)	56(14.0)	54(13.5)	161(13.4)
6	89(22.2)	78(19.5)	80(20.0)	247(20.6)
7	88(22.0)	80(20.0)	96(24.0)	264(22.0)
8	59(14.8)	72(18.0)	75(18.8)	206(17.2)
9	35(8.8)	53(13.2)	49(12.2)	137(11.4)
10	10(2.5)	19(4.8)	18(4.5)	47(3.9)
11	39(9.8)	7(1.8)	1(0.5)	47(3.9)
N	400	400	400	1200(100%)

Diet diversity scores (DDS) of individual subjects ranged between 2-11 (Table 4.7).The dietary diversity of highest frequencies were 7 (22.0%), 6(20.6%), 8(17.2%) 5(13.4%) and 9 (11.4%).

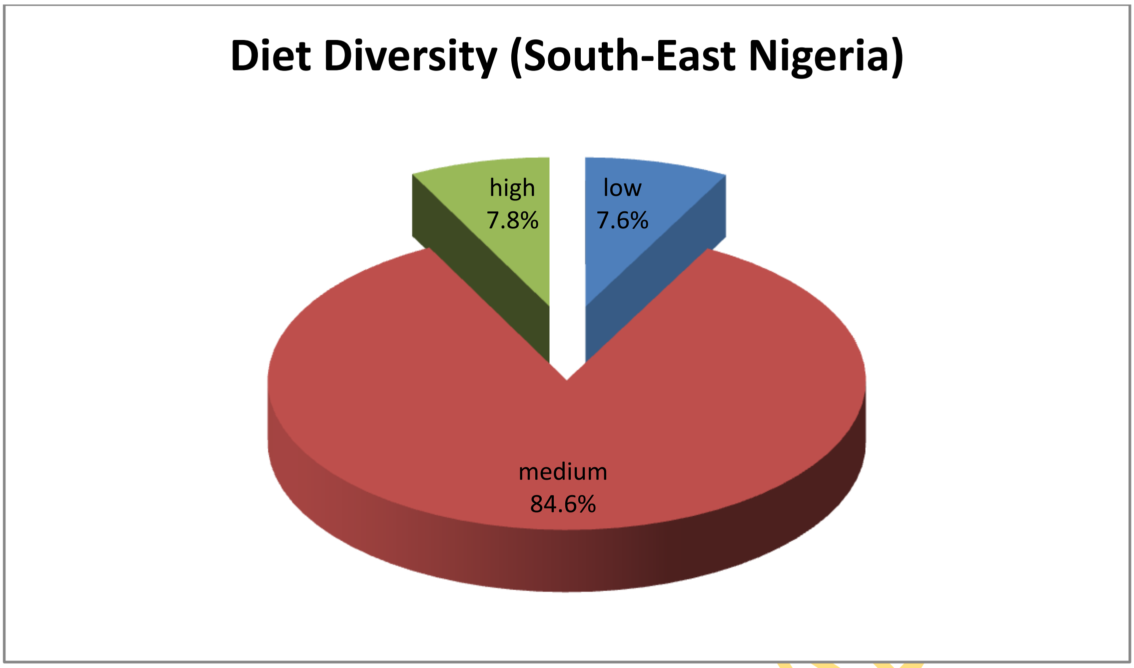

Fig 4.1: Diet Diversity Tercile in the South- East, Nigeria

Figure 4.1 showed the DDS terciles of the South-East, a total of 1015 (84.6%) scored average DDS of (5-9) having the highest frequency, followed by high DDS with 94(7.8%) of the subjects. The least frequency was recorded for low DDS with 91 (7.6%) of the subjects.

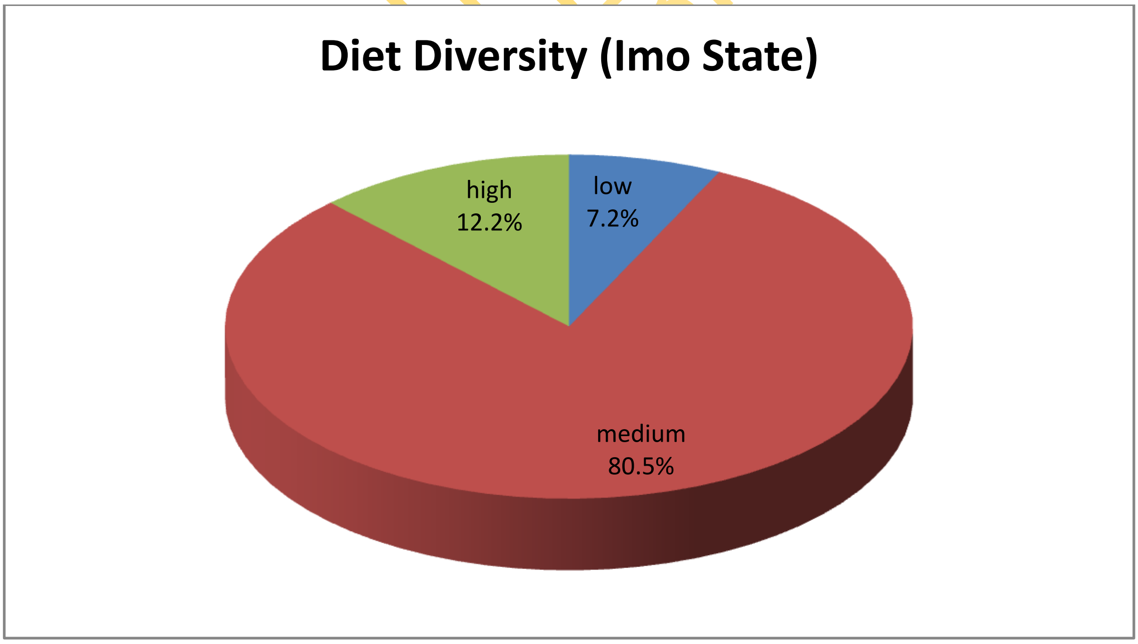

Fig 4.2: Diet diversity terciles of respondents in Imo state

Imo (figure 4.2) recorded 7.2% on the low category, 80.5% on medium and 12.2% on high.

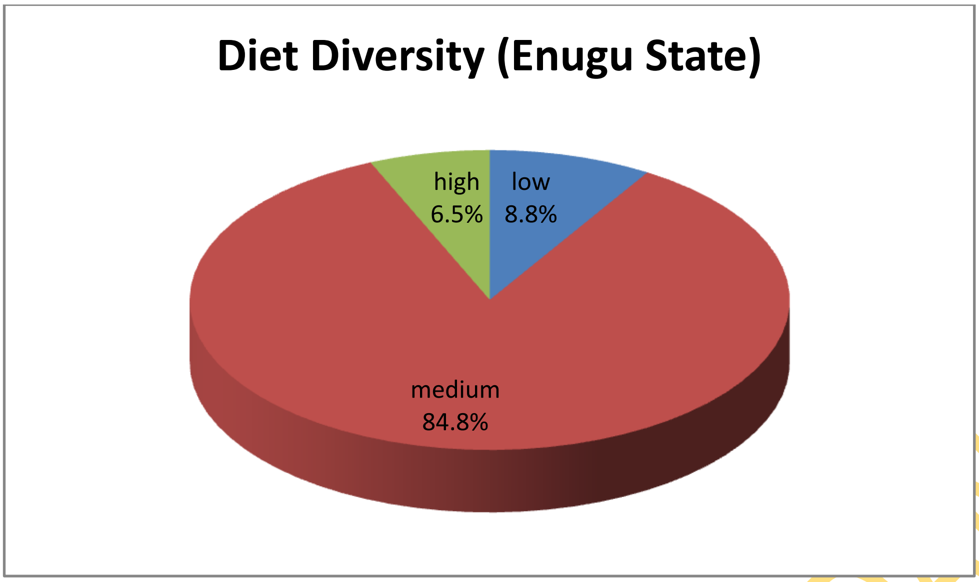

Fig 4.3: Diet diversity terciles of respondents in Enugu state

Enugu (figure 4.3) recorded 8.8% on low, 84.8% on medium and 6.5% on high

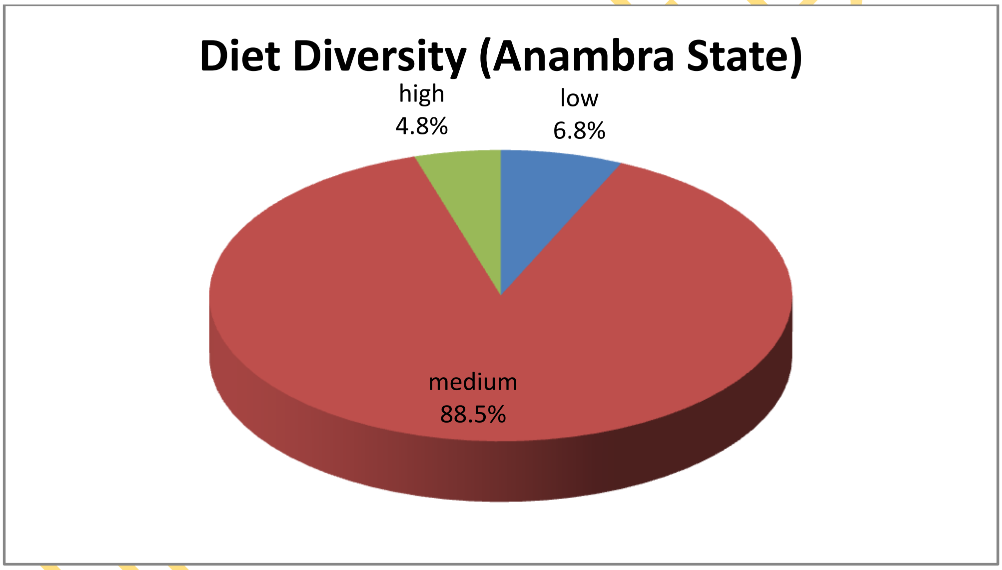

Fig 4.4: Diet diversity terciles of respondents in Anambra state

. Figure 4.4 recorded Anambra Dietary terciles as 6.8% on low, 88.5% on medium and 4.8% on high.

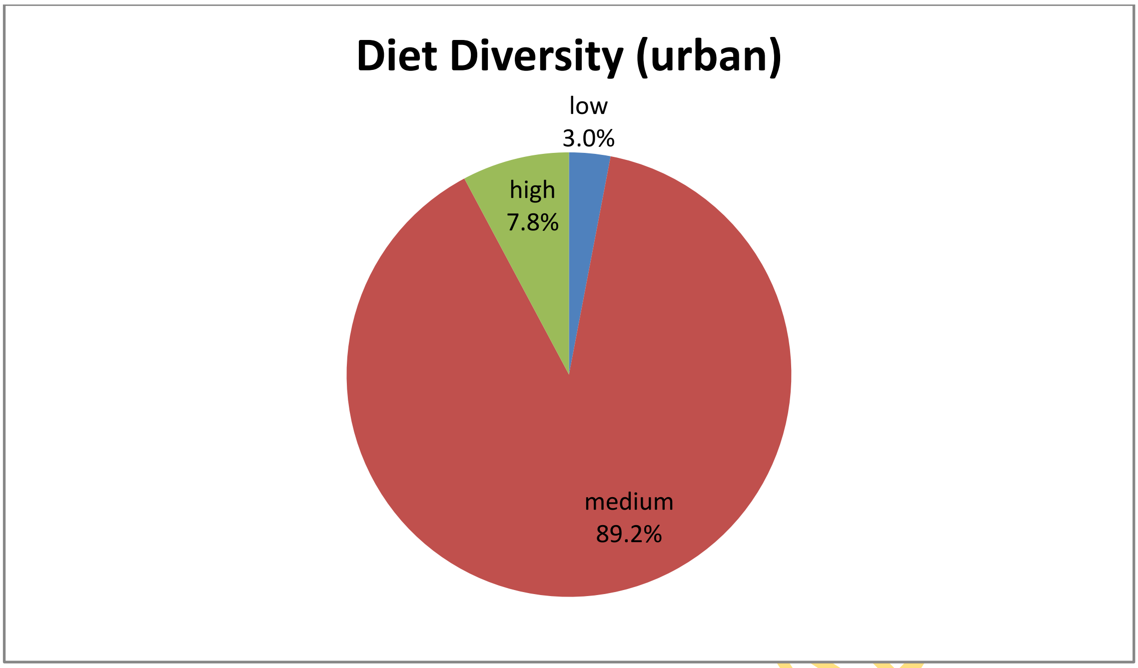

Fig. 4.5 Diet Diversity Terciles of respondents in urban sector

Urban (figure 4.5) recorded 3.0% on the low category, 89.2% on medium and 7.8% on high.

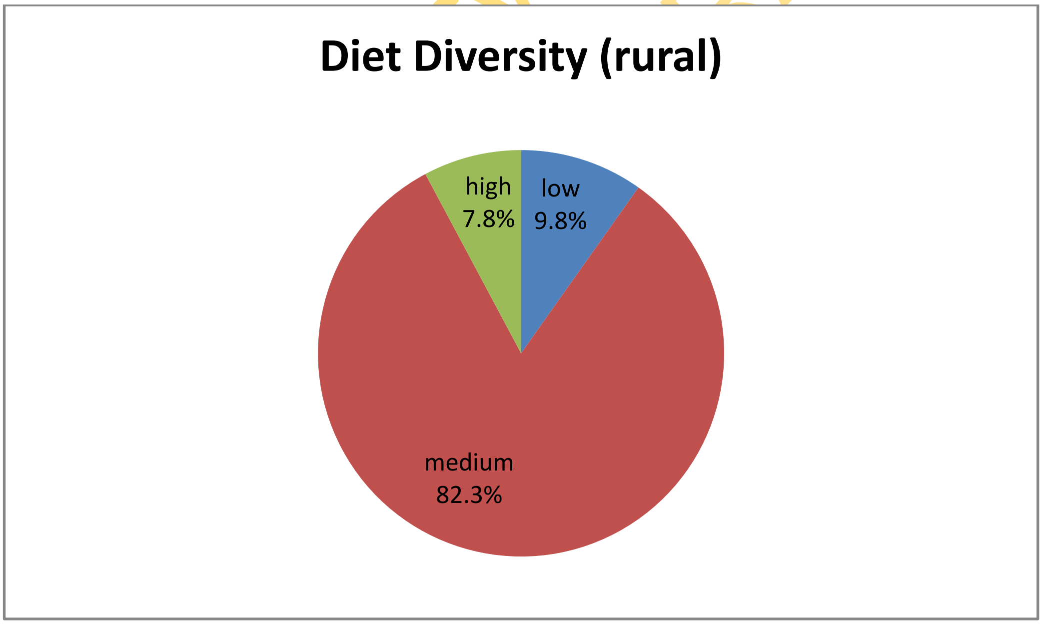

Fig. 4.6 Diet Diversity Terciles of respondents in rural sector

Rural (figure 4.6) recorded 9.8% on the low category, 82.3% on medium and 7.8% on high.

Table 4.8: Comparison of dietary diversity scores (DDS) of respondents in the three states and sectors

State	N	Minimum	Maximum	Mean	SD	p-value
Imo state	400	3.00	11.00	7.10	1.99	
Enugu state	400	2.00	11.00	6.89	1.78	0.17
Anambra state	400	2.00	11.00	6.89	1.62	
Sector						
Urban	397	3.00	11.00	7.04	2.52	
Rural	803	2.00	11.00	6.90	2.43	0.001
Total	**1200**	**2.33**	**11**	**6.96**	**1.80**	

Using one way ANOVA to compare the difference in mean DDS between States, it was found that, there was no significant (P=0.17) difference among States. A t-test revealed a significant (t=6.23, p<.001) mean difference between sectors. Urban with mean (DDS) of 7.04 (2.52) was higher than Rural with a mean (DDS) of 6.90 (2.43). The overall mean DDS among subjects in the South- East was 6.96±1.80. The highest dietary diversity score was recorded for subjects from Imo State (7.10 ± 1.99), followed by Enugu State (6.89±1.78) and Anambra State (6.89 ±1.62).

Table 4.9: mothers' age group, family size DD Score

Age group	Low N (%)	Average N (%)	High N (%)	Total N (%)	p-value
15-19	1(2.6)	24(63.2)	13(34.2)	38(3.17)	0.46
20-34	8(0.8)	584(58.5)	407(40.7)	999(83.25)	
35-50	0(0.0)	98(60.1)	65(39.9)	163(13.58)	
Family size					
1-4	5(0.9)	330(60.0)	215(39.1)	550(45.83)	0.66
5-8	3(0.5)	347(57.8)	250(41.7)	600(50.0)	
9 and above	1(2.0)	29(58.0)	20(40.0)	50(4.17)	

Using one way ANOVA, it was revealed that there was no significant mean difference between different age group of mothers and diet diversity (p=.46).There was no significant difference observed among different family sizes and diet diversity (p=.66). The table above shows that family sizes of between 1-4 and 5-8 had higher DDS.

Table 4.10: Educational level and diet diversity

	DDS Low No (%)	DDS Average No (%)	DDS High No (%)	Total No (%)	p-value
Educational level of head of household					
University degree	3(1.4)	168(76.7)	48(21.9)	219(18.25)	0.88
Polytechnic/diploma	5(6.4)	57(73.1)	16(20.5)	78(6.5)	
Secondary school completed	11(1.7)	509(79.3)	122(19.0)	642(53.5)	
Secondary not completed	2(1.6)	97(77.6)	26(20.8)	125(10.42)	
Primary school	1(0.8)	106(85.5)	17(13.7)	124(10.33)	
No formal education	0(0.0)	8(60.0)	4(40.0)	12(1.00)	
Educational level of respondents					
University degree	3(1.8)	117(70.1)	47(28.1)	167(13.92)	0.62
Polytechnic/diploma	4(2.5)	117(72.2)	41(25.3)	162(13.50)	
Secondary school completed	11(1.7)	539(81.8)	109(16.5)	659(54.92)	
Secondary not completed	3(2.2)	116(83.45)	20(14.9)	139(11.58)	
Primary school	3(1.9)	46(85.2)	7(13.0)	57(4.75)	
No formal education	0(0.0)	8(50.0)	8(50.0)	16(1.33)	

Using ANOVA, to compare the difference in mean the result revealed that there was no significant mean (p= 0.88) difference observed in DDS terciles among educational level of head of household. University degree holders 48(21.9) were highest followed by polytechnic 16(20.5) and secondary school completed 122(19.0). There was no significant difference observed in DDS terciles in different groups of educational attainment of respondents (p=0.62)

Table 4.11: occupation of head of household, respondents and dietary diversity

Occupation of head of household	DDS Low No (%)	DDS Average No (%)	DDS High No (%)	Total No (%)	p-value
Farmer	0(0.0)	20(90.9)	2(9.1)	22(1.84)	
Trader	8(1.7)	371(77.8)	98(20.5)	477(39.75)	
Civil servant	10(4.4)	166(72.5)	53(32.1)	229(19.08)	
Artisan	2(1.1)	153(83.2)	29(15.8)	184(15.33)	
Religious leader	0(0.0)	25(83.3)	5(16.7)	30(2.5)	
Professional	1(1.4)	52(74.3)	17(24.3)	70(5.83)	
Unemployed	1(5.0)	18(90.0)	1(5.0)	20(1.67)	
Others	2(1.19)	140(84.3)	26(15.7)	168(14.00)	0.70
Occupation of respondents					
Farmer	0(0.0)	25(92.6)	2(7.4)	27(2.27)	
Trader	6(1.2)	404(80.8)	90(18.0)	500(41.69)	
Civil servant	6(3.5)	137(79.7)	29(16.9)	172(14.35)	
Artisan	1(1.6)	54(85.7)	8(12.7)	63(5.26)	
Religious leader	0(0.0)	4(80.0)	1(20.0)	5(0.34)	
Professional	1(4.8)	14(66.7)	6(28.6)	21(1.75)	
Unemployed	7(2.3)	227(73.5)	75(24.3)	309(25.75)	
Others	1(1.0)	81(78.6)	21(20.4)	103(8.59)	0.16

Result of comparison of difference in mean of primary occupation of head of household and respondent and dietary diversity, revealed that there was no significant mean difference observed in DDS between terciles for subjects in groups for primary occupation of the head of household (p= 0.70) and respondents (p= 0.16) .

TABLE 4.12: Income of head of household, income of respondents and dietary diversity

	DDS Low No (%)	DDS Average No (%)	DDS High No (%)	Total No (%)	p-value
Income of head of household #					
5,000-14,999	0(0.0)	73(56.6)	56(43.4)	129(10.75)	
15,000-44,999	4(1.7)	140(60.1)	89(38.2)	233(19.42)	
45,000 and above	1(0.9)	65(60.7)	41(38.3)	107(8.91)	
Don't know	4(0.5)	428(58.5)	299(40.9)	731(60.92)	0.51
Income of respondents #					
5,000-14,999	4(1.10)	215(59.90)	140(39.00)	359(29.90)	
15,000-44,999	1(0.53)	117(61.91)	71(37.56)	189(15.75)	
45,00 and above	1(3.13)	18(56.25)	13(40.63)	32(2.67)	
Don't know	0(0.00)	161(57.90)	117(42.10)	278(23.17)	
No income	3(0.90)	195(57.00)	144(42.10)	342(28.51)	0.05

Using ANOVA, to compare the difference in mean the result revealed significant (p<0.05) mean difference in DDS between terciles for different groups of head of household estimated income. Those who claimed don't know and those earning ₦55, 000 and above were significantly higher than the rest. Also, there was a significant (p<0.05) mean difference among different groups of income of respondents on dietary diversity. Those in the ₦5, 000-14,999" "don't know" and "no income" group were observed to be significantly higher than others

Table 4.13: Source of lighting, source of water and dietary diversity score

	DDS Low N (%)	DDS Average N (%)	DDS High N (%)	Total N (%)	p-value
Source of lighting					
Lantern/candle	0(0.0)	66(82.5)	14(17.5)	80(6.67)	
Generator	3(2.0)	120(81.6)	24(16.3)	147(12.25)	
PHCN	19(2.0)	755(78.2)	192(19.9)	966(80.5)	
Solar	0(0.0)	4(100)	0(0.0)	4(0.33)	
Others	0(0.0)	2(66.67)	1(33.33)	3(0.25)	0.16
Source of water					
Pond/lake	0(0.0)	6(66.7)	3(33.3)	9(0.75)	
Spring/river	1(2.5)	38(95.0)	1(2.5)	40(3.34)	
Well	2(2.9)	57(81.4)	11(15.7)	70(5.83)	
Bore hole	9(1.3)	569(79.2)	140(19.5)	718(59.83)	
Pipe-borne	8(2.7)	224(74.4)	69(22.9)	301(25.08)	
Rain harvest	1(3.0)	23(88.5)	2(7.7)	26(2.17)	
Sachet water regularly	1(3.0)	27(81.8)	5(15.2)	33(2.75)	
Others	0(0.0)	3(100)	0(0.0)	3(0.25)	0.001

Using ANOVA, to compare the difference in mean the result revealed that there was no significant mean difference among the source of light among subjects on DDS (p=.16). There was a significant difference on source of water among subjects on DDS (p<.001). Those that source their water from bore-hole 718(59.83%) were significantly higher than those who source from pipe-borne 301(25.08) and 70(5.83) well.

Table 4.14: Types of toilet, method of refuse disposals, socio-economic status and dietary diversity

Type of toilet	low N (%)	Average N (%)	High N (%)	TotaL N (%)	p-value
Bush	5(7.1)	59(84.3)	6(8.6)	70(5.84)	0.001
Pit latrine	4(1.0)	341(85.9)	52(13.1)	397(33.08)	
VIP latrine	2(10.5)	16(84.2)	1(5.3)	19(1.58)	
Water closet	11(1.6)	527(74.4)	170(24.0)	708(59.00)	
River	0(0.0)	1(50)	1(50.0)	2(0.17)	
Others	0(0.0)	3(75)	1(25)	4(0.33)	
Method of refuse disposal					
Bush	10(2.2)	386(86.0)	53(11.8)	449(37.25)	0.09
Refuse dump	6(1.3)	358(76.3)	105(22.4)	469(39.21)	
City service	6(2.4)	183(71.8)	71(25.9)	260(21.67)	
Others	5(0.0)	11(100)	6(0.0)	22(1.87)	
Source of fire of cooking					
Firewood	1(11.1)	147(20.8)	107(22.1)	255(21.2)	0.05
Kerosene stove	8(88.9)	512(72.5)	357(73.6)	877(73.1)	
Electric stove	0(0.0)	23(3.3)	9(1.9)	32(2.7)	
Gas cooker	0(0.0)	24(3.4)	12(2.5)	36(3.0)	
Socio-economic Status					
Low (1-4)	6(66.7)	272(38.5)	195(40.2)	473(39.4)	0.05
Middle (5-8)	1(11.1)	154(21.8)	104(21.4)	259(21.6)	
High (9-12)	2(22.2)	280(39.7)	186(38.4)	468(39.0)	

Using ANOVA, to compare the difference in mean the result revealed that there was no significant mean difference among subjects on method of refuse disposal (p=.09). There was a significant mean difference on the type of toilet used among subjects (p<.001) and DDS. Those that use the water closet toilet were significantly higher than the rest on DDS. There was no significant mean difference between DDS terciles for subjects from different socio-economic status.

Table 4.15: Dietary diversity category and Local Government Areas (LGAs)

LGAs	Low DDS No (%)	Medium DDS No (%)	High DDS No (%)	Total No (%)	p-value
Orlu	1(11.1)	76(10.8)	56(11.5)	133(11.1)	
Owerri	0(0.0)	80(11.3)	54(11.3)	134(11.2)	
Obowo	0(0.0)	81(11.5)	52(10.7)	133(11.1)	
Enugu east	1(11.1)	69(9.8)	63(13.0)	133(11.1)	
Nsukka	3(33.3)	81(11.5)	50(10.3)	134(11.2)	
Enugu north	0(0.0)	78(11.0)	55(11.3)	133(11.1)	
Awka south	0(0.0)	75(10.6)	59(12.2)	134(11.1)	
Aguata	4(44.4)	78(10.5)	51(10.5)	133(11.1)	
Oyi	0(0.0)	88(12.5)	45(9.3)	133(11.1)	0.001

Using ANOVA, to compare the difference in mean the result revealed that there was a significant difference in DDS among local government area ($p<.001$). In a Least Significant Difference (LSD) Post-hoc test Owerri was highest followed by Awka south and Nsukka. These three LGAs were significantly higher than the rest.

SECTION D: Diet quality

Table 4.16: Components of Diet Quality Index- International (DQI-I) and the percentage of respondents in components subcategories in South-East Nigeria.

Component	Score ranges	Point	Score criteria	No (%)
DQI-I, total	0-100			
Variety	0-20			
Overall food group variety	0-15	15	≥1 serving from each food group/d	12(1.0)
		12	Any 1 food group missing/d	189(15.8)
		9	Any 2 food groups missing/d	0(0.0)
		6	Any 3 food groups missing/d	943(78.6)
		3	≥ 4 food groups missing/d	56(4.6)
		0	None from any food group	0(0.0)
Within-group variety from protein source	**0-5**	**5**	**≥3 different sources/d**	**80(6.7)**
		3	2 different sources/d	832(69.3)
		1	From 1 source/d	216(18.0)
		0	None	72(6.0)
Adequacy	**0-40**			
Vegetable	0-5	5	>100% recommendation	267(22.2)
		3	50-100% recommendations	338(28.2)
		1	<50% recommendations	427(35.6)
		0	0% recommendations	168(14.0)
Fruit group	**0-5**	**5**	**>100% recommendations**	**62(5.2)**
		3	50-100% recommendations	82(6.8)
		1	<50% recommendations	324(27.0)
		0	0% recommendations	732(61.0)
Grain/Roots/Tubers group	**0-5**	**5**	**>100% recommendations**	**1044(87.0)**
		3	50-100% recommendations	145(12.1)
		1	<50% recommendations	10(0.8)
		0	0% recommendations	1(0.1)
Fibre group	**0-5**	**5**	**>100% recommendations**	**116(9.7)**
		3	50-100% recommendations	**594(49.5)**
		1	<50% recommendations	**486(40.5)**
		0	0% recommendations	**11 (0.3)**
Protein	**0-5**	**5**	**>100% recommendations**	**847(70.6)**
		3	50-100% recommendations	346(28.8)
		1	<50% recommendations	7(0.6)
		0	0% recommendations	0(0.0)
Iron	**0-5**	**5**	**>100% recommendations**	**242(20.2)**
		3	50-100% recommendations	781(65.1)
		1	<50% recommendations	177(14.8)
		0	0% recommendations	0(0%)
Calcium	**0-5**	**5**	**>100% recommendations**	**21(1.8)**
		3	50-100% recommendations	217(18.1)
		1	<50% recommendations	962(80.2)
		0	0% recommendations	0(0.0)
Vitamin C	**0-5**	**5**	**>100% recommendations**	**233(19.4)**
		3	50-100% recommendations	174(14.5)
		1	<50% recommendations	783(65.2)
		0	0% recommendations	10(0.8)
Moderation	**0-30**			
Total fat	**0-6**	**6**	**≤20% of total energy/d**	**324(27.0)**
		3	>20-30% of total energy/d	752(62.7)
		0	>30% of total energy/d	124(10.3)
Saturated fat	**0-6**	**6**	**≤7% of total energy/d**	**983(81.9)**
		3	>7-10% of total energy/d	212(17.7)
		0	>10% of total energy/d	5(0.4)
Cholesterol	**0-6**	**6**	**≤300 mg/d**	**1130(94.3)**
		3	> 300-400 mg/d	64(5.3)
		0	>400 mg/d	5(0.4)
Sodium	**0-6**	**6**	**≤2400 mg/d**	**952(79.3)**
		3	>2400-3400 mg/d	219(18.2)
		0	>3400 mg/d	29(2.4)
Empty calorie food	**0-6**	**6**	**≤3% total energy/d**	**789(65.8)**
		3	> 3-10% total energy/d	386(32.2)
		0	>10% total energy/d	25(2.1)
Overall balance	**0-10**			
Macronutrient (carbohydrate-protein-fat	**0-6**	**6**	**55-65:10-15:15-25**	**35(2.9)**
		4	52-68:9-16:13-27	222(18.5)
		2	50-70:8-17:12-30	496(41.3)
		0	Otherwise	447(37.2)
Fatty acid ratio	**0-4**	**4**	**p/s=1-1.5; M/S = 1-1.5**	**5(0.4)**
		2	P/S=0.8-1.7; M/S=0.8-1.7	135(11.2)
		0	Outside the above ranges	1060(88.3)

Table 4.16- Only 12 people (1.0%) of the respondents ate at least 1 serving from the five food groups, 189(15.8%) ate from 4 food groups, none ate from 3 food groups, 943(78.6%) ate from 2 food groups and 56(4.6%) ate from 1 food group. Table 4.16 shows that 100% of the population ate at least one serving from the grain, root and tuber group, 77.8% ate at least one serving from vegetable group, 87.2% from beef/fish/egg/poultry group, 35.8% from fruit group and 58.8% from Dairy/Beans group. In table (4.16), 69.3% had two different sources of protein, 216(18.0%) had one source of protein and 72 (6.0%) did not eat any protein at all. Two hundred and sixty seven (22.2%) met the recommendation of vegetables and Intakes above 50% of recommendation were achieved in 50.4%. Only 62 (5.2%) scored above 100% of the recommendation of Fruit, 324(27%) scored below 50% recommendation while 732(61.0%) did not eat fruit at all. About 1044 (87.0%) scored above 100% recommendation for grain/root and tuber group, 145 (12.1%) scored above 50% recommendation. For Fiber only 116(9.7%) scored above 100% recommendation, 594(49.5%) scored between 50% - 100%% recommendation, 486(40.5%) scored below 50% recommendation while 11 (0.3%) scored zero. Eight hundred and fourty seven (70.6%) scored above 100% recommendation of protein, 346 (28.85%) scored between 50%-100% of the recommendation while 7 (0.6%) scored below 50%. Only 242 (20.2%) scored above 100% recommendation for Iron, 781 (65.1%) achieved between 50%-100% recommendation while 177 (14.8%) scored below 50% recommendation for Iron. For calcium intake, 21(1.8%) achieved above 100% recommendation, 217 (18.1%) met 50%-100% recommendation while 962 (80.2%) scored below 50% recommendation for calcium intake. A total of 233 (19.4%) scored above 100% recommendation for Vitamin C, 174 (14.5%) achieved between 50% - 100% recommendation, 783 (65.2%) scored below 50% while 10 (0.8%) scored zero. Under moderation category, only 324(27.0%) and 983(81.9%) of the sample met recommendations for fat and saturated fat goals respectively. Recommended Intakes of cholesterol ≤300mg/d and sodium ≤2400 mg/d were observed in 1130(94.3%) and 952(79.3%) of the population respectively. About 789(65.85%) and 386(32.2%) got ≤3% of total energy and > 3-10% total energy/day respectively while 25 (2.1%) scored > 10% total energy/day. The balance for carbohydrate, protein and fat was met by 753 (62.7%) of the participants while the balance for fatty acid ratio was met by only 140 (11.6%) of the participant.

Table 4.17: Food group and number of servings consumed in Imo, Enugu and Anambra States

Food serving 0 or 1	Imo	Enugu	Anambra	Total
grains/roots/Tubers				
0	0(0.0)	0(0.0)	0(0.0)	0(0.0)
1	400(100)	400(100)	400(100)	1200(100)
Vegetables				
0	109(27.2)	84(21.0)	73(18.2)	266(22.2)
1	291(72.8)	316(79.0)	327(81.8)	934(77.8)
Meat/Fish/Egg/Poultry				
0	66(16.5)	42(10.5)	46(11.5)	154(12.8)
1	334(83.5)	358(89.5)	354(88.5)	1046(87.2)
Fruits				
0	242(60.5)	287(71.8)	242(60.5)	771(64.2)
1	158(39.5)	113(28.2)	158(39.5)	429(35.8)
dairy/Beans				
0	190(47.5)	130(32.5)	175(43.8)	495(41.2)
1	210(53.5)	270(52.5)	225(56.2)	705(58.8)

The table (4.17) indicated that all the respondents 1200(100%) consumed at least one serving of grains, roots and tubers, 934(77.8%) of the subjects consumed one serving from vegetable group, 1046 (87.8%) from Meat/fish/egg/poultry group, 429(35.8%) from fruit group, 705(58.8%) from Dairy/Beans group (Table 4.17).

Table 4.18 Diet Quality Index-International (DQI-I) scores and components

Component	Score ranges (points)	Imo State	Enugu State	Anambra State	South East Nigeria	p-value
Overall Variety	0-15	6.76±2.49	6.95±2.44	6.95±2.54	6.89±2.49	0.001
Variety Within Group	0-5	2.59±1.24	2.66±1.18	2.54±1.08	2.59±1.17	0.14
Variety	**0-20**	**9.35±3.06**	**9.61±3.04**	**9.49±3.03**	**9.48±3.05**	**0.02**
Vegetable group	0-5	2.73±1.69	2.64±1.57	2.62±1.55	2.66±1.60	
Fruit Group	0-5	1.27±1.55	.87±1.34	1.28±1.58	1.14±1.50	
Grain/roots/tubers Group	0-5	4.78±.59	4.83±.50	4.84±.51	4.82±.53	
Fiber Group	0-5	2.15±1.29	2.52±1.24	2.71±1.38	2.46±1.33	
Protein	0-5	5.67±.61	4.70±.54	5.56±.69	5.64±.61	
Iron	0-5	3.16±1.16	3.02±1.19	3.15±1.18	3.11±1.18	
Calcium	0-5	1.46±.93	1.42±.91	1.42±.88	1.43±.90	
Vitamin C	0-5	2.25±1.68	1.95±1.55	1.98±1.58	2.06±1.61	
Adequacy	0-40	**23.47±4.94**	**21.95±4.55**	**23.56±4.51**	**23.82±4.67**	**0.07**
Total Fat	0-6	3.35±1.86	3.63±1.67	3.53±1.75	3.50±1.77	
Saturated Fat	0-6	5.39±1.27	5.45±1.16	5.50±1.16	5.45±1.20	
Cholesterol	0-6	5.84±.72	5.80±.86	5.82±.74	5.82±.78	
Sodium	0-6	5.39±1.39	5.59±1.06	4.95±1.69	5.31±1.43	
Empty Calories Food	0-6	4.97±1.55	4.74±1.67	5.02±1.47	4.91±1.57	
Moderation	**0-30**	**24.94±4.06**	**25.21±3.49**	**24.82±3.68**	**24.99±3.70**	**0.11**
carbohydrate/protein/fat	0-6	1.61±1.61	1.73±1.55	1.89±1.69	1.74±1.62	
Fatty acid ratio	0-4	0.23±.65	0.27±.74	0.23±.64	0.24±.68	
Overall balance	**0-10**	**1.84±1.76**	**2.00±1.71**	**2.12±1.77**	**1.98±1.75**	**0.06**
DQI-I, TOTAL	**0-100**	**58.60±8.28**	**58.77±8.02**	**58.99±8.06**	**58.79±8.12**	**0.15**

The total score of the South Eastern Nigeria DQI-I reached 58.79% of the possible score of 100% (Table 4.18). The best achieved score in this study was Moderation (24.99±3.70), followed by Adequacy (23.82±4.67), then variety (9.48±3.05) and overall balance (1.98±1.75). Overall balance is the weakest area of the diet according to the DQI-I standard. The total dietary quality in Imo, Enugu and Anambra were (58.60± 8.28), (58.77± 8.02) and (58.99 ± 8.06) respectively.

Table 4.19 Components of Diet Quality Index- International (DQI-I) and the percentage of respondents in components subcategories in Imo, Enugu and Anambra States

Component	Score ranges	Point	Score criteria	Imo	Enugu	Anambra	N(%) Total
Variety	0-20						
Overall food group variety	**0-15**	**15**	≥1 serving from each food group/d	4(1.0)	4(1.0)	4(1.0)	12(1.0)
		12	Any 1 food group missing/d	58(14.5)	64(16.0)	67(16.8)	189(15.8)
		9	Any 2 food groups missing/d	0(0)	0(0)	0(0)	0(0.0)
		6	Any 3 food groups missing/d	314(78.5)	319(79.8)	310(77.5)	943(78.6)
		3	≥ 4 food groups missing/d	21(5.2)	13(3.2)	18(4.5)	56(4.6)
		0	None from any food group	0(.00)	0(0.0)	0(0.0)	0(0.0)
Within-group variety from protein source	**0-5**	**5**	**≥3 different sources/d**	**32(8.0)**	**34(8.5)**	**14(3.5)**	**80(6.7)**
		3	2 different sources/d	269(67.2)	272(68.0)	291(72.8)	832(69.3)
		1	From 1 source/d	67(16.8)	76(19.0)	73(18.2)	216(18.0)
		0	None	32(8.0)	18(4.5)	22(5.5)	72(6.0)
Adequacy	**0-40**						
Vegetable	0-5	5	>100% recommendation	109(27.2)	82(20.5)	76(19.0)	267(22.2)
		3	50-100% recommendations	90(22.4)	118(29.5)	130(32.6)	338(28.2)
		1	<50% recommendations	186(48.0)	135(33.8)	140(35.1)	427(35.6)
		0	0% recommendations	49(12.3)	65(16.3)	54(13.3)	168(14.0)
Fruit group	**0-5**	**5**	**>100% recommendation**	**22(5.4)**	**10(2.4)**	**30(7.5)**	**62(5.2)**
		3	50-100% recommendations	31(7.7)	25(6.3)	26(6.6)	82(6.8)
		1	<50% recommendations	121(30.3)	88(21.9)	115(28.4)	324(27.0)
		0	0% recommendations	226(56.4)	277(69.2)	229(57.3)	732(61.0)
Grain/Roots/Tubers group	**0-5**	**5**	**>100% recommendation**	**342(85.4)**	**345(86.2)**	**356(89.0)**	**1044(87.0)**
		3	50-100% recommendations	43(13.3)	54(13.5)	38(9.5)	145(12.1)
		1	<50% recommendations	5(1.2)	0(0.0)	5(1.2)	10(0.8)
		0	0% recommendations	0(0.0)	1(0.2)	0(0.0)	1(0.1)
Fibre	**0-5**	**5**	**>100% recommendation**	**26(6.5)**	**34(8.5)**	**56(14.0)**	**116(9.7)**
		3	50-100% recommendations	**121(23.3)**	**185(46.2)**	**180(45.0)**	**486(40.5)**
		1	<50% recommendations	**257(52.2)**	**181(35.3)**	**41.0)**	**594(49.5)**
		0	0% recommendations	**4(1.0)**	**0(0.0)**	**0(0.0)**	**4(0.3)**
Protein	**0-5**	**5**	**>100% recommendation**	**293(73.2)**	**296(74.0)**	**258(64.4)**	**847(70.6)**
		3	50-100% recommendations	103(25.7)	103(25.7)	140(35.0)	346(28.8)
		1	<50% recommendations	4(1.0)	1(0.2)	2(0.5)	7(0.6)
		0	0% recommendations	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Iron	**0-5**	**5**	**>100% recommendation**	**84(21.0)**	**72(18.0)**	**86(21.5)**	**242(20.2)**
		3	50-100% recommendations	263(65.8)	260(65.0)	258(64.5)	781(65.1)
		1	<50% recommendations	53(13.2)	68(17.0)	56(14.0)	177(14.8)
Calcium	**0-5**	**5**	**>100% recommendation**	**8(2.0)**	**8(2.0)**	**5(1.2)**	**21(1.8)**
		3	50-100% recommendations	75(18.8)	68(17.0)	74(18.5)	217(18.1)
		1	<50% recommendations	317(79.2)	324(81.0)	321(80.2)	962(80.2)
		0	0% recommendations	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Vitamin C	**0-5**	**5**	**>100% recommendation**	**92(23.0)**	**68(17.0)**	**73(18.2)**	**233(19.4)**
		3	50-100% recommendations	67(16.8)	56(14.0)	51(12.8)	174(14.5)
		1	<50% recommendations	238(59.5)	272(68.0)	273(68.2)	783(65.2)
		0	0% recommendations	3(0.7)	4(1.0)	3(0.8)	10(0.8)
Moderation	**0-30**						
Total fat	**0-6**	**6**	**≤20% of total energy/d**	**102(25.5)**	**113(28.2)**	**109(27.2)**	**324(27.0)**
		3	>20-30% of total energy/d	242(60.5)	258(64.4)	252(63.0)	752(62.7)
		0	>30% of total energy/d	56(14.0)	29(7.2)	39(9.8)	124(10.3)
Saturated fat	**0-6**	**6**	**≤7% of total energy/d**	**321(80.2)**	**327(81.8)**	**335(83.8)**	**983(81.9)**
		3	>7-10% of total energy/d	76(19.0)	73(18.2)	63(15.8)	212(17.7)
		0	>10% of total energy/d	3(0.8)	0(0.0)	2(0.5)	5(0.4)
Cholesterol	**0-6**	**6**	**≤300 mg/d**	**379(94.8)**	**375(93.5)**	**377(94.2)**	**1131(94.3)**
		3	> 300-400 mg/d	20(5.0)	22(5.5)	22(5.5)	64(5.3)
		0	>400 mg/d	1(0.2)	3(0.8)	1(0.2)	5(0.4)
Sodium	**0-6**	**6**	**≤2400 mg/d**	**328(82.0)**	**346(86.5)**	**278(69.5)**	**952(79.3)**
		3	>2400-3400 mg/d	62(15.5)	53(13.2)	104(26.0)	219(18.2)
		0	>3400 mg/d	10(2.5)	1(0.2)	18(4.5)	29(2.4)
Empty calorie food	**0-6**	**6**	**≤3% total energy/d**	**271(67.8)**	**245(61.2)**	**273(68.2)**	**789(65.8)**
		3	> 3-10% total energy/d	121(30.2)	142(35.5)	123(30.8)	386(32.2)
		0	>10% total energy/d	8(2.0)	13(3.2)	4(1.0)	25(2.1)
Overall balance	**0-10**						
Macronutrient (carbohydrate-protein-fat	**0-6**	**6**	**55-65:10-15:15-25**	**10(2.5)**	**7(1.8)**	**18(4.5)**	**35(2.9)**
		4	52-68:9-16:13-27	68(17.0)	76(19.0)	78(19.5)	222(18.5)
		2	50-70:8-17:12-30	156(39.0)	173(43.2)	167(41.8)	496(41.3)
		0	Otherwise	166(41.5)	144(36.0)	137(34.2)	447(37.2)
Fatty acid ratio	**0-4**	**4**	**p/s=1-1.5; M/S = 1-1.5**	**1(0.2)**	**4(1.0)**	**0(0.0)**	**5(0.4)**
		2	P/S=0.8-1.7; M/S=0.8-1.7	43(10.8)	46(11.5)	46(11.5)	135(11.2)
		0	Any score outside above	356(89.0)	350(87.5)	354(88.5)	1060(88.3)
DQI-I, total	0-100						

P/S = polyusaurated fatty acid/monounsaturated fatty acid/ M/S = monounsaturated fatty acid to saturated fatty acid

Table 4.19 shows percentage of sample in components subcategories in the different states of the South- East. The total dietary quality score in the three states was 58.79%. In Imo, moderation scored higher than the other three categories, followed by adequacy and then variety. Variety category was best achieved in Enugu, followed by the moderation and adequacy categories. In Anambra state, adequacy was best achieved followed by moderation and variety. Overall balance was the weakest area in all the three states. Enugu scored higher in variety and moderation; Anambra scored higher in adequacy and overall balance.

Variety:

In the variety category, scores for the overall food group variety was higher in Anambra state and the varieties within protein groups were greater in the Enugu state. Seventy-one (17.8%) in Anambra sample had at least one serving from each food group or just one food group missing per day, compared with 68(17%) of the Enugu and 62(15.5%) in Imo state.

Similarly, 301(75.2%) in Imo, 306(76.5%) in Enugu and 305(76.3%) in Anambra state had two or more different sources of protein per day (Table 4.19).

Adequacy:

The total adequacy and subcomponents scores for the three states did not vary significantly. For vegetable group intake, the three states consumed considerably average on the recommended intake of vegetable with 199(49.7%) in Imo, 200(50.0%) in Enugu and 206(51.6%) in Anambra consumed above 50% recommendation while 235(60.3%) in Imo, 200(50.1%) in Enugu and 194(48.4) in Anambra consumed less than 50% recommendation for vegetable. The three states consumed less than the recommended intake of fruits with 56.4% in Imo, 69.2% in Enugu and 57.3% in Anambra scoring 0% recommendation. Only 53(13.1%) in Imo, 35(8.7%) in Enugu, and 56(14.1%) in Anambra scored above 50% recommendation. In the three states adequacy for grain roots and tubers, protein and iron intake was achieved by more than 60% of the population. In Imo State, only 147 (29.8%) scored up to 50% recommendation for fibre while 219(54.7%) in Enugu and 236(59.0%) in Anambra scored up to 50% recommendation respectively.

Moderation:

Calcium intake in Imo 317(79.2%), Enugu 324(81.0%) and Anambra 321(80.2%) was below 50% recommendation. Vitamin C recommendation was not achieved by many with 241(60.2%) in Imo, 276(69.0%) in Enugu and 276(69.0%) scoring below 50% recommendation. The scores for all the components in the moderation category were high in the three states: 344(86%) in Imo, 371 (92.6%) in Enugu and 361(90.2%) in Anambra met recommendation for total fat. The scores for saturated fat were high with 397 (99.2%) in Imo, 400 (100%) in Enugu and 398 (99.6%) in Anambra scoring below 10% energy/day. The scores for cholesterol intake were equally high with scores of 399 (99.8%) in Imo, 397 (99.0%) in Enugu and 399 (99.7%) in Anambra. The study showed that 390 (97.5%) in Imo, 399 (99.7%) in Enugu and 382 (95.5%) in Anambra met recommendation for sodium intake and 392 (98.0%) in Imo, 387 (96.7%) in Enugu and 396(99%) in Anambra met recommendation for Empty calories (Table 4.19).

Overall Balance

Lastly, the goals for balance among energy-yielding nutrients was relatively fair compared to that of fatty acids that were poorly met in the three states. Two hundred and thirty four (58.5%) of the population in Imo, 256(64%) in Enugu and 263(65.8%) in Anambra met the recommended ranges on macro-nutrients while 356(89%) in Imo state, 350(87.5%) in Enugu and 354 (88.5%) in Anambra failed to meet the recommended proportionality in fatty acid resulting in low scores in the fatty acid ratio balance component.

Diet Quality:

Overall, across all four categories, Imo, Enugu and Anambra had a average scores on diet quality, with each scoring approximately 59% of the perfect score of 100%.

Table 4.20: Relationship between Diet Quality and Demographic variables in South-East Nigeria

		1	2	3	4	5	6	7	8	9	10	11
1	**Diet quality**	1										
2	**Educational Level of Head of House hold**	.092**	1									
3	**Occupation of Head of Household**	-.035	-.019	1								
4	**Educational Level of Respondent**	.081**	.503**	-.061*	1							
5	**Occupation of Respondent**	-.058*	.116**	.165**	.029	1						
6	**Source of Light**	.011	.040	.048	.025	-.024	1					
7	**Source of Water**	.020	.045	-.028	.028	-.002	.080**	1				
8	**Method of Refuse Disposal**	.007	.202**	-.051	.193**	.032	.061*	.125**	1			
9	**Type of Toilet**	.047	.299**	-.075**	.264**	.040	.113**	.090**	.378**	1		
10	**Income Of Head of House Hold**	-.038	-.004	.000	.024	.059*	.014	-.077**	-.085**	-.013	1	
11	**Income Of Respondent**	-.020	.095**	.012	.018	.479**	-.054	-.069*	-.027	-.029	.224**	1

*p<.05, **p<.01

Correlation analysis shows that Educational level of head of household had a significant relationship with diet quality (r=.09, p<.01), educational level of respondent also had a significant relationship with diet quality (r=.08, p<.01). Occupation of respondents had a significant but negative relationship with diet quality. These correlations although significant are weak except Educational level of head of house hold and educational level of respondent (r=-0.05, p<.05), occupation of respondent and income of respondent (r=0.48, p<0.05), and method of refuse disposal and type of toilet (r=0.38, p<0.05).

Table 4.21: Socio-economic variables and diet quality

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	**Diet quality**	1												
2	**House Ownership**	.074*	1											
3	**Fuel for cooking**	.073*	.264**	1										
4	**Fridge**	.080**	.043	.196**	1									
5	**Freezer**	.010	.062*	.207**	.240**	1								
6	**Radio**	.036	.006	.061*	.097**	.072*	1							
7	**Television**	.038	.017	.178**	.236**	.114**	.253**	1						
8	**Video**	.067*	.040	.156**	.241**	.123**	.231**	.766**	1					
9	**DSTV**	.051	.051	.235**	.249**	.298**	.094**	.141**	.169**	1				
10	**Car**	.063*	.037	.183**	.248**	.229**	.085**	.112**	.144**	.329**	1			
11	**Motorcycle**	-.054	-.195**	-.167**	-.048	-.086**	.055	.088**	.053	-.076**	-.144**	1		
12	**Bicycle**	-.006	-.280**	-.260**	-.074*	-.085**	.041	-.084**	-.080**	-.054	-.059*	.142**	1	
13	**GSM/phone**	.025	.027	.051	.111**	.038	.085**	.199**	.215**	.068*	.058*	.021	-.050	1

*p<.05, **p<.01

Correlation analysis shows that House ownership (r=.07, p<.05), source of fire for cooking (r=.07, p<.05), fridge (r=.08, p<.01), video (r=.07, p<.05), and car (r=.06, p<.05), had a significant positive relationships with diet quality. Families that possessed these belongings had higher diet quality score than others.

Table 4.22: Association between BMI, dietary diversity and diet quality

		BMI	DD	DQ
	BMI	1		
1	**Diet Diversity**	-.02	1	
2	**Diet Quality**	-.01	.48**	1

**p<.05

Correlation analysis shows that BMI of mother had no significant relationship with diet diversity (r=-.02, p>.05) and diet quality (r=-.01, p>.05). But there was a significant positive correlation between diet diversity and diet quality (r=.48, p<.001).The higher the diet diversity the higher the diet quality.

Table 4.23: Linear regression of Diet Quality Index- International (DQI-I) categories and DQI-I Sub-categories scores in the South- East Nigeria diet pattern

Component	Multiple r	Adjusted r^2	*B*	SE(b)	Β	*P* value
Variety	.51	.51	1.87	.05	.71	0.00
Overall variety	.48	.48	2.48	.08	.60	0.00
Variety within group	.52	.52	1.29	1.40	.21	0.00
Adequacy	.70	.70	1.43	.03	.84	0.00
Vegetable	.21	.21	1.64	.08	.33	0.00
Fruit	.41	.41	1.60	.11	.30	0.00
Grain/roots/tubers	.44	.44	1.81	.24	.12	0.00
Fibre	.55	.55	1.27	.11	.21	0.00
Protein	.63	.62	3.06	.21	.24	0.00
Iron	.66	.66	1.26	.15	.16	0.00
Calcium	.69	.69	1.27	.11	.19	0.00
Vitamin C	.72	.72	1.16	.10	.23	0.00
Moderation	.16	.16	1.06	.07	.40	0.00
Total fat	.07	.07	.46	.15	.09	0.00
Saturated fat	.20	.20	3.18	.28	.35	0.00
Cholesterol	.20	.20	-.60	.31	-.05	0.052
Sodium	.20	.20	.02	.19	.00	0.94
Empty calories	.23	.23	1.25	.18	.19	0.00
Overall balance	.16	.16	1.82	.12	.40	0.00
Macronutrients	.12	.12	1.75	1.29	.36	0.00
Fatty acids	.16	.16	2.16	.28	.21	0.00

Multiple linear Regressions were carried out between the various components and diet quality. They all revealed to be significant predictors (determinants) of diet quality except cholesterol and sodium with (p>.05).

Table 4. 24: Diet Quality in the selected Local Governments in South-East Nigeria

Local Government Area	**N**	**Mean/SD**	**p-value**
Orlu	133	58.81±8.48	
Owerri	134	59.08±7.72	
Obowo	133	57.18±7.77	
Enugu East	133	59.99±6.29	
Nsukka	134	58.03±7.35	0.01
Enugu North	133	58.34±7.68	
Awka South	134	58.77±7.02	
Aguata	133	58.29±7.19	
Oyi	133	57.97±7.11	
Total	1200	58.79±7.47	

A posthoc ANOVA analysis shows that Enugu East scored higher than Obowo, Nsukka and Oyi. Enugu North, Owerri and Aguata were significantly higher in diet quality than Obowo. Awka south was significantly higher than Orlu, Obowo, Nsukka and Oyi in diet quality.

Table 4.25: Diet quality and Socio-economic status among studied states

State	Socioeconomic status	Mean/SD	N	p-value
Imo	Low	58.55±8.34	136	**0.05**
	Average	58.41±7.66	89	
	High	58.37±8.00	175	
Enugu	Low	58.41±6.80	188	
	Average	59.20±7.15	95	
	High	59.61±7.74	117	
Anambra	Low	59.46±7.20	149	
	Average	59.93±6.80	75	
	High	59.20±7.37	175	

Using ANOVA, to compare the difference in mean the result revealed that there was no significant mean difference among socioeconomic status on diet quality among states.

Table 4.26: Diet quality and socio-economic status of South-East Nigeria

Socioeconomic status	N	DQ Mean±SD	p-value
Low	473	59.22±7.39	
Average	259	54.16±7.22	0.98
High	468	58.60±7.71	
Total	1200	59.23±7.47	

Using ANOVA, to compare the difference in mean the result revealed that there was no significant mean difference among socioeconomic status on diet quality.

Table 4.27: Comparison of diet quality of South- East Nigeria with that of USA, China and Mediterranean

Diet quality index-international (DQI-I) scores and components						
Component	**Scores(points)**	**China**	**USA**	**Mediterranean**	**South east Nigeria**	**p-value**
Overall Variety	0-15	9.2±0.04	11.4±0.04	7.58±4.64	6.89±2.49	0.003
Variety Within Group	0-5	2.5±0.03	4.2±0.02	2.12±1.62	2.59±1.17	0.008
Total Variety	0-20	11.8±0.06	15.6±0.04	9.70±5.91	9.48±3.04	0.004
Vegetable	0-5	4.7±0.01	3.8±0.02	1.52±1.16	2.66±1.60	0.019
Fruit	0-5	0.2±0.01	2.0±0.03	1.78±1.42	1.14±1.50	0.05
Grain/Roots/Tubers	0-5	5.0±0.002	3.0±0.02	1.44±1.04	4.82±.53	0.02
Fiber	0-5	2.2±0.02	3.1±0.02	2.53±1.27	2.46±1.33	0.001
Protein	0-5	4.9±0.004	5.0±0.003	4.95±0.33	4.64±.61	0.000
Iron	0-5	4.7±0.01	4.3±0.01	2.88±1.48	3.11±1.18	0.004
Calcium	0-5	2.4±0.02	3.1±0.02	3.53±1.37	1.43±.90	0.01
Vitamin C	0-5	3.9±0.02	3.7±0.02	4.04±1.44	2.06±1.61	0.005
Adequacy	0-40	28.0±0.05	28.1±0.08	22.67±4.66	22.32±4.67	0.001
Total Fat	0-6	3.0±0.04	1.2±0.01	0.50±1.29	3.50±1.77	0.06
Saturated Fat	0-6	4.2±0.04	1.5±0.03	0.74±1.63	5.45±1.20	0.08
Cholesterol	0-6	4.9±0.03	4.5±0.03	3.68±2.65	5.82±.78	0.002
Sodium	0-6	0.9±0.03	2.7±0.03	5.14±1.66	5.31±1.43	0.05
Empty Calories	0-6	5.8±0.01	4.5±0.03	0.29±0.97	4.91±1.57	0.051
Moderation	0-30	18.6±0.10	14.3±0.08	10.35±4.65	24.99±3.75	0.01
Macronutrient ratio	0-6	1.2±0.03	0.5±0.02	0.12±0.63	1.74±1.62	0.09
Fatty acid ratio	0-4	1.0±0.02	0.6±0.02	0.038±0.39	0.24±.68	0.11
Overall Balance	0-10	2.1±0.04	1.1±0.02	0.16±0.74	1.98±1.75	0.06
DQI-I, total	0-100	60.5±0.11	59.1±0.14	42.87±10.09	58.79±8.12	0.001

Table 4.27 shows the comparison of components of total diet quality of South-East Nigeria with other countries like USA, China and Mediterranean. The components showed high significance except for empty calories, macronutrients ratio, fatty acid ratio and overall balance.

SECTION E: Nutrient adequacy of South-East Nigeria

Table 4.28 Nutrient adequacy

Factors	Imo	Enugu	Anambra	South-East	p-value
Energy(kcal)					
Adequate(80%-120% of requirement)	186(46.5)	210(52.5)	175(43.8)	571(47.6)	
Inadequate:					
Mild /moderate (<80% of requirement)	60(15.0)	72(18.0)	40(10.0)	172(14.3)	
Severe inadequacy(<60% Requirement)	24(6.0)	24(6.0)	14(3.5)	62(5.2)	0.001
Excess (> 120% of requirement)	130(32.5)	94(23.5)	171(42.8)	395(32.9)	
Protein(g)					
Adequate(80%-120% of requirement)	192(48.0)	219(54.8)	178(44.5)	589(49.1)	
Inadequate:					
Mild /moderate (<80% of requirement)	55(13.8)	63(15.8)	37(9.2)	155(12.9)	
Severe inadequacy(<60% Requirement)	23(5.8)	24(6.0)	14(3.5)	61(5.1)	0.001
Excess (> 120% of requirement)	130(32.5)	94(23.5)	171(42.8)	395(32.9)	
Carbohydrate(g)					
Adequate(80%-120% of requirement)	153(38.2)	186(46.5)	122(30.5)	461(38.4)	
Inadequate:					
Mild /moderate (<80% of requirement)	36(9.0)	27(6.8)	20(5.0)	83(6.9)	
Severe inadequacy(<60% Requirement)	16(4.0)	13(3.2)	6(1.5)	35(2.9)	0.001
Excess (> 120% of requirement)	195(48.8)	174(43.5)	252(63.0)	621(51.8)	
Fat(g)					
Adequate(80%-120% of requirement)	147(36.8)	114(28.5)	156(39.0)	417(34.8)	
Inadequate:					
Mild /moderate (<80% of requirement)	106(26.5)	134(33.5)	109(27.2)	349(29.1)	
Severe inadequacy(<60% Requirement)	112(28.0)	125(31.5)	72(18.0)	309(25.8)	0.001
Excess (> 120% of requirement)	35(8.8)	27(6.8)	63(15.8)	125(10.4)	
Calcium(mg)					
Adequate(80%-120% of requirement)	12(3.0)	9(2.2)	15(3.8)	36(3.0)	
Inadequate:					
Mild /moderate (<80% of requirement)	37(9.2)	38(9.5)	22(5.5)	97(8.1)	
Severe inadequacy(<60% Requirement)	347(86.8)	349(87.2)	361(90.2)	1057(88.1)	0.001
Excess (> 120% of requirement)	4(1.0)	4(1.0)	2(0.5)	10(0.8)	
Phosphorous(mg)					
Adequate(80%-120% of requirement)	130(32.5)	117(18.2)	113(28.2)	360(30.0)	
Inadequate:					
Mild /moderate (<80% of requirement)	80(20.0)	77(19.2)	63(15.8)	220(18.3)	
Severe inadequacy(<60% Requirement)	114(28.5)	133(33.2)	116(29.0)	363(30.2)	0.001
Excess (> 120% of requirement)	76(19.0)	73(18.2)	108(27.0)	257(21.4)	
Sodium(mg)					
Adequate(80%-120% of requirement)	66(16.5)	45(11.2)	83(20.8)	194(16.2)	
Inadequate:					
Mild /moderate (<80% of requirement)	59(14.8)	64(16.0)	73(18.2)	196(16.3)	
Severe inadequacy(<60% Requirement)	256(64.0)	283(70.8)	218(54.5)	757(63.1)	0.001
Excess (> 120% of requirement)	19(4.8)	8(2.0)	26(6.5)	53(4.4)	
Potassium(mg)					
Adequate(80%-120% of requirement)	20(5.0)	5(1.2)	12(3.0)	37(3.1)	
Inadequate:					
Mild /moderate (<80% of requirement)	24(6.0)	15(3.8)	22(5.5)	61(5.1)	
Severe inadequacy(<60% Requirement)	351(87.8)	378(94.5)	365(91.2)	1094(91.2)	0.001
Excess (> 120% of requirement)	5(1.2)	2(0.2)	1(0.2)	8(0.7)	
Zinc					
Adequate(80%-120% of requirement)	163(40.8)	197(49.2)	193(48.2)	553(46.1)	
Inadequate:					
Mild /moderate (<80% of requirement)	95(23.8)	73(18.2)	44(11.0)	212(17.7)	
Severe inadequacy(<60% Requirement)	58(14.5)	36(9.0)	22(5.5)	116(9.7)	0.001
Excess (> 120% of requirement)	84(21.0)	94(23.5)	141(35.2)	319(26.6)	
Iron					
Adequate(80%-120% of requirement)	126(31.5)	119(29.8)	75(18.8)	320(26.7)	
Inadequate:					
Mild /moderate (<80% of requirement)	26(6.5)	15(3.8)	10(2.5)	51(4.2)	
Severe inadequacy(<60% Requirement)	6(1.5)	6(1.5)	2(0.5)	14(1.2)	0.05
Excess (> 120% of requirement)	242(60.5)	260(65.0)	313(78.2)	815(67.9)	
Magnesium					
Adequate(80%-120% of requirement)	69(17.2)	57(14.2)	73(18.2)	199(16.6)	
Inadequate:					
Mild /moderate (<80% of requirement)	102(25.5)	68(17.0)	101(25.2)	271(22.6)	
Severe inadequacy(<60% Requirement)	214(53.5)	265(66.2)	212(53.0)	691(57.6)	0.001
Excess (> 120% of requirement)	15(3.8)	10(2.5)	14(3.5)	39(3.2)	
Vitamin C(mg)					
Adequate(80%-120% of requirement)	21(5.2)	11(2.8)	13(3.2)	45(3.8)	
Inadequate:					
Mild /moderate (<80% of requirement)	23(5.8)	23(5.8)	13(3.2)	59(4.9)	
Severe inadequacy(<60% Requirement)	298(74.5)	319(79.8)	321(80.2)	938(78.2)	0.001
Excess (> 120% of requirement)	58(14.5)	47(11.8)	53(13.2)	158(13.2)	

Table 4.28 shows the number and percentage of people that met or did not meet their recommended intake of nutrients.

Energy intake showed that 47.5% were adequate, and 19.5% were inadequate of which 5.2% were in the severe category. Excess energy intake was reported in about 33% of the respondents. About 49.1% were adequate in protein consumption, 18.0% were inadequate out of which 5.1% were in severe inadequacy category. Excess protein intake was reported in 32.9% of the respondents. Carbohydrate intake showed that 38.4% were adequate in carbohydrate intake while 51.8% were in the excess category. About 34.8% had adequate intake of fat, 54.9% were inadequate out of which 25.8% were in severe inadequacy category. Excess fat intake was reported in 10.4% of the respondents. Phosphorus intake showed that 30.0% were adequate, 30.2% on severe inadequacy and 21.4% on excess intake category. Sodium intake showed that 16.2% were adequate, 79.4% were inadequate out of which 63.1% were in severe inadequacy category. Only 3.1% were adequate in potassium, 96.3% had inadequate intake with 91.2% on severe inadequacy category. Magnesium intake was adequate in only 16.6% of the respondents, inadequate in 80.2% with 57.6% in severe inadequacy category. Calcium intake showed that 96.2% were inadequate out of which 88.1% were in severe inadequacy category while only 3.0% had adequate intake. Iron intake was adequate in 26.7% of the respondents, 67.9% had excess intake. Zinc intake showed that 46.1% were adequate, 26.6% had excess and 27.7% were inadequate with 9.7% on severe inadequacy category. Vitamin C intake was low with 83.1% on inadequacy category out of which 78.2% was on severe inadequacy.

.

Table 4.29: Nutrient adequacy (adequate/ inadequate) of Respondents in the South-East Nigeria

	Imo	Enugu	Anambra	South East	p-value
Energy (Kcal)					
Inadequate	84(21.0)	96(24.0)	54(13.5)	234(19.5)	0.75
Adequate	316(79)	304(76.0)	346(86.6)	966(80.5)	
Carbohydrate(g)					
Inadequate	52(13.0)	40(10.0)	26(6.5)	118(9.8)	0.51
Adequate	348(87.0)	360(90.0)	374(93.5)	1082(90.2)	
Protein(g)					
Inadequate	78(19.6)	87(21.8)	51(12.7)	216(18.0)	0.81
Adequate	322(80.5)	313(78.3)	349(87.3)	984(83.0)	
Fat(g)					
Inadequate	218(54.5)	259(65.0)	181(45.2)	658(54.9)	0.24
Adequate	182(45.6)	141(35.3)	219(54.8)	542(45.2)	
Calcium(mg)					
Inadequate	384(96.0)	387(96.7)	383(95.7)	1154(96.2)	0.13
Adequate	16(4.0)	13(3.2)	37(9.3)	46(3.8)	
Phosphorus(mg)					
Inadequate	194(48.5)	200(52.4)	179(44.8)	583(48.5)	0.06
Adequate	206(51.5)	190(55.2)	221(55.2)	617(51.4)	
Sodium(mg)					
Inadequate	315(78.8)	347(86.8)	291(72.7)	953(79.4)	0.73
Adequate	85(21.3)	53(13.2)	109(27.3)	247(20.6)	
Potassium(mg)					
Inadequate	375(93.8)	393(98.3)	387(96.7)	1155(96.3)	0.002
Adequate	25(6.2)	7(1.4)	13(3.2)	45(3.8)	
Zinc(mg)					
Inadequate	153(38.3)	109(27.2)	66(16.5)	328(27.4)	0.25
Adequate	247(61.8)	291(72.7)	334(83.4)	872(72.7)	
Iron(mg)					
Inadequate	141(35.2)	144(36.0)	186(46.5)	471(39.2)	0.001
Adequate	259(64.8)	256(64.0)	214(53.5)	729(60.8)	
Magnesium(mg)					
Inadequate	316(79.0)	333(83.2)	313(78.2)	962(80.2)	0.21
Adequate	84(21.0)	67(16.7)	87(21.7)	238(19.8)	
Vitamin C(mg)					
Inadequate	321(80.2)	342(85.5)	334(83.5)	997(83.1)	0.01
Adequate	79(19.8)	58(14.5)	66(16.5)	203(16.9)	

Table 4.29 shows adequacy in Potassium, Iron and Vitamin c was difference in the three States ($p<0.05$).

SECTION F: Nutritional Anthropometry

Table 4.30: BMI of mothers in the three States

State	**N**	**Min**	**Max**	**Mean/SD**	**p-value**
Imo state	400	13.78	54.00	26.25±4.83	
Enugu state	400	17.63	46.93	27.51±4.52	
Anambra state	400	18.14	46.07	26.66±5.02	0.001
Sector					
Urban	397	13.78	46.93	27.23±5.08	
Rural	803	16.23	54.00	26.60±4.67	
Total BMI of mothers	1200	13.78	54.00	26.81±4.82	0.07

The BMI of mothers in Enugu (27.51±4.52) was significantly higher than that of Imo (26.25±4.83) and Anambra (26.66±5.02) while in the sectors, there was no significant difference between the BMI of mothers in the rural and urban sector.

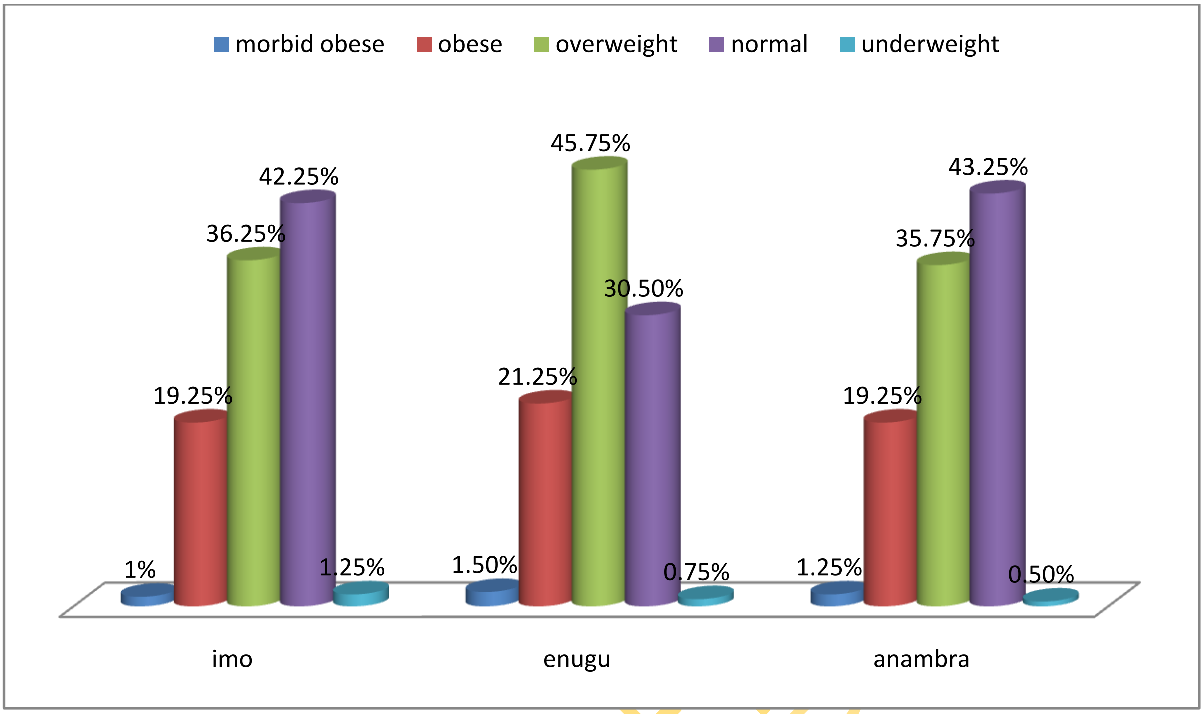

Fig 4.7: Summary of BMI of Mothers in Imo, Enugu and Anambra

The highest BMI was recorded to be 54.00 kg/m^2 while the lowest BMI was 13.78 kg/m^2. The mean BMI (SD) was 26.81 (4.82) kg/m^2. Enugu state scored higher in obesity and overweight, Anambra state scored higher in normal weight and Imo state scored higher in underweight.

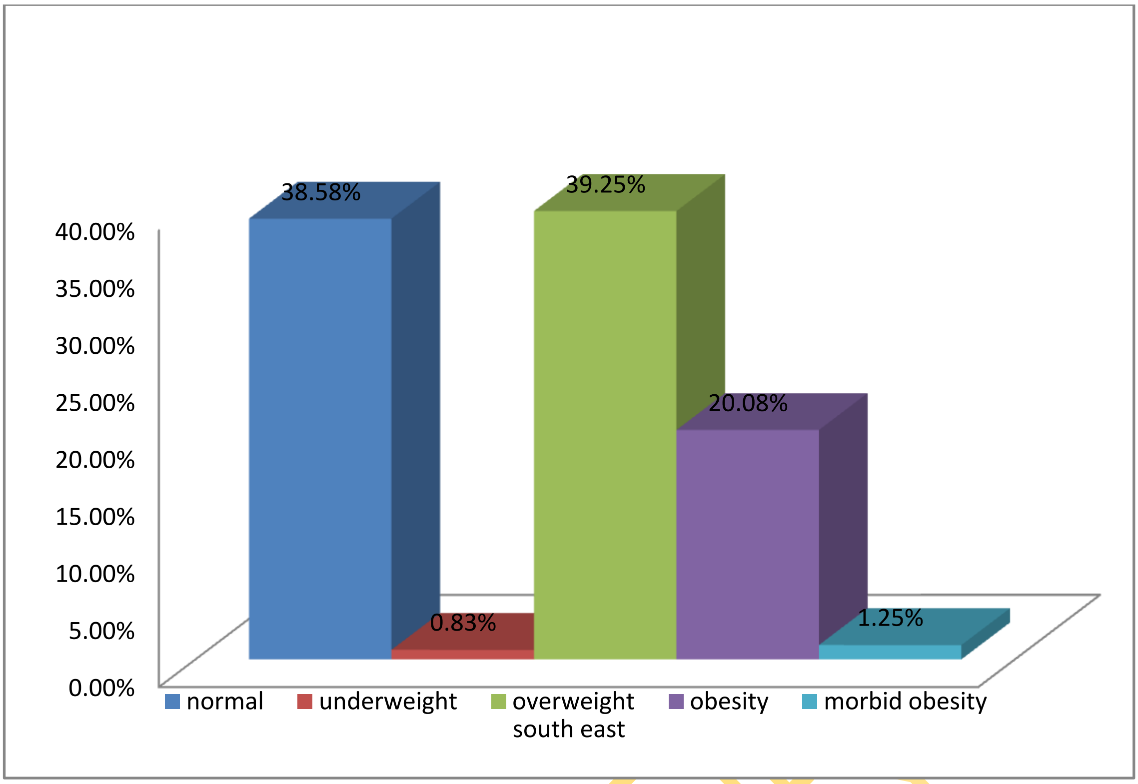

Fig 4.8: Summary of BMI of mothers in the South- East Nigeria

Four hundred and sixty three (38.58%) mothers were in the normal category, 10(0.8%) were in the underweight category, 471(39.3%) were overweight, 241(20.1%) were in grade one obesity and 15(1.3) were in the morbid (grade II) obesity category.

Table 4.31: BMI of mothers and diet diversity

BMI	Low DDS (%)	Medium DDS (%)	HighDDS (%)	p-value
Underweight	0(0.0)	7(70.0)	3(30.0)	0.94
Normal	8(1.7)	360(78.1)	95(20.2)	
Overweight	8(1.7)	373(79.2)	90(19.1)	
Obese	6(2.34)	205(80.08)	45(17.58)	

Correlation analysis shows that there was a negative correlation between dietary diversity and BMI (r=-12, p<.001).

Table 4.32: Comparison of z-score values for children anthropometric indicators in the states

WHZ	**Imo (%)**	**Enugu (%)**	**Anambra (%)**	**Total**
Not wasted	365(91.3)	333(83.2)	362(90.5)	1060(88.3)
wasted mild/moderate	25(6.2)	48(12.0)	17(4.2)	90(7.5)
Severe	10(2.5)	19(4.8)	21(5.2)	50(4.2)
HAZ				
Not stunted	299(74.8)	226(56.5)	261(65.2)	786(65.5)
Mild/moderate	45(11.2)	62(15.5)	58(14.5)	165(13.8)
Severe	56(14.0)	112(28.0)	81(20.2)	249(20.8)
WAZ				
Not underweight	366(91.5)	348(87.0)	358(89.5)	1072(89.3)
mild/moderate	27(6.8)	29(7.2)	30(7.5)	86(7.2)
severe	7(1.8)	23(5.8)	12(3.0)	42(3.5)

Note: WHZ-weight-to-height zscore, HAZ-Height-to-age zscore, WAZ-weight-to-age zscore.

Table 4.32 shows that on WHZ, Enugu 19 (4.8%) and Anambra 21(5.2%) had higher severely wasted children than Imo state 10 (2.5%). The total severely wasted was 50 (4.2%). Enugu 48 (12%) had higher mild/moderate wasted children than Imo 25 (6.2%) and Anambra 17 (4.25%). The total mild/moderately wasted for the three states was 90 (7.5%). Imo 365 (91.3) had higher normal children than Anambra 362 (90.5%) and Enugu 333 (83.2%). The total number of children that were normal was 1060 (88.3).

On HAZ, Enugu scored higher 112 (28%) on severely stunted than Anambra 81(20.2%) and Imo 56 (14%). Total number of severely stunted children was 249(20.8%). Enugu 62 (15.5%) also scored higher than Anambra 58(14.5)and Imo 45(11.2%)in mild to moderate stunting totaling 165 (13.8%) for the south east, while Imo 299 (74.8%) obtained higher score on normal than Anambra 261 (65.2%) and Enugu 226(56.5%). The total children that were normal on HAZ was 786(65.5%), 249(20.8%) severely stunted, 165(13.8%) mild to moderate.

On WAZ, Enugu 23(5.8%) obtained a higher score on severe underweight than Anambra 12(3.0) and Imo 7(1.8). Total 42(3.5%). Anambra 30(7.5) had higher score on moderately underweight children than Enugu 29(7.2) and Imo 27(6.8).Total was

86(7.2%).While Imo 366(91.5) had a higher score on Normal than Anambra 358(89.5) and Enugu 348(87.0) and the total number of children that were normal was 1072(89.3%).

Table 4.33: Comparison of Z-Score values for children anthropometric indicators in the sectors

WHZ	Urban (%)	Rural (%)	Total (%)	p-value
Not wasted	339(85.4)	721(89.8)	1060(88.3)	
Wasted mildly	38(9.6)	52(6.5)	90(7.5)	
severe	20(5.0)	30(3.7)	50(4.2)	0.001
HAZ				
Not stunted	268(67.5)	518(64.5)	786(65.5)	
Mild/moderate	50(12.6)	115(14.3)	165(13.8)	
Severe	79(19.9)	170(21.2)	249(20.6)	0.001
WAZ				
Not underweight	350(88.2)	722(89.9)	1072(89.3)	
Mild/moderate	31(7.8)	55(6.8)	86(7.2)	
severe	16(4.0)	26(3.2)	42(3.5)	0.002

Note: WHZ-weight-to-height zscore, HAZ-Height-to-age zscore, WAZ-weight-to-age zscore.

Table 4.33: Presents Z-scores of values for children's anthropometric indicators weight –for-height (WHZ), Height-for-age (HAZ) and weight-for-age (WAZ) for rural and urban respectively

WHZ which measures wasting or insufficient weight for height indicating acute under-nutrition score indicates that 20 (5.0%) and 30(3.7%) were considered wasted severely in the urban and rural areas respectively. The total wasted severely for the three states was 50 (4.2%). A total of 90 (7.5%) of the children were considered mildly wasted, 38(9.6%) and 52(6.5%) in the urban and rural areas, respectively. A total of 339(85.4%) and 721(89.8%) were normal in the urban and rural areas respectively totaling 1060 (88.3%)).

HAZ score which measures stunting or insufficient height for age indicating chronic under-nutrition shows that 79 (19.9%) and 170 (21.2%) were severely stunted in the urban and rural areas respectively, 50 (12.6%) and 115 (14.3%) were mildly stunted in the urban and rural areas respectively while 268(67.5%) and 518 (64.5%) were normal in the urban and rural areas respectively.

WAZ which measures underweight or insufficient weight for age score shows that 16 (4.0%) and 26 (3.2%) were severely underweight in the urban and rural areas respectively, 31(7.8%) and 55 (6.8%) were mildly underweight in the urban and rural areas respectively and 350 (88.2%) and 722 (89.9%) were normal in the urban and rural areas respectively.

Table 4.34: Relationship between Mothers and child wasting (WHZ) in the South-East

BMI (Mother)	Wasted severely (%)	Wasted mildly (%)	Normal (%)
Underweight	0(0.0)	0(0.0)	10(100)
Normal	25(5.4)	36(7.8)	402(86.8)
Overweight	14(3.0)	34(7.2)	421(89.8)
Obese	9(3.7)	20(8.3)	212(88.0)
Morbid	2(11.8)	0(0.0)	15(88.2)
Total	50(4.2)	90(7.5)	1060(88.3)

Correlation analysis shows that there was no significant relationship between mother's BMI and child (WHZ) (r=-.01, p=.80). From the above table it was discovered that overweight/obese and morbid obesity mothers had 79 children that were wasted.

Table 4.35: Relationship between Mother BMI and child stunting (HAZ) in the South -East

BMI	Stunted severe (%)	Stunted mildly (%)	Normal (%)
Underweight	1(10.0)	1(10.0)	8(80.0)
Normal	91(19.7)	59(12.8)	311(67.5)
Overweight	106(22.5)	73(15.5)	292(62.0)
Obese	47(19.5)	30(12.4)	164(68.0)
Morbid	4(23.5)	2(11.8)	9(64.7)
Total	249(20.8)	165(13.8)	784(65.5)

Correlation analysis shows that there was no significant relationship between mother's BMI and child (HAZ) (r=-.04, p=.14). Overweight/obese and morbid obesity mothers had 262 children that were stunted.

Table 4.36: Relationship between Mother BMI and child wasting (WAZ) in the South-East

BMI (Mother)	Wasted severely (%)	Wasted mildly (%)	Normal (%)
Underweight	0(0.0)	0(0.0)	10(100)
Normal	17(3.7)	34(7.4)	410(88.9)
Overweight	16(3.4)	32(6.8)	423(89.8)
Obese	8(3.3)	17(7.1)	216(89.6)
Morbid	1(5.9)	3(17.6)`	11(76.5)
Total	42(3.5)	86(7.2)	1070(89.3)

Correlation revealed that there was no significant relationship between mother's BMI and child (WAZ) (r=.02, p=.45). Overweight/obese and morbid obesity mothers had 77 children that were wasted.

Table 4.37: Relationship between stunted children and overweight mothers in the State and sector

States	Children stunted (%)	Mothers overweight (%)	Children in SCOWT pairs (%)	Urban residence SCOWT pair (%)	Rural residence SCOWT pair (%)
Imo	62(5.17%)	224(18.67%)	31(2.58%)	12(1%)	19(1.58%)
Enugu	99(8.25%)	274(22.83%)	76(6.33%)	23(1.92%)	53(4.42%)
Anambra	48(4%)	225(18.75%)	27(2.25%)	10(0.83%)	17(1.42%)
Total	209 (17.42%)	723(60.25%)	134 (11.17%)	45 (3.75%)	89 (7.42%)

Z-scores of values for children's anthropometric indicators Height-for-age (HAZ), for the populations shows that 209(17.42%) were stunted (Table 4.37).

Table 4.38: Relationship between energy, diet quality and dietary diversity

		1	2	3
1	**Energy**	1		
2	**Diet quality**	.31**	1	
3	**Dietary diversity**	.30**	.47**	1

**p<.001

4.1.1 Hypothesis 1

- **There is no relationship between nutrient adequacy and diet diversity**
- There was no relationship between nutrient adequacy and diet diversity (r=-.004, p=.90). The null hypothesis is accepted.

4.1.2 Hypothesis 2

- **There is no relationship between nutrient adequacy and diet quality**

There was a positive relationship between nutrient adequacy and diet quality (r=.08, p<.01). The null hypothesis is rejected.

4.1.3 Hypothesis 3

- **There is no relationship between dietary diversity and diet quality**
- There was a positive relationship between diet diversity and diet quality (r=.48, p<.05). The Null is rejected.

CHAPTER FIVE

DISCUSSION

5.1 Dietary Diversity

Dietary guidelines usually recommend increasing the diversity of foods across and within foods groups (U.S. Department of Agriculture Human Nutrition Information Service, 1992; WHO, 1996). To ensure micronutrient adequacy, several dietary guidelines have long emphasized the value of eating a variety of foods (Sandstrom and Sandberg, 1996; Drewnowski, 1997). Diet quality can also be assessed based on compliance with dietary guidelines or recommendations for health, such as those formulated by World Health Organization (WHO) for the prevention of diet-related chronic diseases (WHO, 2003).

The importance of overall diet quality for health is well established. The nutrients essential to meet nutritional requirements are not all found in a single food item (with the exception of human breast milk in the first months of life) but come from a diet composed of a number of foods (Hsu-Hage and Wahlqvist, 1996). Healthy diets are those that are the most varied. Diverse diets have been shown to protect against chronic diseases such as cancer (La Vecchia *et al.*, 1997; McCullough *et al.*, 2002) as well as being associated with prolonged longevity (Kant *et al.*, 1995) and improved health status (Hodgson *et al.*, 1994). Dietary pattern vary in different geographical areas and socioeconomic groups, and also over time. Such variation depends on agricultural practices and on climatic, ecological, cultural and socioeconomic factors, all of which determine the foods that people demand or expect and that are generally available.

Dietary Diversity Scores of populations have been revealed in studies to range from three to six (Azadbakht *et al.*, 2006; Oldewage-Theron and Kruger, 2008). The result of this study revealed the minimum and maximum DDS to be 2 and 11 respectively. A mean DDS of 6.96 ± 1.80 was derived in this study involving 1200 women of reproductive age in the three selected States in the South- East of Nigeria. Furthermore the mean DDS for urban (7.04±2.52) was higher than that of rural (6.90±2.43) and thus significant ($p<0.001$). DDS was on the medium level in the area studied. This was higher than the mean DDS of 4.5, 2, 5.8 and 4.0 recorded by Steyn *et al.*, (2006), Sanusi (2010) and USAID (2012) but comparable to the mean DDS of

6.61, 6.47 reported for Akwa-Ibom and Osun States in Nigeria (Sanusi, 2010), 6.81 by Vakili *et al.*, (2013) in Ahvaz-Iran and 6.50 for women and 6.23 for men in Sri Lanka (Jayawardena, Byrne, Soares, Katulanda, Yadav and Hills, 2013).

Creation of terciles and sometimes quintiles is one of the methods of defining cutoff points for assessing varying levels of dietary diversities in population (Ruel, 2003). These divides the dietary diversity scores into a scale of three or four equal parts such that individual dietary diversity scores are judged based on their position on that scale. Dietary Diversity Score terciles were prepared based on the 14 food groups to determine the proportion of subjects scoring low, medium and high DDS. The average number of food groups consumed by the women over the reference period was more on the medium level when compared to 14 food groups. The reason may probably be because of ignorance of food groups or because of unaffordability. A very low-diversity diet limits the intake of micronutrients (vitamins and minerals) such as iron, iodine, calcium, zinc, selenium and can lead to deficiencies (Huijbregts, Feskens and Kromhout, 1995; Herrmann, Neupert and Stuart, 1997). Dietary Diversity is very important to nutrition and health and the result of this study showed that efforts should be made to increase the DDS above medium level in the South-East.

There is lack of uniformity in methods to measure dietary diversity and in approaches to develop and validate indicators in different countries. These differences in methodological and analytical approaches affect the comparability and generalizability of findings in different countries (Ruel, 2002).

5.1.1 Dietary Diversity and Location (Urban/ Rural, States and Local Government)

The result of this study showed that the mean DDS for urban (7.04±2.52) was higher than that of rural (6.90±2.43) and thus significant ($p<0.001$). The higher diversity found in urban area was in contrast with the findings of (Wahlquist, 2005; Roche *et al.*, 2008; Sanusi 2010) but was consistent to the previous studies conducted by (Hoddinott and Yohannes, 2002; Clasen *et al.*, 2005; and Arroyo and Mendez, 2007) who reported higher DDS in urban areas.

The higher DDS in Owerri, Awka, Nsukka and urban areas may be due to Urbanization. With urbanization, food consumption become more diverse as a result of increased food choice in markets and change in lifestyles associated with higher income levels, time constraints due to women employment, trade and a taste for new foods (Delisle, 1990). Variety is often much greater in urban and peri-urban centers where food markets are vastly supplied and easily accessible (Arimond, Torheim, Wiesmann, Joseph, and Carriquiry, 2008). Torheim, Ouattara, Diarra, Thiam, Barikmo, Hatloy, Oshaug (2004) in their study reported that sector residence was important for dietary diversity: subjects from Ouassala, where there was a greater availability and selection of foods, generally had a more varied diet compared to those from the more isolated Oussoubidiania. Diets in urban areas tend to be based more heavily on processed and pre-prepared foods, the reason being convenience, availability and price e.g bread and rice. Consumption habits in urban areas have been found to reverse in Nigeria to root and tubers in time of economic crises (National Beureau of Statistics (NBS), 2012). A very large section of the world population is becoming urbanized rapidly with an increase from 30-47% in Sub-Saharan Africa. This growth of the urban population poses new food security challenges that need to be addressed. Production of food and easy access to food by household members to achieve food security must be consistent. Because food security in urban and rural environments is not the same**,** policy makers and planners in urban areas need to take the different scenarios into consideration when designing food security programmes to address the specific needs of the urban poor.

5.1.2 Dietary diversity and age

This study found no significant mean difference among age groups and diet diversity (p=0.80). This is in contrast with the reports of studies carried out by Patterson *et al.*, (1994), Rafferty, Teaford and Jungers (2002), Thiele and Weiss (2003), Torheim *et al.*, (2004), Fogli-Cawley, Dwyer, Saltzman, McCullough, Troy and Jacques (2006), Toft, Kristoffersen, Lau, Borch-Johnsen and Jorgensen (2007), who reported that diet quality rises with increase age. Ishara (2005) also reported that when mothers are older, they tend to consume more calories and feed their children well.

5.1.3 Dietary Diversity and Educational Level

There was a significant mean difference observed in DDS terciles among educational level of head of household (p<0.001). University degree holders were highest followed by polytechnic and secondary school completed. Generally, people with better education may have high profile occupations and greater purchasing power which could lead to higher consumption of different food variety (Jayawardena, Byrne, Soares, Katulanda, Yadav and Hills, 2012).

There was no significant mean difference observed in DDS terciles in different groups of educational attainment of respondents. Only 172 (14.3%) of the subjects were civil servants. Most of the respondents had low educational levels therefore they were unemployed, petty traders, working in their husbands shop or doing low-paying jobs. This may probably be the reason why there was no significant mean difference observed in DDS terciles in educational attainment of respondents. Taking care of the family and provision of food for the family in the South- East Nigeria is usually the responsibility of men. Many women with lower educational status did not have any source of income though they joined their husbands in their own businesses.

Studies conducted in other countries have found that improvements in women's educational levels helped to reduce the level of malnutrition among children (Smith and Haddad, 2001). Furthermore, according to Smith and Haddad, (2001), the nutritional status of children can be improved by improving women's social status or their economic or financial power relative to men. Women's educational level and status within the household, the health environment and the care received by children affected the nutritional status of children (Ruel, 2003; Smith and Haddad, 2000). Also, Fabella (1982) found that increase in the educational level of the mother helped to increase the food intake levels of girls.

Ishara, (2005) on the other hand stated that formal education, as measured by years of schooling alone did not seem to contribute to the alleviation of caloric inadequacies but there should be investment in targeted nutrition education programme.

5.1.4 Dietary Diversity and Occupation

There was no significant mean difference observed in DDS between terciles for subjects in groups for primary occupation of head of households (p= 0.70) and respondents (p= 0.16). Traders DDS was higher followed by civil servants and artisans for both head of house hold and respondents. One of the reasons for this is probably due to the fact that majority of the head of households and respondents were traders. This was consistent with the study of Thiele et al., (2004) who reported that Farmers significantly consumed less different products in a given time interval than do blue Collar workers (artisans and traders).

5.1.5 Dietary Diversity and Income

The result shows that the income of the head of house hold and respondent had a significant positive effect on the DDS of the family. There was a significant mean difference observed in DDS between terciles for different groups of head of household estimated Income ($p<0.05$) and that of the respondents ($p<0.05$). This is in line with the findings of Labadorios, Steyn, Maunder, Maclntyre, Swart, Gericke *et al.,* (2011) and Vakili, Abedi, Sharifi and Hosseini (2013) who reported that among women, the micronutrient composition of the diet became more favourable with increasing income and that the income of mothers had a significant positive effect on the caloric intake (CIs) of the household, mother, and children respectively. Also, Febella (1982) reported that the food intake of children increased with increase family income. Household and individual income levels, sources of income, food habits, and household characteristics affect the food intake and thereby the dietary caloric adequacy of household members.

Mothers play a significant role in determining the nutritional level of the household. Studies have shown that there were significant differences between the welfare benefits of income from men and that from women to the household, and the share of income generated by mothers made a significant contribution to the proportion of the household budget that was allocated to education and staple foods. Families with greater incomes and resources tend to have more diverse diets, and are also likely to have better access to health care and better environmental conditions (Arimond and Ruel, 2004).

Clearly, children in wealthier households are better off and grow better for a number of reasons, but improved nutrient adequacy may be one important way in which household wealth and resources translate into better outcomes for children. Arimond *et al.,* (2004) noted that poverty in households is related to poor diet diversity and that mental and physical development of children in households with low food variety, are negatively affected, because dietary diversification is closely related to normal growth of children. Also, Tudawe (1986) in their study on the nutritional status of people in the Kirindi Oya Project area found that differences in distribution of income influenced nutritional intake.

The limitations in assessment of income of the families are that the estimation of the economic situation of families is not simple and or correct, as generally, families do not reflect their real economic situation due to the fear of tax, security and other social matters. From table (4.12), 731(60.92%) of respondents claimed not to know the income of head of household and 278(23.17%) claimed not know their own income.

5.1.6 Dietary Diversity and Socio-economic Status

There was no significant mean difference between DDS terciles for subjects from different socio-economic status even though the socio-economic status of medium and high were higher in diet diversity than that of low socio-economic status. This is in consistent with the findings of Savy, Martin-Prével, Danel, Traissac, Dabiré, and Delpeuch (2008) who reported that the DDS-9 was not associated with the women's socio-economic characteristics but in contrast to the findings of Hatloy *et al.*, (1998) Hatloy *et al.* (2000), Hoddinott *et al.*, (2002) and Ferguson *et al.*, (1993) who reported differences in dietary diversity between households from different socioeconomic status in their study. Also Torheim *et al.*, (2004) reported that dietary diversity was associated with socioeconomic status, residence and age and that increased social economic status was associated with increased dietary diversity but not with nutrient adequacy.

The urban areas also had a higher diet diversity than the rural area and this is in line with the report of Clausen *et al.*, (2005) who found that the diet of older people, living in rural areas in Botswana, had no variety due to poor socio economic status but the older persons who lived in urban areas and had cattle and higher education, had a greater food variety, which resulted in a desirable health outcome.

5.1.7 Dietary Diversity and Family Size

The minimum and maximum family size was 2 and 15 and the mean family size was 5.02 ±1.77. There was no significant mean difference observed among different groups of family sizes and diet diversity (p=0.50) even though family sizes of between 1-4(45.8%) and 5-8(50.0%) had higher DDS. This means that lesser the family size the higher the dietary diversity. This is consistent with the study of Ishara (2005) who reported that the larger the family size, the lower the household calorie adequacy ratio (CAR). This finding could be explained by considering the high cost of providing for large families than smaller families. Smaller families could be able to afford diverse varieties of foods since the provision for small families would be easier with little amount of money.

5.1.8 Food Groups Consumption

Indigenous foods are foods which are commonly consumed by communities and those to which households have a traditional attachment. In many groups, the food that is preferred by a community is influenced by the culture and beliefs of a particular group of people (Mugabe, 1998). Cultural beliefs significantly affect eating habits. Traditional developing country's diets consist largely of unprocessed foods, and most households struggle to get enough for everyone to eat (Garrett and Ruel, 2005). Yet with increased economic development and urbanization, populations in many developing countries are now consuming more energy, more processed foods, including more refined grains, and foods higher in saturated fat, sugar, and salt (Garrett and Ruel. 2005).

According to (FAO, 2007) food group classification, it was found that the diets of the population consisted mainly of cereal, oils and fats, roots and tubers, Fish, flesh meat, dark green vegetables, legumes and nuts, milk. This report was in line with the study carried out by (USAID, 2009) who reported that the maternal diets in the different countries studied were based on starchy staples. Ahmed, Segal and Hassan (2000) reported that a predominantly starch-based diet of cereals, roots and tubers is frequently found amongst poverty-stricken populations, resulting in a dietary intake low in micro-nutrients. Most diets in developing countries predominantly consist of cereals, roots and tubers with little animal products, few fresh fruits and vegetables when available (Styen *et al.*, 2006; Maruapula and Chapman 2007).

Predominantly, carbohydrate diets raise plasma glucose, insulin, triglycerides and non-esterified fatty acids leading to insulin resistance (Wolever, Blasche, Ball and Crawford, 2003). Total carbohydrate intake is associated with risk of diabetes among South Indian adults (Mohan, 2009). Majority of the women (98.0%) consumed oils and fats, 76.6% ate foods from fish, 58.2%. from flesh meat, 52.8% from dairy products, 6.5% from eggs, and 1.8% from organ meat. Apart from the little percentage that ate from organ meat and eggs, other animal based foods were moderately consumed by the subjects. The protein intake of the subjects was above 70%. Proteins are good sources of amino acids essential for growth and maintenance (Korhonen, Lahti, Kankaanranta and Moilanen, 2005). The subjects consumed excess amount of starchy foods but lower amount of fruits, vegetables and dairy products. This is in consistent with the findings of Jayawardena *et al.,* (2012). About 55.2% ate from dark green vegetables, 53.8% ate foods from legumes and nuts, products, 47.6% consumed foods from Vitamin A vegetables, and 32.8% ate from other vegetables. Starchy staples were consumed by all women in the States; Substantial numbers of women in these states also consumed legumes and nuts (53.8%).

Fewer people consumed foods from vitamin A fruits, other fruits, organ meat, and egg. This was in consistence with the findings of USAID (2012). USAID (2012) in their study of maternal dietary diversity in Cambodia, Ghana and Haiti, found out that organ meat and other animal products like dairy and eggs were consumed quite infrequently in the three countries. Some food groups such as vegetables and fruits are particularly rich in antioxidant compounds including vitamin C (Block, Buta, Knapen, Elmegreen, Elmegreen and Puerari, 2004), beta carotene (Erlinger, Conlin, Macko, Bohannon, Miller III and Moore, 2002), dietary flavonoids (Chun, Chung and Song, 2007), and lycopene (Jacob, Periago, Bohm and Berruezo, 2008). Diets that are particularly rich in fruit and vegetables are now globally recognized as having protective effects against cardiovascular diseases and certain types of cancer (Kant, Schatzkin, Harris, Ziegler and Block, 1993; Cockcroft, Durkin, Masding and Cade, 2005; Ness and Powles, 1997) and to have a positive impact on long-term health outcomes from heart disease and asthma for children (Forastiere, Pistelli, Sestini, Fortes, Renzoni, Rusconi *et al.,* 2000; Nicklas, 1995). Vitamins and minerals can be obtained in great quantities from fruits and vegetables such as citrus, tomatoes and potatoes (WHO, 2000) and can enhance absorption of nutrients (Sam, 2005).

Cereals, oils and fat, were consumed by majority of the subjects. White tuber, Fish, flesh meat, dark green vegetables, legumes and nuts, milk products made up those food groups consumed by average number of subjects. The least consumed foods were in this order- organ meat, eggs, vitamin A fruits, other fruits, other vegetables, vitamin A rich vegetable. The commonest foods consumed in the South-East Nigeria were eba (garri), bread, yam, rice, beans, fish and meat. The commonest soups consumed were okro soup, ogbono soup, orah soup, bitter leaf soup and egusi soup. The beverages taken were satchet milo and milk.

Micro-nutrient intake can only be sufficient if vegetables, fruits and animal products are combined with staple foods. The low micronutrient intakes in this study reflected their inadequate consumption of important food groups such as fruits, vegetables, dairy, meat and fish in comparison to their recommendations. The consumption of excess amount of starchy foods but lower amount of fruits, vegetables and dairy products might be due to affordability and ignorance. Majority of people are ignorant of the nutrient contents of the food but eat food to fill their stomach.

5.2 Diet Quality

Food is a basic necessity of life. It is a key for healthy and productive life. Its importance is seen in the fact that it is a basic means of sustenance of an adequate food intake, in terms of quantity and quality. The importance of food is also shown in the fact that it accounts for a substantial part of a typical Nigerian household budget (Omonona and Agoi, 2007). Various foods serve as important "vehicles" for taking nutrients into the body and bringing about human pleasure, hence, the need for food to be taken in the right quantity and quality. To measure the quality of any food taken, there are classes of essential nutrients, which must be combined, in appropriate proportion to ensure a balanced food intake. These include carbohydrates, protein, fats and oil, vitamins and minerals. High intakes of food from the different food groups will enhance the intakes of micro-nutrients and energy.

5.2.1 Diet Quality in the South East of Nigeria

The total DQI-I obtained for the South East Nigeria was 58.79 ±8.12 out of a maximum possible diet quality score of 100 points. This was in the same range with the TDQI-I score reported by Kim *et al.*, (2003) and Mejean *et al.*, (2007) but higher than that reported by Tur *et al.*, (2005). Mejean, Traissac, Eymard-Duvernay, Ati, Delpeuch and Maire (2007) in their study using three groups reported that the total DQI-I score in the 3 groups was between 57.8 ± 6.6 and 64.4 ± 6.8 points while Kim *et al.*, (2003) reported that the DQI-I for China and US was 60.5± 0.11 and 59.1 ± 0.14, respectively. On the other hand Tur *et al.*, (2005) reported a TDQI-I of 42·87± 10·09 for the Mediterranean. Even though the total diet quality of South-East was average, the total variety and overall balance was poor due to ignorance of food groups and their nutrient content. Feeding habits and culture affected choices of food and intake of its variety.

5.2.2 Diet Quality in the South East of Nigeria: (a) Variety

The total variety achieved was 9.48±3.04 out of a total score of 20. When the variety score was analysed, it was found that only 201 subjects (16.8%) had at least 1 serving from each food group, or just one food group missing per day. Majority of the women 943(78.6%) consumed two food groups per day. In this study only 80 subjects (6.7%) ate up to 3 or more different sources of protein.The percentage that ate from one source and zero were 216(18.0%) and 72 (6.0%), respectively. The main source of protein was fish, flesh meat and legumes/nut. Only 78(6.5%) consumed eggs. One of the Findings from this study showed that the DDS according to food guide pyramid (USDA, 2000) in the South East was average. The average food groups consumed a day was 3.60± 0.88 out of 5 food groups (appendix 5) in the food guide pyramid and 6.96±1.80 out of 14 food groups (FAO, 2007) which was average.

In the variety category, scores for overall food group variety was higher in Anambra and the score for variety within protein groups was higher in Enugu state. Lack of foods from different food groups can lead to low diet diversity. Diversity is low when food access is compromised. Even though food supplies improved considerably after deregulation especially in the immediate post deregulation period in Nigeria, food accessibility and utilization worsened and overall food security status of the populace worsened (Dauda, 2006). In Nigeria, food security is less well established and the Nigerian diet often lacks variety because of food security challenges. The likelihood of Nigerians to have economic access to food can be measured from what is happening to employment and income. Unemployment and underemployment rates have been quite high and have not improved significantly over the years. Meanwhile, the per capita income has been declining progressively, making Nigerians not to have economic access to food on continuous basis (Ekong, 2013). Progressive increase in population from 88.9 million in 1991 to 103.3 million in 1996 and to 150million in 2006 without corresponding increases in food output seem to have worsened the food security situation in Nigeria (Omonona and Agoi, 2007; National Population Commission (NPC), 2010).

There was a positive correlation between diet diversity and Food variety. The higher the food variety, the higher diet diversity scores (Krebs-Smith, Smiciklas-Wright, Gutherie and Krebs-Smith, 1987, Thiele *et al.*, 2003). Increasing the variety of foods in the diets is crucial as it is able to ensure an adequate intake of essential nutrients, resulting in good health (Ruel, 2008). It is evident that for a household to have a diversified diet there has to be a variety of foods from different food groups and this can be explained in the light that families with higher socio-economic status and higher educational level can afford more variety of foods and thereby can obtain a higher dietary diversity. From the population studied in the South-Eastern Nigeria, 473(39.4) were on low socio-economic status (Table 4.14) coupled with low educational status where only 297 (24.8%) of the head of household and 329(27.0%) of respondents had University and polytechnic Education (Table 4.10).

5.2.3 Diet Quality in the South East: (b) Adequacy

This category evaluates the intake of dietary elements that must be supplied sufficiently as a precaution against under-nutrition and deficiency disorders**.** The total adequacy found in this study was 23.82% out of a total of 40%. The intakes of 50% and above of the recommendation were recorded for vegetable, grain/roots/tubers, protein iron, and calcium in the south East. However majority of the subjects scored lower than 50% recommendation for fiber, fruit and vitamin C.

The total adequacy and subcomponents scores for the three states did not vary significantly. Although for the fruit group intake, Imo and Anambra obtained higher mean score than Enugu. For vegetable group intake, the three states consumed barely average on the recommended intake of vegetable. Fruit and vegetables promote cardiovascular health by virtue of potassium, fiber and phyto-nutrients which they contain. Heaney (1993) reported that vegetables contain phytochemicals which act as antioxidants that help in the prevention of coronary diseases.

The low consumption of fruits observed in this study could have negative implication on health of the respondents because fruits supply most of the micronutrients which are vital to health. Fruits and vegetables have a protective effect and this partly due to the fact that they counteract the action of free radicals thus reducing the damage these free radicals cause to the body (Heimendigher and Van Dayn, 1995). Ness and Cottreau (1999) reported that consumption of fruits is very effective in the prevention of stroke and coronary heart attack among the elderly. Also, the low consumption of fruits could be a risk factor for hypertension among the aged. Amounts of 400-500g per day are recommended to reduce the risk of stroke, coronary heart disease, and high blood pressure.

In the three states adequacy for grain/roots and tuber was achieved by most of the population, and adequacy for fiber intake was not achieved in most of the population, also, there was near adequacy in the three states for protein. More than 70% of the subjects met above 50% recommendation for Iron for the three states. For Calcium intake, 52.1% in Imo, and 55.9% in Anambra state scored upto 50% of recommendation while only 49.7% in Enugu met 50% of the Calcium recommendation. Vitamin C and fiber consumption was also low and Vitamin C recommendation in most of the population was not achieved. Vitamin C helps to hold the body's cells together, aids with the healing process, helps with tooth and bone development, strengthens the walls of the blood vessels, improves iron absorption, and is essential for the immune system to function properly (Bellows and Moore, 2013; Haas and Brownlie, 2001). Fiber is protective against coronary disease and ischemic stroke and may contribute to lowering of blood pressure (WHO/FAO, 2003). Dietary fibres aid in energy intake control and reduced risk for development of obesity. The relationship of body weight status and fiber effect on energy intake suggests that obese individuals may be more likely to reduce food intake with dietary fiber inclusion (Evans and Miller 1975, Porikos and Hagamen, 1986). The role of dietary fiber in energy intake regulation and obesity development is related to its unique physical and chemical properties that aid in early signals of satiation and enhanced or prolonged signals of satiety.

Insoluble fiber is associated with reduced diabetes risk, but the mechanism by which this occurs is unknown (Weickert and Pfeiffer, 2008). However, one type of insoluble dietary fiber, resistant starch has been shown to directly increase insulin sensitivity in healthy people, type 2 diabetics (Robertson, Currie, Morgan, Jewell and Frayn, 2003; Robertson, Bickerton, Dennis, Vidal and Frayn, 2005; Zhang, Wang, Zhang and Yang, 2007) and in individuals with insulin resistance, possibly contributing to reduced risk of type 2 diabetes (Johnston, Thomas, Bell, Frost, and Robertson, 2010; Maki, Pelkman, Finocchiaro, Kelley, Lawless, Schild *et al.*, 2012; Robertson, Wright, Loizon, Debard, Vidal *et al.*, 2012).

5.2.4: Diet Quality in the South East Nigeria: (c) Moderation

Moderation was the area of the diet that the south east scored highest. The total moderation found in this study was 24.99% out of a total of 30% (Table 4.18).

Moderation evaluates intake of food and nutrients that are related to chronic diseases and that need restriction. Certain levels of total fat, saturated fat, cholesterol and sodium are necessary for the body to function normally, but when taken in excess may contribute to the onset of chronic diseases (Weisburger, 2000). The lowest consumption gets the highest score because intakes on low level will prevent a healthy person to show any evidence of harmful effect even though very low fat diet contributes to under nutrition and stunting in children (Steyn *et al.*, 2006). In this study, a total number of 1076 (89.7%) consumed the recommended level of total fat in the South East. Intake of saturated fat was also normal, 1195 (99.6%) of the participants consumed recommended level of saturated fat (Table 4.19). Lack of moderation and unbalanced diet, are important dietary risk factors of chronic diseases.

The three states recorded high scores in moderation category. High saturated fat has been implicated in lower semen concentration (Jensen, Heitmann, Jensen, Halldorsson, Andersson, Skakkebak, Joensen *et al.*, 2012), heart diseases (Siri-Tarino *et al.*, 2010) diabetes (Hu, 2010) and high blood cholesterol levels (Jakobsen, Dethiefsen and Joensen, 2010). Cholesterol consumption was within the recommended ranges with 1195(99.6%) consuming less than 400mg/day. The reason may be because cholesterol is not found in significant amounts in plant sources (USDA, 2008; Behrman, 2005) but in all foods containing animal fat to varying extents.

Consumption of different sources of foods from animal product was not really high by this study group. Major dietary sources of cholesterol include cheese, egg yolks, beef, pork, poultry, fish, and shrimp (USDA, 2008) Human breast milk also contains significant quantities of cholesterol. Intakes of sodium was normal with 967 (97.5%) of the subjects consuming the recommended level of sodium. Too much sodium in the diet may lead to high blood pressure in some people, a serious build-up of people with congestive heart failure, cirrhosis, or kidney failure (Aronow, 2011). Only 25 (2.1%) of the subjects got more than 10% of their total energy from empty calorie foods.

Some of the empty calorie foods considered were sugar, honey, alcohol and soft drinks. Majority of the breast feeding mothers did not take sugar and soft drinks at all because they believed that these food items could affect the health of their babies negatively. Generally, women in the South- East especially nursing mothers do not like taking alcohol, and honey on the other hand was not affordable. Sedentary individuals and those eating less to lose weight may suffer malnutrition if they eat food supplying empty calories but not enough nutrients (CDC, 2013).

The main oil used by the Ibos in soups was palm oil and other types of vegetable oil in smaller quantities for stew. The higher score achieved in moderation may be because of the low to moderate levels of palm oil consumption by Nigerians (Ayodele and Olajide, 2010). Also majority of the subjects ate their bread dry; they did not use margarine as spread in their bread. Palm oil is widely used in African cooking, especially in soups and sauces. At low to moderate levels of palm oil consumption, such as prevailing among the bulk of the Nigerian population the hypercholesterolemia of consuming high levels of palm oil, risk may not apply. There may be a risk in populations with a high fat intake.

The typical Nigerian diet contains significant amounts of invisible fats rich in PUFA, high dietary fiber which has hypocholesterolemic factors (Ayodele *et al.*, 2010). The hypercholesterolemia risk of consuming high levels of palm oil has been investigated extensively in experimental animals and in human subjects in various countries with different types of diets. All these Studies have established that palm oil does not behave like a saturated fat in its effects on blood cholesterol or blood clotting, as might be anticipated from its fatty acid composition (Chong, 1991). The vitamin E tocotrienols present in palm oil are known to reduce circulating cholesterol concentrations in humans (Haave, Nicol and Innis, 1990).

5.2.5: Diet Quality in the South East Nigeria: (d) Overall Balance

Lastly, the recommendations for balance among energy-yielding nutrients as well as among fatty acids were very poorly met in this population. The total overall balance was 1.98 % out of 10% which showed that their diet was highly unbalanced**.** This is in line with the result of Kim *et al.*, (2003) and Tur *et al.*, (2005). The goals for balance among energy-yielding nutrients was relatively fair compared to that of fatty acids that were poorly met in the three States. About 58.5% of the population in Imo, 64.0% in Enugu and 65.8% in Anambra met the recommended ranges on macro-nutrients, while 89% in Imo state, 87.5% in Enugu and 88.5% in Anambra failed to meet the recommended proportionality in fatty acid resulting in low scores in the fatty acid ratio balance component.

In Imo, moderation was the strongest quality of diet among the four categories, followed by adequacy and variety. Variety category was best achieved in Enugu, followed by the moderation and adequacy categories. And in Anambra state, moderation was best achieved followed by adequacy. Overall balance was the weakest area in all the three States. Enugu scored highest in variety and moderation while Anambra scored highest in adequacy and overall balance. Overall, across all four categories, Imo, Enugu and Anambra had medium range of good quality diet with each scoring up to 58.6%, 58.8%, and 59.0% of the perfect score of 100% respectively.

Increased intake of saturated fatty acids (SFA) is a risk factor for several chronic diseases, especially cardiovascular diseases, whereas increased intakes of PUFA and monounsaturated fatty acids were found to be protective of these conditions (Aguilera, Amirez-Tortosa, Mesa and Gil, 2001). However, excess intake of any of these fatty acids is undesirable, and maintaining a balance among the intakes of these fatty acids is more critical to a healthy diet (Zheng, Hu, Zhao, Yang, and Li, 2013).

When a Linear regression and correlation coefficient was carried out in the category and sub categories of the DQI-I, it was observe that most of the components used to construct the DQI-I positively and significantly correlated and are significant predictors (determinants) of good quality diet except for cholesterol and sodium categories. Cholesterol and sodium are not good predictors of diet quality.

5.2.6: Diet Quality and Demography

Diet quality in this study did not increase with increasing age and this is in contrast with the report of Thiele *et al.*, (2004) who found out in their study of determinants of diet quality in German Nutrition Survey of 1998 that, diet quality increased with increasing age constantly for women and for men from approximately age 45 years upwards.

The results of this study showed positive correlation between diet quality and family size. Smaller family sizes of 3, 4, and 5 had higher diet quality. Educational level of respondents (r=.08, p<.01) and head of household (r=.09, p<.01) correlated positively with diet quality. The educational level of head of household and respondents significant relationship to diet quality could be that the higher the educational level of head of household and respondents the higher the awareness and understanding of the need for good quality diet in the family. Occupational status of respondents had a negative significant relationship with diet quality (r=-.06, p<0.05). This means that the less occupied the respondent is the higher their diet quality. This could be explained by considering the fact that mothers who were career workers or seriously engaged in jobs had little or no time to prepare good meals for their families compared to mothers who were house wives or engaged in less tedious occupations that granted them more time to take proper care of their families. Also, mothers who were nursing their babies spend more time at home and consequently cooked good meals for the family.

Some Socio-economics variables (car, house ownership, and source of fire) correlated positively with diet quality. This was consistent with the reports of Thiele *et al.*, (2003). This result was also consistent with previous studies that reported that lower socioeconomic position was associated with poorer diet quality (Whichelow and Prevost, 1996; Milligan, Ramsey, Miller, Kaster and Thompson, 1998; Mishra and Samantaray, 2004; Ball, Crawford and Mishra, 2006). Also Links between socioeconomic status and child nutrition and health outcomes had long been established.

Other Studies also reported that diet quality was affected not only by age and sex, but also by occupation, education, income levels and social economic status (Krieger *et al.*, 1997; Galobardes *et al.*, 2001; Groth *et al.*, 2001; Turrell *et al.*, 2003). Drewnowski and Darmon (2005) in their study reported that more affluent population subgroups were not only healthier and thinner, but they also consumed higher quality diets than the poor. High quality diet in terms of the consumption of vitamins, minerals and trace elements increased when income and education levels are high (Thiele *et al.*, 2003). Surprisingly it was found that, diet quality was higher with respondents who claimed income of between #5,000-#14,999 (29.9%) and those without income (28.5%). The reason for this could be that these women were housewives and had more time to cook a normal diet and took care of their family than the working class mothers and secondly that their husbands provided enough money for the housekeeping.

5.3 Comparison of Diet Quality of South East Nigeria with that of USA, China and Mediterranean

The total diet quality index-International of these countries were on the same range but the major categories however, revealed some differences between the countries, reflecting each country's nutritional status and concerns. Some distinct patterns of poor quality diet in each country were also identified.

5.3.1: Comparison of Diet Quality between Countries: (a) Variety

The total variety achieved was 9.48±3.04 out of a total score of 20. The variety score was lower than that of China (11.8±0.06), USA (15.6±0.04) and Mediterranean (9.70±5.91) (Kim *et al.*, 2003: Tur *et al.*, 2005). When the variety score was analysed, it was found that only 201subjects (16.8%) had at least 1 serving from each food group, or just one food group missing per day, compared with 64.9% from USA, 30% from China and 28.6% from Mediterranean (Kim *et al.*, 2003: Tur *et al.*, 2005). High diet variety and high adequacy was a sign of the availability of a wide range of foods that followed the rapid economic development. The lower diet diversity score compared to USA and China obtained could be as a result of fewer varieties as compared to the western world, ignorance about the nutrient content, culture, food habit and affordability.

Diverse diets have been shown to protect against chronic diseases (McCullough *et al.*, 2002). Even though diet diversity is seen as a good strategy to improve micro-nutrient deficiencies, many challenges exist such as the bioavailability of micro-nutrients in the food, the allocation of food within the households, the availability of foods in certain seasons and preference for certain foods. Different strategies need to be adopted to address factors that lead to unavailability of micro-nutrients. Diet diversification is a crucial component when it comes to improving health status in a household, because a diet that has been diversified with fruits and vegetables will benefit individuals through decreasing their chances of contracting deficiency diseases and chronic diseases. The fruits and vegetables in diversified diets will provide the body with Vitamin A and Vitamin C (Johns, 2001).

US dietary guidelines recommend using a variety of grains especially whole grains and a variety of fruits and vegetables. It is shown that dietary variety is associated with higher energy intake (Foote *et al.*, 2004) as well as overweight and obesity (McCrory, Fuss, McCallum, Yao, Vinken, Hays and Roberts, 1999*);* it therefore, seems that the new recommendation advocates consumption of a diverse diet while staying within energy needs. It is suggested that consumption of a varied diet reduces the risk of developing a deficiency or excess of any one nutrient (Krebs-Smith *et al.*, 1987*)*; it may therefore, somehow be associated to the dietary nutrient quality.

5.3.2: Comparison of Diet Quality between Countries: (b) Adequacy

The total adequacy found in this study was 23.82 ±4.67 out of a total of 40 (Table 4.18). This was lower than the adequacy by Kim *et al.,* (2003) for USA (28.1±0.08) and China (28.0±0.05) but higher than the adequacy score by Tur *et al.*, (2005) for Mediterranean (22.67±4.66) Table 4.27.

Comparing all the variables under Adequacy across the four countries, it was found that USA and China diets scored higher in vegetable, protein, vitamin C and iron than South- East. Also the diet of Mediterranean scored higher in protein, vitamin C, fibre, calcium and fruit than the South- East. South- East diets scored higher than USA in grains, roots and tubers, China in fruit and fiber and Mediterrenian in vegetables and grains, roots and tubers. The main staple foods of the South-East were mainly grains, roots and tubers eaten with soups that contained vegetables.

5.3.3: Comparison of Diet Quality between Countries: (c) Moderation

The scores for moderation was higher in the South- East study than found by Kim, *et al.,* (2003) and Tur, *et al.,* (2005). The diets of USA, China and Mediterranean lacked moderation when compared with South- East diet. The South East diet scored better in all the components under moderation than the other three countries. Even though over-nutrition, which is lack of moderation, is the predominant nutrition problem in the developed countries, the problem of under-nutrition is still very real in the United States (Kim *et al.,* 2003) as in Nigeria (Ndukwu, Onwudike, Idigbor, Ihejirika and Ewe, 2013) . The higher variety score and the lower moderation score in the United States correspond to what was observed through the stages of the nutrition transition. With economic development comes increased food availability, which leads to greater food security and thus dietary variety and adequacy (Drewnowski, *et al.*, 1997). Lack of moderation in some dietary components, such as fat, has also become a nutritional concern in China and the Mediterranean (Du, Lu, Zhai and Popkin, 2002; Tur *et al.*, 2005).

5.3.4: Comparison of Diet Quality between Countries: (d) Overall balance

The recommendations for balance among energy-yielding nutrients as well as among fatty acids were very poorly met in the population studied. This was the weakest score in all groups. The total overall balance was 1.98% out of a total score of 10% which showed that their diet was highly unbalanced**.** This was lower than that of China (2.1±0.04) but higher than USA (1.1±0.02) and Mediterranean (0.16±0.74) (Table 4.27). The disparity between availability and prudence in intake appeared to cause imbalance in their diet, as shown in the lower overall balance scores in the United State (Kim *et al.,* 2003). Intakes of grains, roots and tubers (carbohydrate foods) in South- East Nigeria were higher than recommended intakes. One of the notable findings in the DQI-I evaluation of the South East subjects was that the proportion of people with intakes less than the recommended intakes was high for many nutrients This is in line with Kim *et al.*, 2003 and Tur *et al.*, (2005). This could be as a result of poverty and lack of nutrition knowledge.

5.4: Nutrient Adequacy of Diets of Women in South-East Nigeria

Nutrient Adequacy was measured using the nutrient adequacy ratio (NAR). The NAR for a given nutrient is the ratio of a subject's intake to current recommended allowance for the subject's sex and age category (Madden *et al.,* 1976; Guthrie and Scheer, 1981). This term refers to the achievement of recommended intakes of energy and other essential nutrients considered in this study. The nutrient adequacy ratio (NAR) of the diet of these subjects was calculated for energy and eleven other (11) nutrients (Table 4.28).

Placing the nutrient intake on adequate/ inadequate category, it was confirmed that over 80% of the subjects had adequate intake of energy, protein, and carbohydrate while over 90% did not meet adequacy for calcium, potassium and zinc. Also majority of the subjects did not meet adequacy of these nutrients; magnesium, vitamin C, sodium, fat and phosphorus. Adequacy of iron was met by 60.8% of the population studied.

5.4.1: Energy

The mean energy intake of the subjects was 2464.7 Kcal±678.2Kcal (appendix 4) while recommended total energy intakes range from 1600 to 2400 calories per day for women, depending on age and physical activity level (DGAC, 2010) and 1600 to 2700. Although some mean intakes of energy may be within recommended ranges, the increase over time in the number of adults and children classified as overweight or obese indicates that for some, usual energy intakes exceed needs. An excess intake of energy of 32.9% was recorded for the subjects. The result is in line with a study carried out with students of University of Nigeria, Nsukka (UNN) where the energy and protein intake exceeded that recommended by the FAO/WHO (Nnanyelugo and Okeke, 1987). If this excess energy intake continues for sometime without the individual burning it, it might lead to obesity and its associated complications.

Some nutrient-dense foods also are naturally energy-dense (e.g., nuts, olive oil), and these foods can be incorporated into a total diet that is relatively low in energy density. The association of variety with energy consumption can be viewed as a reason not to recommend dietary variety, and it appears that reducing dietary variety can reduce energy intakes (Rolls *et al.*, 1989), and perhaps also the risk of obesity. Thus, any guidance to consumers that promotes dietary variety should emphasize that the goal is to alter variety within the context of a diet that maintains appropriate energy balance. Furthermore, the association of variety with energy intake is stronger for some food groups than for others, i.e., adjusting for energy intake had little effect on the correlations between fruit variety and nutrient adequacy, but this same adjustment essentially eliminated the association between meat/protein variety and nutrient adequacy (Foote *et al.*, 2004). It is important to note that dietary variety, food group intakes, and nutrient adequacy are all strongly correlated with energy intake.

5.4.2: Protein

The mean protein intake by the subjects was 94.3g ± 91.7g (appendix 4). Protein can be found both in plants and animal origins. Most of the protein they consumed was from fish, flesh meat, legumes and nuts and milk and milk products. Protein being one of the macronutrients was consumed significantly higher with about 32.9% consuming excess. Excess of its consumption has been implicated in kidney stone (food and Nutrition Board, 2005).

5.4.3: Carbohydrate

The mean carbohydrate intake of 423.2g±188.9g (appendix 4) was recorded for the subjects. About 51.8% ate excess carbohydrate from energy, grains, roots and tubers. The prevalence of obesity has increased worldwide and hence the importance of considering the role of diet in the prevention and treatment of obesity. Carbohydrate is among the macronutrients that provide energy and can thus contribute to excess energy intake and subsequent weight gains (Van damme, Rouge and Peumans, 2007).

5.4.4: Fat

The mean intake of fat for the subjects was 65.3g±58.9 (appendix 4). While 34.8% of the population met the recommended intake of fat, 54.9% did not consume enough and 10.4% ate excess amount (Table 4.28). The South-Eastern population of Nigeria consumed mostly palm oil, peanut oil and soya oil but the quantities used per meal were not usually high. This might be the reason while 34.8% did not meet their recommended intake of fat. Fat is essential to health because it supports a number of body's functions. Some common oils include palm oil, peanut, canola, corn, olive, safflower, and soya oils.

5.4.5: Calcium

The mean intake of calcium by the subjects was 371.8mg±249.0mg (appendix 4). It was shown that 96.6% of the population did not meet their recommended intake for calcium. The result is in line with the report of Nnanyelugo and Okeke (1987) who found out that intake of calcium were below FAO recommendation. Even though the consumption of food items that were sources of calcium was average in this study, calcium intake was still low probably because of inadequacy in quantities consumed or that not all the calcium consumed was absorbed because of presence of calcium antagonist like phytate and oxalate in the foods/diets consumed.

Lack of Calcium in the diet is responsible for the high rate of bone diseases, low bone mass, placing people at risk of bone fractures and falls (Thacher, Aliu, Griffin, Pam, O'Brien, Imade *et al.*, 2010). Adequate calcium status is important for optimal health of the skeleton, in addition to having vital roles in nerve transmission, vasoconstriction, vasodilation, and muscle contraction. Emerging evidence suggests a role for calcium intake in cardiovascular health and lowering risk for breast cancer (Chung, 2009). Evidence on other health-related outcomes, such as growth in infants and children, body weight, colorectal (CRC), prostate and pancreatic cancer, preeclampsia, pregnancy-induced hypertension, and preterm birth, is too insufficient or inconsistent to permit strong conclusions (Chung, 2009).

Beans, fluid milk and milk products can contribute substantially to calcium intakes. Removing fluid milk and milk products from the diet requires careful replacement with other calcium-rich or calcium-fortified foods. This is the reason why Kim *et al.*, (2003) placed dairy and beans in the same group for population in the developing countries who cannot afford milk and milk products.

5.4.6: Phosphorus and Magnesium:

The mean intake of phosphorus was 630.3mg±373.6 (appendix 4). About 30.0% met the recommended level of phosphorus and 48.5% were low on phosphorus intake which reflects a low intake of fluid milk and milk products. Fifty percent of the population studied consumed milk and milk products but the amount they consumed might not be adequate and the consumption might not be on a regular basis.

Magnesium intake was also poor. The mean magnesium intake was 214.2mg ±756.9mg (appendix 4). Only 16.6% had adequate intake of magnesium while 80.0% were below recommended level. Low intakes of magnesium tend to reflect low intakes of vegetables, nuts, seeds, and cooked dry beans and peas. Even though the above mentioned food products were consumed, the result of this study revealed that the quantity consumed and the frequency of consumption was not enough to meet their recommended nutrient intake.

Phosphorus and magnesium requirements may be met by increasing dietary intakes of vegetables, nuts, seeds, cooked dry beans and peas, and fluid milk and milk products (Thomas, Annette and Friedrich, 1999).

5.4.7: Sodium

The mean sodium intake of the population studied was 1280mg ±88.6mg (appendix 4). Intake of less than the upper intake levels of 2300 mg per day for sodium by all individuals is recommended with an eventual goal of less than 1500 mg per day. The result of this studied showed that a lot of people did not meet the recommended level of their sodium intake. Though 16.2% of the population met the adequate intake level, 79.4% did not meet the recommended level for sodium. This might be due to the fact that majority of the respondents used more of the traditional spices like fermented locust bean and fermented castor oil seed in their diets than bullion cubes. Also, consumption of fast foods was not high among this study group.

In some people, sodium increases blood pressure because it holds excess fluid in the body, creating an added burden on the heart (Cox, 2012). Too much sodium in the diet may also have other harmful health effects, including increased risk for stroke, heart failure, osteoporosis, stomach cancer and kidney disease (Passmore, 2008).

5.4.8: Potassium

The mean potassium intake by the subjects was 1110.24mg ±902.6 (appendix 4) only 3.1% of the population met the adequate intake of potassium, leaving 96.3% below the recommended intake.

The consumption of fruits and dietary sources of potassium like banana, pear, plantain, avocado, water melon and sour soup was low in the population studied. This might be because of high cost of these food items or probably because of ignorance of the nutrient content of the foods.

Increased potassium consumption modifies systolic and diastolic blood pressure. Approximately 57 million Nigerians have pre-hypertension or hypertension (WHO, 2013) and many more have inadequate dietary intake of potassium. Thus, potassium should be a nutrient of public health significance. Potassium which is contained in fruits like banana, plantain, sour soup, water melon and avocado helps to lower blood pressure by relaxing blood vessels and helps the body to expel sodium and water (Rimando and Perkins-Veazie, 2005). These fruits are natural diuretics due to their potassium content making them excellent for cardiac disorders (Ensminger, 1995). Dietary sources of potassium are found in all food groups, notably in vegetables and fruits,

5.4.9: Zinc

The average mean intake of zinc was 12.4mg ±5.2mg (appendix 4), only 46.1% met the recommended intake of zinc, 26.6% ate excess, while 27.4% of the population was below the recommended dietary allowance. The population under study had large consumption of fish, and foods from plant origin (cassava products and yam) which made more than 70% of them had adequate consumption of zinc.

Zinc is seen as an appetite stimulator (Suzuki, Asakawa, Li, Tsai, and Amitani, 2011). Studies have shown that zinc treatment results in a 25 percent reduction in duration of acute diarrhea and 40 percent reduction in treatment failure or death in persistent diarrhea (Bhutta, Bird and Black, 2000). Zinc deficiency contributes to increased incidence and severity of diarrhea and pneumonia and may cause a decrease in appetite which can degenerate into anorexia nervosa. Zinc deficiency can interfere with many organ systems especially when it occurs during a time of rapid growth and development when nutritional needs are high such as during infancy (Sandstead, Frederickson and Penland, 2000). Cognitive and motor function may also be impaired in zinc deficient children. Zinc deficiency during pregnancy can negatively affect the mother and fetus, an increased incidence of difficult and prolonged labour, hemorrhage, uterine dystocia and plancental abruption (Shah and Sachdev, 2006). Foods of plant origin contain less zinc than foods of animal origin.

5.4.10: Iron

The mean iron intake was 54.3mg ± 183.8mg (appendix 4), with 26.7% of the population within the recommended intake of iron, 67.9 % consumed excess. The result is in line with the report of Nnanyelugo and Okeke (1987) in their study with students of University of Nigeria Nsukka (UNN) who found that the intakes of iron were above, the FAO recommendation. There was dietary intake of foods that are sources of heme-iron, such as fish and meat, and sources of nonheme-iron, such as cereals and whole grains. Foods containing nonheme-iron should be consumed along with enhancers of iron absorption, such as vitamin C-rich foods and foods containing heme-iron. Moderation need to be considered because too much iron can be just as bad as too little, as bacteria and cancer cells thrive in an iron-rich environment, reproducing fast and furiously. Too much iron causes free radicals to form, which have been linked to everything from cancer to heart diseases and aging (Kaplan, 2013).

5.4.11: Vitamin C

The mean intake of vitamin C was 50.0 ± 88.3mg (appendix 4). Majority (78.2%) of the subjects scored below recommended level of vitamin C. The best sources of vitamin C are citrus fruits including grapefruits, oranges and kiwis but the consumption of these fruits was low (18%) in the population studied.Since our bodies cannot produce or store vitamin C, an adequate daily intake of this nutrient is essential for optimum health. Vitamin C works with vitamin E as an antioxidant, and plays a crucial role in neutralizing free radicals throughout the body. Red and green peppers are also healthy sources of vitamin C. Vitamin C acts as an antioxidant, and may decrease the risk of heart disease and some cancers.

5.5 Relationship between dietary diversity, diet quality and nutrient adequacy:

There was a significant positive correlation between diet diversity and diet quality (hypothesis 3) (r=.48, p<.001). There was no relationship between nutrient adequacy and diet diversity (r=-.004, p=.90) and there was a positive relationship between nutrient adequacy and diet quality (r=.08, p<.01) (hypothesis 1 and 2 respectively).The higher the diet diversity the higher the diet quality in this study. The observed positive relationship found between dietary diversity and dietary quality is in line with the study carried out by Krebs-Smith *et al.*, (1987) and Thiele *et al.*, (2003) which indicated that a well-balanced diet might be reached more easily by choosing a large variety of foods.

Some studies had generally supported the association between diversity and nutrient adequacy (Ogle *et al.*, 2001; Torheim *et al.*, 2004). Accordingly, dietary variety or diversity and various indices of micronutrient adequacy have been used to reflect dietary quality (Drewnowski *et al.*, 1997; Krebs-Smith *et al.*, 1989; Murphy *et al.*, 1996; Ruel, 2003). Recently, the association between dietary diversity and micronutrient adequacy of diets of women of reproductive age was assessed in five countries and dietary diversity was significantly associated with micronutrient adequacy in all sites (Arimond *et al.*, 2010). Also the DDS was found to be a useful indicator of some specific nutrient adequacy in women from Tehran (Mirmiran, Azadbakht and Azizi, 2006). Two other studies that have looked at the association between diversity measures and nutrient intakes in Nigeria and Kenya respectively, confirmed the positive association between dietary diversity and intake of a variety of nutrients (Tarini *et al.*, 1999; Onyango, 1998). Only one study, conducted in Ghana and Malawi, documented weak and even in some cases negative associations between diversity and certain nutrients (Ferguson, *et al.*, 1993).

One exception to this was reported in a study from urban Guatemala, but in this study diversity was defined as the number of unique foods consumed over 14-24-hour periods; this meant that even very infrequently consumed items counted in the score (Fitzgerald, Hwang, Brix, Bush, Qiunn and Cook, 1992). There is ample evidence from developed countries showing that dietary diversity is indeed strongly associated with nutrient adequacy and is thus an essential element of diet quality (Kant 1996; Drewnowski *et al.*, 1997; Lowik *et al.*, 1999; Foote *et al.*, 2004) whereas there is less evidence from developing countries where monotonous diets, relying mostly on a few plant-based staple foods, are typical. Even fewer studies from developing countries have aimed to confirm this association specifically among adult women (Ruel, 2003).

Increasing the variety of foods and food groups in the diet helps to ensure adequate intake of essential nutrients and promotes good health. Food choices influence the health and well-being of individuals. Current dietary concerns include the over consumption of calories, added sugars, and saturated fats; under consumption of whole grains, fruits, and vegetables. More recently, there has been an increased incidence of noncommunicable diseases among the Nigerian population and health conditions such as obesity. The positive influence of high food diversity on diet quality could be interesting for public health strategies.

5.6: Diet Quality, Diet Diversity and Energy intake

There was positive association between Dietary diversity Score/Dietary quality and energy intake. The positive association between total energy intake, dietary diversity and dietary quality in this study was as expected. If a person eats more, he has a higher ability to reach the recommended intakes of vitamins, minerals and trace elements. However, he may additionally tend to have excessive intakes of fat, cholesterol, saturated fatty acids, sugar, alcohol and sodium Combs (2008). Several studies showed a positive correlation between calorie intake and dietary diversity (Torheim *et al.*, 2004; Mirimiran *et al.*, 1996). When dietary diversity increases, there is a significant increase in the total consumption of calories. The study carried out by Mirmiran *et al.*, (2006) found that dietary diversity score, food group intake, and nutrient adequacy all strongly correlate with energy intake. Also, Thiele *et al.*, (2003) in their study on determinant of diet quality found a positive association between total energy intake and diet quality.

Studies by Ranil, Nuala, Mario, Prasad, Bijesh and Andrew (2013) also reported that consumption of large number of food items may lead to excessive intake of calorie and weight gain. Also dietary variety within food groups was positively associated with body fatness among healthy adults (McCrory *et al.,* 1999). On the contrary, an inverse association between DDS and obesity/abnormal adiposity was reported among the female students of Isfahan University (Azadbakht and Esmaillzadeh , 2011) while in USA women, low BMI was associated with higher DDS (Kant *et al.*, 1993). Krebs-Smith (1987) in their study reported that dietary diversity among and within food groups was not related to total energy, fat, sugar, sodium, or cholesterol intake, and also Murphy *et al.*,(1996) reported a strong inverse correlation between energy intake and the number of nutrient intakes below recommended guidelines.

This association of dietary diversity score, dietary quality with energy can be considered as reason not to recommend dietary diversity score and only recommend it within the context of a diet that maintains appropriate energy balance (Mirmiran *et al.*, 2006). Although many dietary guidelines promote consumption of varied diet, it should be selective (e.g vegetable) rather than absolute number. Increased dietary diversity in health promotion may not be appropriate for combating obesity epidemic (Ranil *et al.,* 2013) but reduction in dietary variety of highly palatable and energy rich foods may be appropriate strategy to prevent and treat obesity (Ranil *et al.,* 2013). In the U.S., this has led to the incorporation of concepts of diversity, proportionality and moderation in the definition of dietary quality, following the principles underlying the current Food Guide Pyramid (Haines *et al.*, 1999; Welsh *et al.,* 1992). These guidelines recommend that, in addition to including the recommended levels of energy and nutrients, a healthy, high quality diet should also contain a limited amount of fat, saturated fat, cholesterol, sodium and refined sugars, and many servings of fruits, vegetables and whole grain products.

McCrory *et al.*, (1999) demonstrated that consuming a variety of foods from food groups such as “sweets, snacks, and carbohydrates” was associated with increased body fat among healthy adults, whereas consumption of a variety of vegetables was associated with decreased body fat. Similarly, Bernstein, Whittleesea and Loftus (2002) found that a score of variety for all foods was associated with increased intakes of energy, fat, and cholesterol, whereas a fruit and vegetable variety score was not. Kant *et al.*, (1993) used a dietary variety score based on 113 food codes, which were heavily weighted toward fruit and vegetable types. They found that dietary variety was positively associated with vitamin C intakes and negatively associated with intakes of sugar, saturated fat, and sodium.

5.7: BMI of mothers in the South-East

The lowest and highest BMI recorded for the respondents were 13.78kg/m^2 and 54.00kg/m^2 respectively with mean of 26.81(4.82) kg/m^2. The mean BMI (SD) of mothers of 26.81 (4.82) kg/m^2 was higher than the mean BMI of 23.34Kg/m^2 found in the study to assess the dietary diversity in six Nigerian States by (Sanusi, 2010) and mean BMI of 22.3kg/m^2 found for Nigerian women in National Demography and health survey (2004). The BMI of 26.81(4.82) kg/m^2 was above the internationally accepted normal range (between 18.5 and 24.9). There was a significant positive correlation between energy intake and BMI ($r=.19$, $p<0.001$), this means that the higher the energy intake the higher the BMI. There was no significant relationship between BMI and protein ($r=-.03$, $p=.37$) but a significant relationship between energy and protein ($r=0.21$, $p<0.001$) (appendix 3).

Result of this study showed that a lot of women ate the energy giving food above recommended level. One thousand fourty four (87.0%) consumed far above the recommended food servings of Grains/Roots/Tubers according to food guide pyramid (Table 4.18). Also 621(51.8%), 395(32.9%), 125 (10.4%) ate excess of carbohydrate, protein and fat respectively while majority did not meet their recommendation in the other nutrients considered (Table 4.25). This finding is line with Garrett *et al.*, (2005) who reported that populations in many developing countries are now consuming more energy, more processed foods, including more refined grains, and foods higher in saturated fat, sugar, and salt.

In this study, four hundred and sixty three (38.58%) were classified as normal, 10 (0.8%) as underweight, 471 (39.3%) as overweight 241 (20.1%) as grade one Obesity, 17(1.4) as having morbid (grade 11) obesity (Figure 8). This result showed that one third of the population was normal and more than 50% was either overweight or obese while a smaller percentage was underweight. This is consistent with a study carried out in Nigeria (Zaria) that have reported high level of overweight and obesity with a smaller percentage in underweight (Bakari *et al.*, 2005). Bakari *et al.*, (2007) in their study in Zaria, Nigeria reported that obesity rate in this population was 11.2% among males and 22.0% among females respectively. In Nigeria, found prevalence of obesity and overweight to range between 9.0-9.6% and 18.6-27%, respectively in the urban areas and 3.6-4.6% and 12.6-16.6%, respectively in the rural area, indicating significant urban rural differences. Steyn *et al.,* (2006) in Kenya reported the prevalence of overweight, obesity and underweight in women as 26.1%, 30.1%, 5.6% respectively.

It is indeed disturbing that obesity in the population studied was high. The reason could be attributed to the eating habits such as excess intake of food with high calorie content combined with sedentary lifestyles. This can cause increase in the prevalence of overweight and obesity among children and adults. For example, in this study 1044 (87.0%) consumed far above the recommended food servings of Grains/Roots/Tubers according to food guide pyramid. When the food consumption was put under a scale of severely inadequate, moderately inadequate, adequate and excess, it was found that 621(51.8%), 395(32.9%), 125 (10.4%) ate excess of carbohydrate, protein and fat respectively (Table 4.25). The fact that 67.7% of these mothers have children between the ages of 0.25 to 12 months (Appendix 2) who were still enjoying the cultural privileges granted nursing mothers in Igbo land where the women are kept at home for period of 6 months or more after giving birth and are taken care of by the head of the household and other family members could be another reason. Also the high prevalence of overweight and obesity could be because of availability of modern transportation system (Okada) in both the rural and urban areas which made a lot of women have little or no reason to trek or involve themselves in any physical activity.This may be the explanation for the high proportion of those with overweight and obesity in both the rural and urban areas.

Gunasekara (1999) found that the status of malnutrition, as measured by anthropometric indices, depends on the employment status of the mother, the number of living children, the pregnancy status of the mother, and her level of education. Griffiths and Bentley (2001) in their study in Indian State of Andhra Pradesh found that socioeconomic status was a more important determinant of under and or overweight among women than was urban or rural residence. Popkin (1998) also reported that it is not urban residence per se that causes overweight, but difference in lifestyle factors associated with urban environment.

Many developing countries are confronting health risks from diseases associated with excess, such as diabetes and obesity. These diseases are associated with increased economic development and urbanization, which lead to changes in diets, consumption of more processed foods, and decreased levels of physical activity. This shift in the nature of problems of disease and nutrition in many developing countries has been termed the nutrition transition. This may be because in countries with a higher level of economic development, both urban and rural areas are usually integrated with economic markets. These rural areas may share lifestyle similarities with urban areas. Rural towns are connected by roads and telecommunication with the rest of the world, just as are cities. The foods available to urban consumers are advertised and available in rural areas as well. The factors that lead to the nutrition transition are associated with economic development and are apparent in rural as well as urban areas, and so the distinction becomes not between urban and rural, or even between more and less urban, but between more and less developed (Industrialized) (Popkin, 2002).

5.8: BMI, dietary diversity and diet quality

BMI is regarded as an outcome of energy balance, with particular reference to weight, while DDS and diet quality is associated with adequate macro and micronutrients intakes (Kennedy *et al.*, 2007 and Styen *et al.*, 2006). The result showed a negative correlation between dietary diversity and maternal BMI ($r=-.12$, $p<.001$).This means the higher the dietary diversity the lower the BMI and vice versa. This is consistent with previous findings by Torheim *et al.*, (2004), Savy *et al.*, (2008) and Sanusi (2010) but in contrast to some others (Hatløy *et al.*, 2000; McCrory *et al.*, 1999). Ranil *et al.*, (2013) reported positive relationship between BMI and DDS which means the higher the BMI the higher the DDS. Some other studies who documented strong association between DDS and nutritional status were Onyango *et al.*, (1998), Arimond and Ruel (2004), Savy *et al.*, (2005), Styen *et al.*, (2006), Azadbakht and Esmaillzadeh (2010). Savy *et al.*, (2008) in their study on socio-economic and anthropometric status of women living in an urban area in Burkina Faso reported that, neither the DDS-9 nor the DDS-22 was associated with the women's anthropometric status. The apparent lack of consistency of associations between dietary DDS and BMI within as well as between studies using different methods of analyses as shown by the contradictory findings, suggest that the concept of using DDS rather than single nutrient approach may not be useful (Togo, Osler, Sorensen and Heitmann, 2001).

The negative association between BMI and DDS found in this study may be attributed to inadequate intake of some nutrients by the participants of the study. Even though dietary diversity is accepted as an excellent measuring tool to reflect food security within households, more research needs to be conducted to harmonize measurement approaches and indicators and develop new approaches that can be used to improve dietary measurements (Ruel, 2008).

There was no significant correlation between BMI and dietary quality (r=-.01, p=0.85). This was in contrast to other nutrition studies which reported that macronutrient distribution of the diet affects human body weight and composition (Samaha *et al.*, 2003; Normand, Yadh, Corinne, Pachiaudi, Jean-Michel, Stéphane *et al.*, 2001). Both excess calories and an imbalanced diet cause changes in body weight, although these changes may take different amounts of time depending on the amount of excess calories and the extent of deviation from dietary guidelines (Strychar, 2006). Studies on obesity have found variations or differences in diet quality across population based on individual characteristics such as educational level, income, health knowledge, physical activity, genetics and other demographic and economic variables (Finke and Houston 2003 and Variyam, James and David., 1998).

Also low dietary quality in children usually leads to inadequate micronutrient intake, which in turn causes micronutrient deficiencies and poor growth, health, and developmental outcomes. In adults, low-quality diets may result in micronutrient deficiencies and increase the risk of obesity because of the excessive amounts of energy, saturated fats, and refined sugars that these diets often contain (Garrett and Ruel, 2005).

5.9 Z scores of children

Most of the children were stunted (34.6%) (Short for age) followed by waisting (11.7%) (Low weight-for-height) and underweight (10.7%) (Low weight for-age). The National Demography Survey (NDS) data puts the figure at 9.2%, 38.3% and 28.7% for waisting, stunting and underweight respectively. Although the two studies were not comparable owing to the wide difference in the scale and coverage of the surveys, such comparison was useful as it provided a snapshot of the situation in the study area, against the national baseline data. This work showed that levels of undernutrition were high in the study areas. This could be as a result of inappropriate feeding practices, diets not adequate in quantity and quality, laziness on the part of the mothers or lack of adequate care.

Malnutrition has been responsible, directly or indirectly, for 60% of the 10.9 million deaths annually among under- five children (Awogbenja and Ndife, 2012). Well over two-thirds of these deaths are often associated with inappropriate feeding practices occurring during the first year of life. Complementry feeding frequently begins too early or too late, and foods are often nutritionally inadequate and unsafe. Malnourished children who survive are more frequently sick and suffer life-long consequences. Child nutritional status is clearly the outcome of a host of factors (starting with the nutritional status of pregnant women).

Four hundred and sixty one (38.4%) of subjects (women)) were classified as normal, 10(0.8%) as underweight, 471(39.3%) as overweight 241(20.1%) as grade one obesity, 15(1.3) as having morbid (grade II) obesity (Fig 7). Z-scores of values for children's anthropometric indicators (weight-for-age (WAZ), Height-for-age (HAZ), and weight –for-height (WHZ)) for the populations shows that 140 (11.7%) of the children were wasted, 414(34.6%) stunted and 128(10.7%) underweight (Table 4.29). It was observed that overweight, obese and morbid obesity mothers had 79 children that were severely and mildly wasted, 262 children that were severely and mildly stunted and 77 children that were underweight. Only 10(0.83) children had underweight mothers.

5.10 Stunted Children and overweight Mothers (SCOWT)

Comparing the percentage of underweight, obese and morbid obesity mothers and the percentage of the stunted children, showed an obvious sign of coexistence of stunted child and overweight mother (SCOWT) in the population studied. From this study of the South East Nigeria, overweight mothers (BMI index > 25 kg/m^2) were 723 (60.25%), severely stunted children (HAZ <-2 SD) were 209 (17.42%) and the SCOWT pairs were 134 (11.17%). Overweight mothers and stunted children pair in the urban and rural area were 45(3.75%) and 89(7.42%) respectively. The SCOWT prevalence in this study was higher in urban areas. This was consistent with the study by Garrett and Ruel (2005) who in their study in Africa reported that SCOWT prevalence was higher in rural areas in only three out of the 27 countries studied. They also reported that SCOWT primarily occurred in urban areas in Africa because fewer rural women than urban women were overweight. The prevalence of SCOWT in urban areas as well as rural areas confirms that SCOWT is not necessarily associated with living in an urban environment, but could be as a result of negligence and laziness on the part of the mothers to prepare adequate meals for their children and lack of nutrition education to carefully look out for quality food varieties. Previous research on the coexistence of under and overweight individuals in the same household indicated SCOWT could appear as part of a nutrition transition associated with increasing urbanization and economic development (Doak *et al.*, 2000; Doak *et al.*, 2002). The poor dietary quality associated with energy sufficient households and urbanization may be related to SCOWT.

In a Demographic and Health survey of 27 countries, children stunting and mothers overweight in Nigeria was reported to be 48.6% and 19.6% respectively and the children in SCOWT pairs to be 8.3% (Garrett and Ruel, 2005). The coexistence of underweight and overweight individuals in the same household presents a difficult problem that highlights the importance of individual level factors. It also complicates efforts to improve nutrition (Garrett and Ruel, 2005). Many programmes in developing countries assume that child undernutrition indicates household food insecurity. Programmes then target more food or more income to households with malnourished children. Under and overnutrition in the same household makes this sort of targeting less effective (Garrett and Ruel, 2005).

Policymakers may need to emphasize changes in individual dietary and activity patterns and in caring and feeding behaviors, including dietary quality, not only general household access to food. They will also face a serious challenge in having to deal with conflicting demands of dietary excess and deprivation not only in the same population but also in the same household. Garrett and Ruel (2005) suggested that Strategies that once focused only on raising incomes, improving water and sanitation, or elevating the availability of food for the household must now pay close attention to individual factors, addressing multiple and perhaps somewhat conflicting causes of over- and under-nutrition within the same household.

5.11 Hypotheses

5.11.1 Hypothesis 1

- **There is no relationship between nutrient adequacy and diet diversity**
- There was no relationship between nutrient adequacy and diet diversity (r=-.004, p=.90). The null hypothesis is accepted.

5.11.2 Hypothesis 2

- **There is no relationship between nutrient adequacy and diet quality**

There was a positive relationship between nutrient adequacy and diet quality (r=.08, p<.01). The null hypothesis is rejected.

5.11.3 Hypothesis 3

- **There is no relationship between dietary diversity and diet quality**
- There was a positive relationship between diet diversity and diet quality (r=.48, p<.05). The Null is rejected.

CONCLUSIONS AND RECOMMENDATIONS

5.11.4 Conclusions

The mean Dietary Diversity score of 6.96 found in this study fell within the medium range of DDS tercile. However, when considered based on the 14 food groups used for this study, the mean number of food groups consumed by the subjects over the reference period was 49.71% which was below 50% of the total number of food groups under study. There was no significant mean difference between the States on dietary diversity. The mean DDS were observed to be significantly different between Local Government areas and sectors (Urban and Rural).

The Total Diet Quality of the population studied was evaluated using the Diet Quality Index International (DQI-I). It was observed that their diet quality reached 58.79% of the possible score of 100% with Moderation scoring higher than Adequacy, Variety and Overall balance. Majority of the subjects failed to meet recommendation for calcium, vegetable, fruit, fiber and vitamin C.

Nutrient Adequacy Ratio (NAR) was calculated for energy intake and eleven (11) other nutrients, and it was observed that majority of the subjects did not meet the recommended allowance for fat, calcium, phosphorus, sodium, zinc, potassium, magnesium and vitamin C while energy, carbohydrate, protein and iron were consumed in excess. It was evident that many women in this study had low micronutrient intakes, and if continued in the longer term, these women were at great risk of developing micronutrient deficiencies. It was also observed that about 39.3% of the population studied was overweight and 21.5% was obese. Result of this study showed that a lot of women were eating the energy giving food above recommended levels.

Z-scores values for children's anthropometric indicators for the population showed that 11.5% of the children were wasted, 34.5% stunted and 10.7% underweight. In comparing the percentage of underweight, obese and morbid obesity mothers and the percentage of the wasted, stunted and underweight children, there was an obvious sign that there was co-existence of stunted child and overweight mother (SCOWT) in the population studied. It was observed that overweight, obese and morbid obesity mothers had 79 children that were wasted, 262 children that were stunted and 77 children that were underweight and 10 children with underweight mothers.

It was further observed that educational level of head of household, income of respondents and head of household and other Socio economic variables were significantly associated with dietary quality and diet diversity scores of the individuals.

5.11.5 Recommendations

1. High dietary diversity is widely recommended as it can be used as proxy indicators of nutrient adequacy. Therefore public health messages should emphasize improvement in dietary diversity in selective food items like fruits, vegetables, legumes, oil crops, foods of animal origin, and also indigenous wild food which is important in enhancing dietary quality
2. Producing food of greater quantity and diversity by farmers to ensure that all population groups, urban and rural, have secure access to sufficient, safe and nutritious food all year round is recommended.
3. Government institutions/agencies combined with Nutritionists should promote healthier dietary habits by designing and leading dietary educational programmes, including simple messages to initiate a change in food habits.
4. Concerted efforts should be made by nutritionists in partnership with hospitals that take care of women of child bearing age (pregnant and nursing mothers) to educate them on food groups and advantages of diversifying their diets to appropriately control the prevalence of overweight and Obesity. The underweight women should increase the portion sizes of these nutrient dense foods to increase body weight, and achieve a healthy BMI.
5. It is recommended that all women consume nutrient dense foods such as fruits, vegetables, whole grain foods, dairy, fish and meat in order to increase nutrient intake and reduce risk for micronutrient deficiencies. Also, overweight and obese mothers should be advised to substitute nutrient dense foods for energy dense foods to prevent weight gain and achieve weight loss
6. In addition, it is recommended that all women should consume more of the currently availazble fortified foods and strategies should be put in place to fortify other foods with nutrients (e.g., calcium and folate in milk or ready-to-eat breakfast cereals). These food-based strategies will increase the nutrient density of the diet, thereby improve nutrient adequacy, and this will help

reduce risk of micronutrient deficiencies and related nutrient-deficiency diseases.

7. Dietary recommendations should be based on prevailing food patterns/ indigenous foods in this population in order to be relevant and suitable to this specific population.
8. Because of the low variety observed, it is recommended that increased production of most neglected traditional foods of South –East Nigeria be encouraged by the agriculturists and the health educators should encourage the consumption of their traditional foods.
9. Producing a comprehensive food composition table of all our indigenous foods/diets could be a promising area of future research.
10. Further studies on dietary Diversity and Dietary Quality should be carried out in the other parts of Nigeria to find out the Dietary Quality of their diets as well as the effects of DDS on the nutrients intakes of the subjects.

5.11.6 Contribution to knowledge

Dietary diversity and dietary quality studies in Nigeria are very scarce. Diet quality study of Nigerian diet using international standard has not been done before in the South East Nigeria. This study has come up with the following additional knowledge for the study area:

1. The study established the fact that the mean DDS of subjects in the South East Nigeria was 6.96 ± 1.80. There was no significant mean difference in DDS among the three States though mean DDS for urban (7.27±1.58) was higher than that of rural (6.62±1.65) and thus significant.

2. The study established that total DQI-I obtained for the south east Nigeria was 58.79%.

3. It was also established that the total diet quality of the South-East Nigeria was not significantly different from that of the developed countries like USA, China but significantly higher than Mediterranean.

4. The study also established that for the South-East, overweight mothers were 471 (39.25%), severely stunted children were 209 (17.42%) and the SCOWT pairs were 134 (11.7%). Overweight mothers and severely stunted pair in the urban and rural area were 45(3.75%) and 89(7.42%) respectively.
5. It was established that Educational level, the income of the head of house hold and respondent, and other socio economic variables were significantly associated with dietary quality and diet diversity scores of the individuals.

REFERENCES

Adekunle, L. 2005. The effect of Family structure on a sample of malnourished Urban Nigerian children. *Food and Nutrition Bulletin,* 26: 2-5.

Akinyele O. 2005. Poverty, malnutrition and the Public Health dilemma of disease. *University of Ibadan Post -International Food Policy Research Institute (IFPRI).* 2006. Washington, DC.

Allen, L.H., Black, A.K., Backstrand, J.R., Pelto, G.H., Ely, E.D., Molina, E. and Chavez, A. 1991. An analytical approach for exploring the importance of dietary quality versus quality in the growth of Mexican children. *Food Nutr. Bull,* 13: 95-104.

Allen, L.H. 1994. Nutritional influences on linear growth: a general review. *European Journal Clinical Nutrition,* 48 (l): 75-89.

Allison, M.F., Fowler, J.H. and Allen, E. J. 1999. The nutrition of the potato crop. *British potato Council Research Report*, 807:182- 92.

Alvarado, A., Pacheco-Delahaye, E. and Hevia P. 2001.Value of a tomato byproduct as a source of dietary fiber in rats. *Plant Foods Hum Nutr,* 56 (4): 335–48.

Amakihe, B.U. 2013. South east Nigeria Deserves additional state. http://Nigeriaworld.com/feature/publication/amakihe/021413.html/2014-10-12

Anderson, S.E., Whitaker, R.C. 2009. Prevalence of obesity among U.S. preschool school children in different racial and ethnic groups. *Arch Pediatr. Adolesc Med,* 163: 344-8.

Andrews, N.C. 1999. Disorders of iron metabolism. *N Engl J Med,* 341:1986-95.

Angeloni, C., Leoncini, E. and Malaguti, M. 2009. Modulation of phase II enzymes by sulforaphane: implications for its cardioprotective potential. *J Agric Food Chem, 57*(12): 5615-22.

Arimond, M. and Ruel, M.T. 2004. Dietary diversity is associated with child nutritional status: Evidence from 11 demographic and health surveys. Washington/ International Food Policy Research Institute.

Arimond, M. and Ruel, M. 2002. Progress in Developing an Infant and Child Feeding Index: An Example from the Ethiopia Demographic and Health Survey 2000. *Food Consumption and Nutrition Division Discussion Paper.* International Food Policy Research Institute, Washington, DC.

Arimond, M., Wiesmann, D., Becquey, E., Carriquiry, A, Daniels, C. M., Deitchler, M. and Torheim, L. E. 2010. Simple food group diversity indicators predict micronutrient adequacy of women's diets in 5 diverse, resource-poor settings. *Journal of Nutrition*, *140*(11): 2059-2069. http://dx.doi.org/10.3945/jn.110.123414.

Aronow, W.S. 2011. ACCF/AHA 2011 expert consensus document on hypertension in the elderly: a report of the American College of Cardiology Foundation Task Force on Clinical Expert Consensus Documents developed in collaboration with the American Academy of Neurology. *J Am Soc Hypertens*, 5(4):259-352.

Arroyo, P. and Mendez, O. 2007. Energetic density, diversity of diets and familial income in rural and urban households of Mexico. *Gac Med Mex*, *143*(4): 301-307.

Ayodele, J.T. and Olajide, O.S. 2001. Proximate and Amino Acid Composition of *Celosia argentea* Leaves. *Nigerian Journal of Basic and Applied Science,* 19 (1): 162-165

Azadbakht, L. and Esmaillzadeh, A. 2011. Dietary diversity score is related to obesity and abdominal adiposity among Iranian Female youth. *Public Health Nutr*, 14:62-69.

Azadbakht, L., Mirmiran, P. and Azizi, F. 2005. Variety Scores of food groups contribute to the specific nutrient adequacy in Tehranian men: *European Journal of Clinical Nutrition,* 59 (11): 1233 – 40

Azadbakht, L., Mirmiran, P., Esmaillzadeh, A., Azizi, T. and Azizi F. 2006. Beneficial effects of a Dietary Approaches to Stop Hypertension eating plan on features of the metabolic syndrome. *Diabetes Care*, 28 (12): 2,823-2,831.

Azizi, F. 2005. Whole-grain consumption and the metabolic syndrome: A favourable association in Tehranian adults. *European Journal of Clinical Nutrition*, 59(3): 353-362.

Babbie, E. 1986. *The practice of social Research.* 4th ed. Reliability test. Belmont, CA: Wadsworth Publishing Co.

Bahl, R., Bhandari, N. Hambidge, K.M. and Ban, M.K. 1998. Plasma zinc as a predictor of diaheal and respiratory morbidity in children in an urban slum setting. *American Journal of Clinical Nutrition* 68: 414-417.

Bailey, R.L., Dodd, K.W., Gache, J.J., Dwyer, J.T., McDowell, M.A. and Yetley, E.A. 2010. Total folate and folic acid intake from foods and dietary supplements in the United States: 2003-2006. *American Journal of Clinical Nutrition* 91(1): 231-237.

Bakari, A.G., Onyemelukwe G.C., Sani, B.G., Aliyu, I. S., Hassan S.S. and Aliyu, T.M. 2007. Obesity, overweight and underweight in suburban northern Nigeria: *International Journal of Diabetes and Metabolism,* 15(2):68-69.

Bakari, A.G., Sani, B.G., Hassan, S.S. and Aliyu, T. M. 2005. Overweight and underweight in northern Nigeria. *American Journal of Clinical Nutrition,* 57 (1):1271-1290.

Ball, K., Crawford, D. and Mishra, G. 2006. Socioeconomic inequalities in women's fruit and vegetable intakes: A multilevel study. *Public Health Nutrition,* 9:623-630.

Barker, M.E., McClean, S.I., Thompson, K.A. and Reid, N.G. 1990. Dietary behaviours and sociocultural demographics in Northern Ireland. *British Journal of Nutrition,* 64:319–29.

Barrett-Connor, E., Chang, J.C. and Edelstein, S.L. 1994. Coffee-associated osteoporosis offset by daily milk consumption. *JAMA*, 271: 280-3.

Bates, C.J., Prentice, A. and Cole, T.J. 1993. Micronutrients highlights and research challenges. *British Journal of Nutrition. 82*, 7-15.

Behrman, E.J.2005. Cholesterol and Plants. *Journal of Chemical Education, 82* (12): 1791-1801.

Bennett, N., Todd, T. and Flately, J. 1993. Health Survey for England. London: Her Majesty's Stationery Office.

Bentley, M.E., Caulfield, L.E., Ram, M., Santizo, M.C., Hurtado, E., Rivera, J. A., Ruel, M.T. and Brown, K.H. 1997. Zinc supplementation affects the activity patterns of rural Guatemalan infants. *Journal of Nutrition, 127*: 1333-1338.

Bernal, R. J. and Lorenzana, A. P. 2003. Dietary diversity and associated factors among beneficiaries of 77 child care Centers: *Central Regional, Venezuela,* 53(1): 52-81.

Bhaskaram, P. 2001. Immunobiology of mild micronutrient deficiencies. *British Journal of Nutrition, 85*:75-80.

Bhutta, Z. A., Bird, R. E. and Black, K. H., 2000. Prevention of diarrhea and pneumonia by zinc supplementation in children in developing countries: pooled analysis of randomized controlled trials. *Journal of Pediatrics,* 135: 689-697.

Popkin, P. and Bisgrove, E.Z. 1988. Does women's work improve their nutrition: Evidence from the urban Philippines. *Social Science and Medicine* 43 (10): 1475–1488

Black, R. E. 1998. Therapeutic and preventive effects of zinc on serious childhood infectious diseases in developing countries. *American Journal of Clinical Nutrition,* 68*:*476-479.

Block, D.L., Buta, R., Knapen, J. H., Elmegreen, D.M., Elmegreen, B.G. and Puerari, I. 2004. Gravitational bar and spiral arm torques from k_s-band observations and implications for the pattern speeds. *The Astronomical Journal*, 128: 183-201.

Bothwell, T.H., Charlton, R.W., Cook, J.D. and Finch, C.A. 1979. Iron Metabolism in Man. St. Louis: Oxford: Blackwell Scientific.

Brown, K. H. 1998. Effect of infections on plasma zinc concentration and implications for zinc status assessment in low-income counties. *American Journal of Clinical Nutrition,* 68:425-429.

Brown, K. H., Peerson, J. M. and Allen, L. H. 1999. Effect of zinc supplementation on children's growth: a meta-analysis of intervention trials. Sandstrom, B. Walter, P. eds. *Role of Trace Elements for Health Promotion and Disease Prevention*: 76-83 University of California at Davis Davis, CA.

Brune, M., Rossander, L. and Hallberg, L. 1989. Iron absorption and phenolic compounds: importance of different phenolic structures. *European Journal of Clinical Nutrition,* 43:547-57.

Bucher, H.C., Griffith, L.E. and Guyatt, G.H. 1999. "Systematic review on the risk and benefit of different cholesterol-lowering interventions". *Arteriosclerosis Thrombosis and Vascular Biology,* 19 (2): 187–195.

Calvo, M.S. 1993. Dietary phosphorus, calcium metabolism and bone. *Journal of Nutrition* 123:1627-33.

Caulfield, L. E., Zavaleta, N. and Figueroa, A. 1999a. Maternal zinc supplementation does not affect size at birth or duration of pregnancy in Peru. *Journal of Nutrition,* 129:1563-1568.

Caulfield, L. E., Zavaleta, N. and Figueroa, A. 1999b. Adding zinc to prenatal iron and folate supplements improves maternal and neonatal zinc status in a Peruvian population. *American Journal of Clinical Nutrition,* 69:1257-1263.

Centre for Disease Control (CDC). 2013. Healthy Weight: Caloric Balance.Cdc.gov. 2011-10-31. Retrieved 2013-05-21.

Chesters, J. K. 1982. Metabolism and biochemistry of zinc. Prasad, A. eds. *Clinical Biochemistry of Nutritional Aspects of Trace Elements*: *221*-234 Alan R. Liss Inc NY.

Chinese Nutrition Society. 1990. The recommended dietary allowance of nutrients and the Chinese dietary guidelines. *Acta Nutr. Sini,* 12: 1–5.

Christopher, C. and Patrick, G. 2007. *Critical Pathways in Cardiovascular Medicine, 2nd Edition*. Lippincott Williams and Wilkins. p. 243.

Chun, O.K., Chung, S.J. and Song, W.O. 2007. Estimated dietary flavonoid intake and major food sources of U.S. adults. *Journal of Nutrition*, 137 (5): 1244-1452.

Chung, Y. 2009. To do or not to do? *Geographical monographs in East Asia, progress in Human geography*, 33(1): 116-18.

Clark, R.G. 2005. Surgical nutrition. *British Journal of Surgery*, 54: 13-20.

Clarke, G.M., Frost, K., Collins, S., Appleby, N. and Deto, B. 1997. Food frequency dietary assessment. *Am. J. Epdidemiol*, 154, 1087-1088.

Clarke, R., Frost, C., Collins, R., Appleby, P. and Peto, R. 1997. "Dietary lipids and blood cholesterol: quantitative meta-analysis of metabolic ward studies". *BMJ (Clinical research ed.)* 314 (7074): 112–7.

Clasen, T., Charlton, K.E., Gobotswang, K.S. and Holmboe-Ottsesen, G. 2005. Predictors of food variety and dietary diversity among persons in Botswana. *Nutrition*, 21(1): 86-95.

Cockroft, F.E., Durkin, M., Masding, C. and Cade, J.E. 2005. Fruit and vegetable intakes in a sample of pre-school children participating in the 'five for all, project in Bradland. *Public Health Nutrition* 8(7): 861-7.

Codex Alimentarius Commission. 2009. Food and Agriculture Organization; *World Health Organization. Report of the 30th session of the Codex Committee on nutrition and foods for special dietary uses*. ALINORM 9/32/26. Available from:http://www.codexalimentarius.net/download/report/710/al32_26e.pdf.

Committee Review Dietary Reference Intakes for Vitamin D and Calcium, Food and Nutrition Board, Institute of Medicine. *Dietary Reference Intakes for Calcium and Vitamin D. Washington, DC:* National Academy Press, 2010.

Cook, J.D., Reddy, M.B., Burri, J., Juillerat, M.A. and Hurrell, R.F. 1997. The influence of different cereal grains on iron absorption from infant cereal foods. *Am J Clin Nutr* 65: 964-9.

Corbett, J.V. 1995. Accidental poisoning with iron supplements. *MCN Am J Matern Child Nurs*, 20: 234-244.

Cox, L. 2012. Why is too much salt bad for you? My health news daily. http://myhealthnewsdaily/whyistoomuchsaltbadforyou?/21910099/11222. retrieved 2013-11-12.

Crowe, F.L, Allen, N.E. and Appleby, P.N. 2008. "Fatty acid composition of plasma phospholipids and risk of prostate cancer in a case-control analysis nested within the European Prospective Investigation into Cancer and Nutrition". *The American Journal of Clinical Nutrition*, 88 (5): 1353–63.

Cullen, K.W., Ash, D.M., Warneke, C. and de Moor, C. 2002. Intake of soft drinks, fruit-flavored beverages, and fruits and vegetables by children in grades 4 through 6. *Am J Public Health,* 92: 1475–8.

Dallman, P.R. 1986. Biochemical basis for the manifestations of iron deficiency. *Annu Rev Nutr,* 6:13-40.

Darwin, L. 2011. "Chapter 11 Adverse Blood Lipid Profile". *Epidemiology and prevention of cardiovascular disease: a global challenge* (2 ed.). Jones and Bartlett Publishers. p. 290. ISBN 978-0-7637-4689-6.

Dauda, B.E.N. 2006. Some local floral petals as acid-base indicators. Environmental Technology and Science Journal *1* (1) 12-15.

Davidson, A. 2006. The Oxford companion to food. 2nd ed. UK: Oxford University Press.

Davidsson, L. 2003. Approaches to improve iron bioavailability from complementary foods. *J Nutr* 133:1560-2.

D'Elia, L., Barba, G., Cappuccio, F.P. and Strazzullo, P. 2011. Potassium intake, stroke and cardiovascular disease. *Journal of the American College of Cardiology,* 57(10):1210-1219.

Delisle, H. 1990. Patterns of urban food consumption in developing countries: perspective from the 1980's FAO, Rome. (Available at www.fao.org/es/ESN/nutrition/national_urban_publication_en.stm).

Delzenne, B.G, Fayomi, B. and Delisle, H. 2005. Child malnutrition and Maternal overweight in same households in urban areas of benin. *Sante* 15(4): 263-70.

De Vaus, D.A. 1996. Surveys in Social research, London: UCL Press.

Dietary Guidelines for American council (DGAC)**.** 2010**.** Nutrient Adequacy Report of the Part D. Section 2: DGAC on the Dietary Guidelines for Americans**.**

Dietary supplement Fact. 2011. Office of Dietary Supplements, NIH. Retrieved 31 March 2011. *Diet Assoc* 88:786-90.

Doak, C., Adair, L., Monteiro, C. and Popkin, B. 2000. Overweight and underweight coexist within households in Brazil, China, and Russia. *J Nutr*,130:2965–71.

Doak, C., Adair, L., Bentley, M., Fengying, Z. and Popkin, B. 2002. The Underweight/overweight household: an exploration of household sociodemographic and dietary factors in China. *Public Health Nutr*, 5:215–21.

Drescher, L.S., Thiele, S. and Mensink, G.B. 2007. A New Index to measure Healthy Food Diversity Better Reflects a healthy Diet than Traditional Measures. *Journal of Nutrition* 137: 647-651.

Drewnowski, A., Henderson, S.A., Driscoll, A. and Rolls, B.J. 2005. The dietary variety score: assessing diet quality in healthy young and older adults. *J Am Diet Assoc*, 97: 266–71.

Drewnowski, A. and Popkin, B. M. 1997. The nutrition transition: new trends in the global diet. *Nutr. Rev*, 55: 31–43.

Drewnowski, A. and Darmon, N. 2005. The economics of obesity: dietary energy density and energy cost. *Am J Clin Nutr; 82):* 265S-73S.

Dietary Reference Intake (DRI). 2005. Dietary reference intakes for water, potassium, sodium, chloride, and sulfate. Washington, D.C.: National Academies Press.

Du, S., Lu, B., Zhai, F. and Popkin, B. M. 2002. A new stage of the nutrition transition in China. *Public Health Nutr* 5 (1): 169-174.

Duggan, C, Watkins, J.B. and Walker, W.A. 2008. Nutrition in pediatrics (4th ed.). PMPHUSA.

Dynesen, A.W., Haraldsdottir, J., Holm, L. and Astrup, A. 2003. Socio-demographic differences in dietary habits described by food frequency questions–results from Denmark. *Eur J Clin Nutr*, 57: 1586–97.

Eastwood, M. and Kritchevsky, D. 2005. "Dietary fiber: how did we get where we are?" *Annu Rev Nutr*, 25: 1–8.

Eastwood, M.A. and Morris, E.R. 1992. Physical properties of dietary fibre that influence physiological function: a model for polymers along the gastrointestinal tract. *Am J Clin Nutr*, 55: 436–442.

Ekong, F.U. 2013. Women and development process in Nigeria: a case study of rural women in organizations in community development in Cross River state. *Herald Journal of geography and regional planning*, 2(2): 098-104.

Ene-Obong, H., Ibeanu, V., Onuoha, N. and Ejekwu. 2012. A Prevalence of overweight, obesity, and thinness among urban school-aged children and adolescents in southern Nigeria. *Food Nutr Bull*, 33 (4):242-50.

Ene-Obong, H.N., Enugu, G.I. and Uwaegbute, A.C. 2001. Determinants of Health and nutritional Status of Rural Nigerian Women. *J. Health Popul. Nutr*, 19(4): 320-330.

Ene-Obong, H.N. and Ejekwu, A. 2007. Prevalence of obesity, overweight and thinness among school children and adolescents from southern Nigeria. (In Press).

Ene-Obong, H.N., Odoh, I.F. and Ikwuagwu, O.E. 2003. Plasma vitamin A and C status of in-school adolescents and associated factors in Enugu State, Nigeria. *J. Health Popul. Nutr,* 21(1): 18-25.

Ensminger, A.H. 1995. Health and Fitness. The Concise Encyclopedia of foods and Nutrition. Boca Ration, Florida, CRC Press.

Enwonwu, C. 2008. The implication of epidemiologic transition in Sub-Saharan Africa: Volume 372, August 15, 2008 posted on Friday, January 25th, 2008 at 2:14 pm and is filed under Non-Communicable Diseases, Article. The Lancet cover image.

Escott-Stump, S. 2008. *Nutrition and diagnosis-related care*. 6th ed. Philadelphia, Pa: Lippincott Williams and Wilkins.

Espenshade, P.J. and Hughes, A.L. 2007. Regulation of sterol synthesis in eukaryotes. *Annu. Rev. Genet*, 41: 401-27.

European Society of Cardiology. 2007. "European guidelines on cardiovascular disease prevention in clinical practice: executive summary". *European Heart Journal* 28 (19): 2375–2414.

Evans, E. and Miller, D. S. 1975. Bulking agents in the treatment of obesity. *Nutr. Metab*, 18:199-2003.

Fabella, V, R. 1982. A Nash Mirlees model of intra-family allocation. Chapter 5 in Economies of scale in the household production model and intra-family allocation of resources. PhD dissertation, Yale University, New Haven, Conn, USA.

FANTA, 2006. Developing and validating simple Indicators of Dietary Quality and Energy Intake of Infants and Young Children in Developing countries: summary of findings from analysis of 10 data sets. Working group on Infant and Young Child feeding Indicators. Food and Nutrition Technical (FANTA) project, Academy for Educational Development (AED), Washington, DC. http;//www.fantaproject.org/publications/rycf_datasets.shtml. 2006.

Farid, M., Abdul, R.A. and Fawzy, S. 2010. Dietary practices, physical activity and health education in Qassim region of Saudi Arabia. *International Journal of Health Sci. (Qassim),* 4(1): 3-10.

Fenton, T.R., Eliasziw, M., Lyon, A.W., Tough, S.C. and Hanley, D.A. 2008. Meta-analysis of the quantity of calcium excretion associated with the net acid excretion of the modern diet under the acid-ash diet hypothesis. *Am J Clin Nutr*, 88(4):1159-66.

Fierke, C. 2000. Function and mechanism for zinc. *Journal of Nutrition*, 130: 1437-1446.

Figoni, P.I. 2010. *Bleaching and maturing Agents.* How baking works: Exploring the fundamentals of baking science. John Wiley and Sons. P.86.

Finke, M.S. and Houston, S.J. 2003. Factors affecting probability structure, 1960-1990. *population research and policy review*14: 215-232.

Fitzgerald, E.F., Hwang, S., Brix, K.A., Bush, B., Qiunn, J. and Cook, K. 1992. Chemical contaminants in the milk of Mohawk women from Akwesasne. Report for the Health Risk Assessment of the General Motors Centreal Foundry Division Superfund Waste. Albany, New York state Department of Health.

Fleck, H. 1976. *Introduction to Nutrition* 3rd ed. Dietary diversity. MacMillan Publishing Co. New York, 1976, pp. 14-19.

Fogli-Cawley, J.J., Dwyer, J.T., Saltzman, E., McCullough, M.L., Troy, L.M. and Jacques, P.F. 2006. The 2005 Dietary Guidelines for Americans Adherence Index: development and application. *Journal of Nutrition*, *136*, 2908-2915.

Food and Agriculture Organization /World Health Organization (FAO/WHO). 1998. Requirements of vitamin A, iron, folate and vitamin B12, Food and Agriculture Organization, Rome. 4: 45-50

Food and Agriculture Organization (FAO), 2007. Guidelines for measuring Household and individual dietary diversity. FAO Nutrition and consumer Protection Division, with support from EC/FAO Food Security Information for Action Programme and the food and Nutrition Technical Assistance (FANTA) project. http://wwwfoodsec.org/tr/nut/guidelnes.pdf. Visited on March 2010.

Food and Agriculture Organization. 2008. Nutrition information, communication and education: Food based dietary guidelines by country. http://www.fao.org/ag/agn/nutrition/education. (Accessed 10th January, 2013)

Food and Agriculture Organization /World Health Organization (FAO/WHO). 2002. The Nigerian Experience On Food Safety Regulations: FAO/WHO Global Forum of Food Safety Regulators Marrakesh, Morocco, 28- 30 January 2002.

Food and nutrition board (2005). Are port of panel on Macronutrients. Subcommittees on upper reference levels of nutrients and interpretation and use of dietary reference intakes, and the standing committee on scientific evaluation of dietary reference intake. Dietary reference intakes for energy, carbohydrate.

Fiber, fat, fatty acids, cholesterol, protein, and amino acids (macronutrients). The national academies press, Washington, D.C.

Foote, J.A., Murphy, S.P., Wilkens, L.R., Basiotis, P.P. and Andrea, C. 2004. The American Society for Nutritional Sciences Dietary Variety Increases the Probability of Nutrient Adequacy among Adults Cancer Research Center of Hawaii, University of Hawaii and U.S. D.

Forastiere, F., Pistelli, R., Sestini, P., Fortes, C., Renzoni, E., Rusconi, F., Dell'Orco, V., Ciccone, G. and Bisanti, L. 2000. Consumption of fresh fruit rich in vitamin C and wheezing symptoms in children. SIDRIA collaborative Group, Italy (Italian Studies on Respiratory Disorders in Children and Environment). *Thorax, 55(4):* 283-288.

Frankfort-Nachimias, C. and Nachimias, D. 1992. Research methods in social Sciences: Fourth Edition. Published by Edward Arnold Ltd, Kent, England PP 97- 426.

Frederickson, S. F. 2003. A Low-Carbohydrate as Compared with a Low-Fat Diet in Severe Obesity.*New England Journal of Medicine*, 348, 2074–2081.

Freedman, L.S., Kipnis, V., Schatzkin, A. and Potischman, N. 2008. "Methods of Epidemiology: Evaluating the Fat–Breast Cancer Hypothesis – Comparing Dietary Instruments and Other Developments". *Cancer Journal (Sudbury, Mass.)*14 (2): 69–74.

Frison, E., Francesco, B. and Fanzo, J. 2004. The Role of Food and Nutrition System Approaches in Tackling Hidden Hunger. *Int J Environ Res Public Health,* 8(2): 358–373.

Fung, T., Hu, F., McCullough, M., Newby, P., Willett, W. and Holmes, M. 2006. Diet quality is associated with the risk of estrogen receptor-negative breast cancer in postmenopausal women. *Journal of Nutrition*, 136, 466–472.

Gallaher, D. and Daniel, D. 2006. Dietary Fiber. Washington, D.C.: ILSI Press. pp. 102–110.

Galobardes, B., Morabia, A. and Bernstein, M.S. 2001. Diet and socioeconomic position: does the use of different indicators matter? *Int J Epidemiol,* 30: 334–40.

Garret, J.L. and Ruel, M.T. 2005. Stunted child-overweight mother pairs: An emerging policy Concern? FCND Discussion Paper 148. (Available and http://www.ifpri.org/divs/fcnd/dp/papers/fcndp148.pdf). Retrieved 2011-11-9.

Genton, L, Melzer, K. and Pichard, C. 2010. Energy and macronutrient requirements for physical fitness in exercising subjects. Clinical Nutrition 29 (4): 413– 423.

Goldenberg, R. L., Tamura, T., Neggers, Y., Copper, R. L., Johnson, K. E., DuBard, M. B. and Hauth, J. C. 1995. The effect of zinc supplementation on pregnancy outcome. *J. Am. Med. Assoc.* 274: 463-468.

Gerber, M. 2001. The comprehensive approach to diet. *A critical review J. Nutr*, 131 (suppl. 11): 30515-30555.

Greger, J.L. 1999. Nutrition versus toxicology of Manganese in human: Evaluation of potential Biomarkers. *Neurotoxicology*, 20(2-3), 205-212.

Greger, J.L. 2000. Non-digestible carbohydrates and mineral bioavailability. *J Nut,* 129 (7): 1434–5.

Groth, M.V., Fagt, S. and Brondsted, L. 2001. Social determinants of dietary habits in Denmark. *Eur J ClinNutr,* 55: 959–66.

Gropper, S.S., Jack, L.S. and James, L.G. 2008. Advanced nutrition and human metabolism (5th ed.). Cengage Learning.114.

Guthrie, H.A. and Scheer, J.C. 1981. Validity of a dietary score for assessing nutrition adequacy. *J. Am. Diet. Assoc*, 78, 240-245.

Haas, J.D. and Brownlie, T. 2001. Iron deficiency and reduced work capacity: a critical review of the research to determine a causal relationship. *J Nutr*, 131:691-6.

Haave, N.C., Nicol, L.J. and Innis, S.M. 1990. Effect of dietary fat content and composition during pregnancy on fetal HMG CoA reductase activities and lipids in rats. *J. Nutr*, 120: 539-543.

.Haines, T.H. 2001. "Do sterols reduce proton and sodium leaks through lipid bilayers?". *Prog. Lipid Res*, 40 (4): 299–324.

Haines, P., Siega-Riz, A. and Popkin, B. 1999. The Diet Quality Index revised: a measurement instrument for populations. *Journal of American Dietitians Association*, 99: 697–704.

Hallberg, L., Hulten, L. and Gramatkovski, E. 1997. Iron absorption from the whole diet in men: how effective is the regulation of iron absorption? *Am J Clin Nutr*, 66:347-56.

Hambidge, K.M. and Krebs, N.F. 1995. Assessment of zinc status in man. *Indian Pediatr*, 62: 169-180.

Hambidge, K.M. and Walravens, P. A. 1982. Disorders of mineral metabolism. *Clin. Gastroenterol*, 11: 87-118.

Hambidge, K.M., Krebs, N.F. and Walravens, A. 1985. Growth velocity of young children receiving a dietary zinc supplement. *Nutr. Res* 1: 306-316.

Hamrick, I. and Counts, S.H. 2008. Vitamin and mineral supplement. *Wellness and prevention, 35*(4): 729-747.

Harris, F.M. and Mohammed S. 2003. Relying on nature: Wild foods in Northern Nigeria. School of Earth Sciences and Geograph University of Kingston,Kingsyon-upon *Feb* 32(1):24-7.

Hatloy, A., Halland, J., Diarra, M. and Oshaug, A. 2000. Food variety, socioeconomic status and nutritional status in urban and rural areas in Koutiala (Mali). *Public Health Nutr*, 3:57-65.

Hatløy, A., Torheim L. E., and A. Oshaug. 1998. Food variety: A good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa. *European Journal of Clinical Nutrition*, 52: 891-898.

Heaney, R.P. and Rafferty, K. 2001. Carbonated beverages and urinary calcium excretion. *Am J Clin Nutr*, 74: 343-7.

Heaney, R. 1993. Decisions in Nutrition (2nd Edition). Dietary diversity. Times Mirror/ Mosby Publishing Company St. Louis, Missouri. Pp. 425-457

Heaney, R.P., Recker, R.R., Stegman, M.R. and Moy A.J. 1989. Calcium absorption in women: relationships to calcium intake, estrogen status, and age. *J Bone Miner Re* ,4:469-75.

Heaney, R.P. 1996. Bone mass, nutrition, and other lifestyle factors. *Nutr Rev*, 54:3-10.

Heimendigher, J. and Van Dayn, M.A. 1995. Dietary behavior changes. The challenge of recasting the role of fruit and vegetables in the American diet. *American Journal of clinical Nutrition*, 61 (6): 13975-14001.

Hermann, J.R. 2013. Protein and the Body., Oklahoma Cooperative Extension Service Division of Agricultural Sciences and Natural Resources • Oklahoma State University: T–3163–1– T–3163–4.*pods.dasnr.okstate.edu/docushare/dsweb/Get/Document.../T-3163web.pd (Accessed on 16th May, 2013).*

Hillbrunner, C. and Egan, R. 2008. Seasonality, Household food Security and nutritional Status in Dinajpur, Bangladesh. *Food and Nutrition Bulletin*, 29(3): 221-31.

Hirsch, P.E. and Peng, T.C. 1996. Effects of alcohol on calcium homeostasis and bone. In: Anderson J, Garner S, eds. Calcium and Phosphorus in Health and Disease. Boca Raton, FL: CRC Press. 289-300.

Hoddinott, J. and Yohannes, Y. 2002. Dietary Diversity as a Food Security Indicator. Food Consumption and Nutrition Division Discussion Paper 136 2002 International Food Policy Research Institute, Washington, DC.

Hodgson, J. M., Hsu-Hage, B. and Wahlqvist, M.L. 1994. Food variety as a quantitative descriptor of food intake. *Ecology of Food and Nutrition,* 32: 137-148.

Hooper, L., Summerbell, C.D., Thompson, R., Sills, D., Roberts, F.G., Moore, H. and Smith, G.D. 2011. "Reduced or modified dietary fat for preventing cardiovascular disease". *The Cochrane Library,* (7): CD002137.

Hsieh, C. 2005. Treatment of constipation in older adults. *Am Fam Physician,* 72(11): 2277-84.

Hsu-Hage, B. and Wahlqvist, M.L. 1996. Food variety of adult Melbourne Chinese: a case study of population in transition. *World Rev. Nutr. Diet,* 79: 53-69.

Hu, F.B. 2010. Are refined carbohydrates worse than saturated fat? *Am Clin Nutr,* 1: 1542-2.

Huijbregts, P.P., Feskens, E.J.M. and Kromhout, D. 1995. Dietary patterns and cardiovascular risk factors in elderly men: the Zutphen Eldersly study. *International Journal of Epidemiology,* 24(2): 313-320.

Huijbregts, P.P., Feskens, E.J.M., Rasanen, I. Fidanza, F., Alberti-Fidanza, A. and Nissinen, A. 1997. Dietary patterns and cognitive function in elderly men in Finland. Italy and the Netherlands. *European Journal of Clinical Nutrition,* 52: 826-28.

Hulshof, K.F., Lowik, M.R. and Kok, F.J. 1991. Diet and other life-style factors in high and low socio-economic groups (Dutch Nutrition Surveillance System). *Eur J ClinNutr,* 45:441–50.

Huncharek, M. and Kupelnick, B. 2001. "Dietary fat intake and risk of epithelial ovarian cancer: a meta-analysis of 6,689 subjects from 8 observational studies". *Nutrition and Cancer,* 40 (2): 87–91.

Hunt, C.D. 1994. The biochemical effects of physiologic amounts of dietary boron in animal nutrition models. *Environ. Health perspect,* 102 (7): 35-43.

Huot, I., Paradis, G., Receveur, O. and Ledoux, M. 2004. Correlates of diet quality in the Quebec population. *Public Health Nutr*7:1009–16.

Hupkens, C.L.H., Knibbe, R.A. and Drop, M.J. 1997. Social class differences in women's fat and fibre consumption: a cross national study. *Appetite* 28: 131–149.

Igbedioh, S O. 1993. Under nutrition in Nigeria: dimension, causes and remedies for alleviation in a changing socio-economic environment: *Nutr. Health,* 9 (1): 1-14.

Ishara, M. 2005. Rathnayake and Jeevika weerahewa. Maternal employment and income affect dietary calorie adequacy in households in Sri Lanka. *Food and Nutrition Bulletin* 26, 222-229.

Jakobsen, M. U., Dethiefsen, C. and Joensen, A.M. 2010. Intake of carbohydrates compared with intake of saturated fatty acids and risk of myocardial infarction: importance of the glycemic index. *Am Journal Clin Nutr*, 91: 1974-8.

James, W.P., Nelson, M., Ralph, A. and Leather, S. 1997. Socioeconomic determinants of health. The contribution of nutrition to inequalities in health. *British Medical Journal*, 314:1545–9.

Jamison, D.T., Leslie, J. and Musgrove, P. 2003. Malnutrition and dietary protein: evidence from China and from international comparisons. Fogarty International Center, National Institutes of Health, Bethesda, Maryland, USA. *Food Nutr Bull*, 24(2):145-54.

Jayawardena, R., Byrne M. N., Soares, J. M., Katulanda, P., Yadav, B. and Hills, P. A. 2012. High dietary diversity is associated with obesity in Sri Lankan adults: an evaluation of three dietary scores. BMC Public Health 2013, 13:314 http://www.biomedcentral.com/1471-2458/13/314

Jeanene, J., Fogli, C., Johanna, T.D., Edward, S., Marjorie, L.M., Lisa, M.T. and Paul, F.J. 2006. The 2005 dietary guidelines for Americans Adherence Index: Development and Application. *Journal of Nutrition*, 136:2908-2915.

Jensen, R.G., Hagerty, M.M. and McMahon, K.E. 2008. Lipids of human milk and infant formulas: a review. *Am J Clin Nutr*, 31 (6): 990–1016.

Jensen, T.K., Heitmann, B.L., Jensen, M.B., Halldorsson, T.I., Andersson, A., Skakkebak, N.E., Joensen, U.N., Lauritsen, M.P., Christiansen, P., Dalgard, C.I. Lassen, T. and Jorgensen. N. 2012. High dietary intake of saturated fat is associated with reduced semen quality among 701 young Danish men from the general population. *Am Clin Nutr*, 98, 1: 23-30.

Johns, T. 2001. Dietary diversity, Gobal Change and Human Health. Proceedings of the Symposium Managing Biodiversity in Agricultural Ecosystems, Montreal, Canada, 8-10 November, 2001. http://www.unu.edu/env/plec/cbd/Montreal/papers/Johns.pdf Visited on March 2005.

John, T. and Eyzaguirre, P. B. 2006. Linking biodiversity, diet and health in policy and practice: *Proceedings of the Nutrition Society*, 65: 182–189.

John, S., Sorokin, A. V. and Thompson, P.D. 2007. Phytosterols and vascular disease. *Curr. Opin. Lipidol*, 18(1): 35-40.

Johnston, K.L., Thomas, E.L., Bell, J.D., Frost, G.S. and Robertson, M.D. 2010. Resistant starch improves insulin sensitivity in metabolic syndrome. *Diabetic Medicine,* 27 (4): 391–397.

Jones, W.J., Turnbaugh, P.J., Hamady, M., Yatsunenko, T., Cantarel, B.L., Duncan, A., Ley, R.E., Sogin, M.L., Roe, B.A., Affourtit, J.P., Egholm, M., Henrissat, B., Heath, A.C., Knight, R., Jeffrey, I. and Gordon, J.I. 2008. A core gutmicrobiome in obese and lean twins. *Nature,* 457, 480-484.

Kant, A.K. and Braubard, B.I. 2007. Secular trends in the association of socio-economic position with self-reported dietary attributes and biomarkers in the US population: National Health and Nutrition Examination Survey (NHANES) 1971-1975 to NHANES 1999-2002. *Public Health Nutr,* 10 (2): 158-167.

Kant, A.K, Schatzkin, A. and Ziegler, R.G. 1995. Dietary diversity and subsequent cause-specific mortality in the NHANES I epidemiologic follow-up study. *Journal of American College on Nutrition*, 14, 233 - 238.

Kant, A.K., Schatzkin, A., Harris, T.B., Ziegler, R.G. and Block, G. 1993. Dietary diversity and subsequent mortality in the First National Health and Nutrition Examination Survey Epidemiologic Follow-Up Study. *Am. J. Clin. Nutr,* 57*:*434-440

Kennedy, E. and Meyers, L. 2005. Dietary reference intakes: development and uses for assessment of micronutrient status of women-a global perspective. *Am. J. Clin. Nutr*, 81: 194–1197.

Kennedy, E.T., Ohls, J., Carlson, S. and Fleming, K. 1995. The Healthy Eating Index: design and applications. *Journal of the American Dietetic Association*, 95(10): 1103–8.

Kennedy, G.L., Pedro, M.R., Seghieri, C., Nante, l.G. and Brouwer, I. 2007. Dietary Diversity Score Is a Useful Indicator of Micronutrient Intake in Non-Breast-Feeding Filipino Children. Community and International Nutrition. *The American journal of Nutrition*, 137:472-477.

Kerstetter, J.E., O'Brien, K.O., Caseria, D.M.., Wall, D.E and Insogna, K.L. 2005. The impact of dietary protein on calcium absorption and kinetic measures of bone turnover in women. *J Clin Endocrinol Metab*, 90 (1): 26-31.

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. *J Nutr*, 133: 3476–84.

King, J. and Burgess, N. 1993. Household consumption profile of cowpea (*Vigna unguiculata)* among low-income families in Nigeria. *Ecol. Fd. Nutr*, 16: 209-221.

Kirby, S.D.., Baranowski, T, Reynolds, K.D. and Binkley, D. 1995. Children's fruit and vegetable intake: socio-economic, adult-child, regional and urban-rural influences. *J Nutr Educ*, 27: 261–71.

Kovacs-Nolan, J., Phillips, M. and Mine, Y. 2005. Advanced in the value of egg components for human health. *J. Agric Food Chem*, 53(22): 8421-31.

Krebs-Smith, S.M., Smiciklas-Wright, H., Guthrie, H.A. and Krebs-Smith, J. 1987. The effects of variety in food choices on dietary quality. *Journal of the American Dietetic Association,* 87: 897–903.21.

Krebs-Smith, S.M., Guthrie, H.A. and Krebs-Smith, J. 1989. Dietary quality. *Journal of the American Dietetic Association,* 23: 101–127.

Krieger, N., Williams, D.R. and Moss, N.E. 1997. Measuring social class in US public health research: concepts, methodologies, and guidelines. *Annu Rev Public Health*, 18:341–78.

Kunst, A.E., Groenhof, F., Mackenbach, J.P. and Health, E.W. 1998. Occupational class and cause specific mortality in middle aged men in 11 European countries: comparison of population based studies. EU Working Group on Socioeconomic Inequalities in Health. *British Medical Journal*, 316: 1636–42.

Kushi, L.H., Folsom, A.R., Jacobs, D.R. Jr., Luepker, R.V., Elmer, P.J. and Blackburn, H. 1998. Educational attainment and nutrient consumption patterns: the Minnesota Heart Survey. *J Am Diet Assoc* 88: 1230–6.

Labadorios, D., Steyn, N.P., Maunder, E., Maclntyre, U., Swart, R., Gericke, G., Huskisson, J., Dannhauser, A., Vorster, H.H. and Nesamvuni, A.E. 2011. The national Food Consumption Survey (NFCS): Children Aged 1-9 years, South Africa. Pretoria: Department of Health, 2010.

Lallukka, T., Laaksonen, M., Rahkonen, O., Roos, E. and Lahelma, E. 2004. Multiple socio-economic circumstances and healthy food habits. *Eur J Clin Nutr*, 61: 701–10.

Lartey, A. 2008. Nutrition in Promoting the Public's Health. *Strategies, Principles and Practice. Maternal and Child Nutrition,* 5(1): 95-100.

Latham, M.C. 1997. Human nutrition in the developing world. Food and Agriculture Organization of the United Nations.

Leung, F.W. 2007. Etiologic factors of chronic constipation: review of the scientific evidence. *Dig. Dis. Sci*, 52 (2): 313-6.

Lewington, S., Whitlock, G., Clarke, R., Sherliker, P., Emberson, J., Halsey, J., Qizilbash, N., Peto, R. and Collins, R. 2007. Blood cholesterol and vascular mortality by age, sex, and blood pressure: a meta-analysis of individual data from 61 prospective studies with 55,000 vascular deaths". *Lancet,* 370 (9602): 1829–39.

Linseisen, J., Bergstrom, E. and Gafa, L. 2002. Consumption of added fats and oils in the European Prospective Investigation into Cancer and Nutrition (EPIC) centres across 10 European countries as assessed by 24-hour dietary recalls. *Public Health Nutr* 5: 1227–42.

Lopez, H.W., Leenhardt, F. and Remesy, C. 2004. New data on the bioavailability of bread magnesium. *Magnes Res,* 17(4): 335-40.

Loughley, K., Basiotis, P., Zizza, C. and Dinkins, J.M. 2004. Profiles of selected target audiences: promoting the dietary guidelines for Americans. *Fam Econ Nutr Rev,* 13: 3–14.

Low, J.W. 2008. The potential contribution of bread buns fortified with beta-carotene-rich sweet potatoes in central Mozambique. *Food Nutr. Bull,* 29(2): 98-107.

Löwik, M., Hulshof, K. and Brussaard, J. 1999. Food-based dietary guidelines: Some assumptions tested for The Netherlands. *British Journal of Nutrition,* 81: 143-149.

Lynch, S.R., Dassenko, S.A., Cook, J.D., Juillerat, M.A. and Hurrell, R.F. 1994. Inhibitory effect of a soybean-protein-related moiety on iron absorption in humans. *Am J Clin Nutr,* 60: 567-72.

Maki, K.C., Pelkman, C.L., Finocchiaro, E.T., Kelley, K.M., Lawless, A.L., Schild, A.L. and Rains, T.M. 2012. Resistant starch from high-amylose maize increases insulin sensitivity in overweight and obese men. *Journal of Nutrition,* 142 (4): 717–723.

Malhotra, A. and Passi, S.J. 2007. Diet quality and nutritional status of rural adolescent girl beneficiaries of ICDS in north India. *Asia Pac J Clin Nutr,* 16(l) 1:8-16.

Mann, J.I. 2002. Diet and risk of coronary heart disease and type 2 diabetes. *Lancet* 360:783-9.

Männistö, S., Pietinen, P. and Virtanen, M.J. 2003. "Fatty acids and risk of prostate cancer in a nested case-control study in male smokers". *Cancer Epidemiology, Biomarkers and Prevention,* 12 (12): 1422–8.

Martikainen, P., Joutsenniemi, K., martelin, T., Kestila, L., Pirkola, S. and Koskinen, S. 2005. Living arrangement heavy drinking and alcohol dependence. *Alcohol,* 42(5) 480-491.

Martin-Prével, Y., Danel, P., Traissa, T., Dabire, H. and Delpeuch, F. 2008. Use of variety/diversity scores for diet quality measurement: relation with nutritional status of women in a rural area in Burkina Faso. *Eur J Clin Nutr,* 59. 5:703-16.

Martorell, R. 1995. Results and implications of the INCAP follow-up study. *Journal of Nutrition* 1127-38.

Maruapula, C.J. and Chapman, A.D. 2007.Global and regional cause of death pattern. *Bulletin World Health Organization,* 77:447-480.

Mason, J.E. and Bassuk, S.S. 2001. Obesity in the United States: A fresh look at its high toll. *JAMA,* 289(2):229-30.

Mayo Clinic Staff. 2011. Nutrition and healthy eating. Mayo Foundation for Medical Education and Research (MFMER) June 9, 2011.

Maziya-Dixon,B.B., Akinyele, I.O., Oguntona, E.B., Nokoe, S., Sanusi, R.A. and Harris E. 2004. Nigeria food consumption and Nutrition Survey 2001-2003 (Summary). International Institute for Tropical Agriculture (IITA); Ibadan, Nigeria.

McCrory, M.A., Fuss, P.J., McCallum, J.E., Yao, M., Vinken, A.G., Hays, N.P. and Roberts, S.B. 1999. Dietary variety within food groups: association with energy intake and body fatness in men and women. *Am J Clin Nutr,* 69: 440-447.

McCullough, M.L., Feskanich, D., Stampfer, M.J., Giovannucci, E.L., Rimm, E.B., Hu, F.B., Spiegelman, D., Hunter, D.J., Colditz, G.A. and Willitt, W.C. 2002. Diet quality and major chronic disease risk in men and women: moving toward improved dietary guidance. *Am J Clin Nutr,* 76*: 1261*– 1271.

Méjean, C., Traissac, P., Eymard-Duvernay, S., Ati, J.E., Delpeuch, F. and Maire, B. 2007. Influence of socio-economic and lifestyle factors on overweight and nutrition-related diseases among Tunisian migrants versus non-migrant Tunisians and French. *BMC Public Health,* 7: 265.

Merialdl, G. 1998. Cereal non-cellulosic Polysaccaharides structure and function relationship- an overview. *Crit Rev food Sci Nutr,* 47, 6: 599-610.

Milligan, S.D., Ramsey, C.B., Miller, M.F., Kaster, C.S. and Thompson, L.D. 1998. Resting pigs and hot fat trimming and accelerated chilling of carcasses to improve pork quality. *Journal of Animal Science,* 76:74-86.

Miller, G.D., Jarvis, J.K. and McBean, L.D. 2001. The importance of meeting calcium needs with foods. *J Am Coll Nutr*, 20.2: 168-185.

Minihane, A.M. and Fairweather-Tair, S.J. 1998. Effect of calcium supplementation on daily nonheme-iron absorption and long- term iron status. *Am J Clin Nutr,* 68: 96-102.

Miret, S., Simpson, R.J. and McKie A.T. 2003. Physiology and molecular biology of dietary iron absorption. *Annu Rev Nutr*, 23:283-301.

Mirimiran, P. 2005. Results and implications of the INCAP follow-up study. *Journal of nutrition,* 1127-38.

Mirimiran, P., Azadbakht, L. and Azizi F. 2006. Dietary diversity within food groups: an indicator of specific nutrient adequacy in Tehranian Women. *J Am Coll Nutr*, 25:354-361

Mirmiran, P., Wu, Z. and Swanson, J. 1996. "Fatigue Behavior of Prestressed Tubular Bridge Deck of Fiber-Reinforced Polymer," *Transportation Research Record No. 1892*, *Design of Structures, Part 8 – Structural Fiber-Reinforced Plastics*, Transportation Research Board, National Research Council, Washington, D.C., pp. 246-255.

Mirmiran, P., Azadbakht, L., Esmaillzadeh, A. and Azizi, F. 2004. Dietary diversity score in adolescent indicator of the nutritional adequacy of diets: Tehran lipid and glucose study. *Asia Pac Nutr*, 13, 56-60.

Mishra, K. and Samantaray, K. 2004. Interacting effects of dietary lipid and temperature on growth, body composition and fatty acid profile of rohu, *Labeo rohita* (Hamilton). *Aquaculture Nutrition*, 10: 359-369.

Mohan, S.F. 2009. Factors Affecting Probability of Choosing a Risky Diet," *Journal of Family and Economic Issues*, 24, 291–303.

Monson, E.R. 1988. Iron and absorption: dietary factors which impact iron bioavailability. *J Am*, 68: 96-102.

Moore, M.G. and Smith, C. 2011. Abnormal uterine bleeding in the reproductive years. Part II medical management. *J. Am. Assoc. Gynecol. Laparosc*, 7: 17–35.

Mozie, A. 2000. Food habits and nutrient intakes of pregnant women and their effect on birth weight of infants in Izzi Local Government Area, Ebonyi State, Nigeria. M.Sc project report; Department of Home Science, Nutrition and Dietetics, University of Nigeira, Nsukka.

Mugabe, S. 1998. Dietary quality and survival among middle-age and older adults in the NHANES 1 Epidemiologyic Follow-up study. *Nutr Res,* 16: 1641-1650.

Must, A., Spadano. J., Coakley, E.H., Field, A.E., Colditz, G. and Dietz W.H. 1999. The disease

National Institutes of Health Optimal calcium intake. 1994. *NIH Consensus Statement* 12:1-31.

National Population Commission. 2010. Population Distribution by sex, state, L.G.A and Senatorial district for 2006.Priority table, 3, 1-60.

Ndukwu, B., Onwudike, S.U., Idigbor, M.C., Ihejirika, C.E. and Ewe, K. S. 2013. Spatial variability in the physio-chemical properties of soils affected by animal wastes in Uyo, Akwa Ibom state of Nigeria. *African Journal of Agricultural Research,* 8(4): 373-379.

Ness, A.R. and Powles, J.W. 1997. Fruits, Vegetables and Cardiovascular Diseases. *A review. Int. J. Epidemiol,* 26: 1-13.

Neumark-Sztainer, D., Story, M., Hannan, P. and Croll, J. 2002. Overweight status and eating patterns among adolescents: where do youths stand in comparison with the healthy people objectives? *Am J Public Health,* 92:844–51.

Ngugen, C.T., Vingrys, A.J. and Bui, B.J. 2008. Dietary Omega-3 fatty acids amd ganglion cell function. *Invest Ophthalmol Vis Sci,* 49 (8): 3586-94.

Normand, S., Yadh, K., Corinne, L., Pachiaudi, C., Jean-Michel, A., Stéphane B., Michel, D., Riou, J.P. and Laville, M. 2001. Influence of Dietary Fat on Postprandial Glucose Metabolism (Exogenous and Endogenous) using intrinsically (13) C-Enriched Durum Wheat. *British Journal of Nutrition,* 86, 3–11.

Obaid, T.A. 2004. Health and link to nutrition: Maternal health is key. UN/SCN: *Nutrition and the Millennium Development Goals,* 28: 15-18

Ogle, B.M., Hung, P.H. and Tuyet, H.T. 2001. Significance of wild vegetables in micronutrient intakes of women in Vietnam: an analysis of food variety. *Asia Pac J ClinNutr, 10: 21*– 30.

Ogunba, O. 2002. Factors influencing mothers choice of complementary foods in Ilesha Area of Osun State,Nigeria. *Early Child Development and CareM* 172, 4: 385-390.

Ohvo-Rekilä, H., Ramstedt, B., Leppimäki, P. and Slotte J.P. 2002. Cholesterol interactions with phospholipids in membranes. *Prog. Lipid Res,* 41 (1): 66–97.

Okeke, E.C. 1987. Food habits and nutrient intakes of Nigerian University students in traditional halls of residence. *J. Am. Coll. Nutr, 6:* 369-374.

Olayemi, J.K. 1996. Food Security in Nigeria. The Report of a Research Study Sponsored by Development Policy Centre, Ibadan, Nigeria, September 1996. Research Report No.2

Omonona, B. T. and Agoi, G. A. 2007. An analysis of food security situation among Nigerian urban. *Journal of Central European Agriculture,* 8(3): 397-406.

Onyango, A., Koskia, K.G. and Tucker, K.L. 1998. Food diversity versus breastfeeding choicein determining anthropometric status in rural Kenyan toddlers. *International Epidemiological Association 1998 Printed In Great Britain International Journal of Epidemiology,* 27(4): 84-89

Orr, S.K. and Bazinet, R.P. 2008. The emerging role of docosahexaenoic acid in neuro-inflammation. *Curr Opin Investig Drugs*, 9(7): 735-43.

Oyunga-Ogubi M.A, Waudo, N.J, Afullo, A. and Oiye, SO. 2009. Potential role of street foods as micronutrients sources among low income groups in Nairobi, Kenya. *African Journals Online*, 20 (9): 2-8.

Pappas, G., Queen, S., Hadden, W. and Fisher, G. 1960. The increasing disparity in mortality between socioeconomic groups in the United States, 1960 and 1986. *N Engl J Med,* 329:103–9.

Pappas, G., Queen, S., Hadden, W. and Fisher, G. 1986. The increasing disparity in mortality between socioeconomic groups in the United States, and 1986. *N Engl J Med*. 329: 103–9.

Parikh, S. 2000. Improving diet, physical activity and other lifestyle behaviours using computer-tailored advice in general practice: a randomized controlled trail. International Journal of behavioural Nutrition and physical activity.

Park, Y., Subar, A.F., Hollenbeck, A. and Schatzkin, A. 2011. Dietary fiber intake and mortality in the NIH-AARP Diet and Health Study. *Arch Intern Med,* 171 (12): 1061–8.

Parker, S.Y., Murphy, S.P. and Wilkens, L.R. 2005. Dietary patterns using the Food Guide Pyramid groups are associated with sociodemographic and lifestyle factors: the multiethnic cohort study. *J Nutr*, 135:843–9.

Parvin, M., Azadbakht, L. and Azizi, F. 2006. Dietary Diversity within Food Groups: An Indicator of Specific Nutrient Adequacy in Tehranian Women. *Journal of the American College of Nutrition,* 25(4): 354-361.

Patterson, R.E., Haines, P.S. and Popkin, B.M. 1994. Diet quality index: capturing a multidimensional behavior. *J Am Diet Assoc*, 94:57–64.

Penland, J. G., Sandstead, H. H., Alcock, N. W., Dayal, H. H., Xue-Cun, C., Jue-Sheng, L., Jia-Jiu, Y. and Faji, Z. 1998. Zinc and micronutrients affect cognitive and psychomotor function of rural Chinese children. *FASEB* , 12:649-658.

Popkin, B. and Bisgrove, C. 1998. Population and development and development overview: The nutrition transition. In: Sadler Mj, Strain JJ, Caballero B,eds. The encyclopedia of human nutrition. London: *Academic Press*,1562-73

Popkin, B.M. 2001. Nutrition in transition: the changing global nutrition challenge. *Asia Pac J Clin Nutr*, 10:13-8.

Popkin, B. M. 1998. The nutrition transition and its health implications in lower income countries. *Public Health Nutrition,* 1:5-*21.*

Porikos, K. and Hagamen, S. 1986. Is fiber satiating? Effects of a high fiber preload on subsequent food intake of normal-weight and obese young men. *Appetite,* 7:153-162

Potischman, N. 2008. Race/ethnic variation in serum levels of IGF-I and IGFBP-3 in US adults. *Journal of the Growth Hormone Research Society and the international IGF Research Society*. 19 (2), 146-155.

Pulfrey, A. 2006. Demographic and health profile. Public health department, NHS Wasall Jubilee house, Bloxwich lane Walsall, WS27JL. Published by Canadian Center of Science and Education 181

Ralet, M.C., Saulnier, L. and Thibault, J.F. 1993. Raw and extruded fibre from peahulls. Part II: Structural study of the water-soluble polysaccharides. *Carbohydrate Polymers*, 20: 25-34.

Ralet, M.C., Thibault, J.F. and Delia Valle, G. 1990. Influence of extrusion-cooking on the structure and properties of wheat bran. *Journal of Cereal Science,* 11: 249-259.

Ranil, J., Nuala, M.B., Mario, J.S., Prasad, K., Bijesh, Y. and Andrew, P. 2013. High dietary diversity is associated with obesity in Sri Lankan adults: an evaluation of three dietary scores. *Public health,* 13: 314-324.

Raschka, L. and Daniel, H. 2005. Mechanisms underlying the effects of inulin-type fructans on calcium absorption in the large intestine of rats. *Bone,* 37 (5): 728–35.

Robertson, M., Denise, B.A.S., Dennis, A.L., Vidal, H. and Frayn, K.N. 2005. Insulin-sensitizing effects of dietary resistant starch and effects on skeletal muscle and adipose tissue metabolism. *American Journal of Clinical Nutrition,* 82 (3): 559–567.

Robertson, M., Denise, B.A.S., Currie, J.M., Morgan, L.M,. Jewell, D.P. and Frayn, K.N. 2003. Prior short-term consumption of resistant starch enhances postprandial insulin sensitivity in healthy subjects. *Diabetologia*, 46 (5): 659–665.

Robertson, M., Denise, B.A.S., Wright, J.W., Loizon, E., Debard, C., Vidal, H., Shojaee-Moradie, F., Russell-Jones, D. and Umpleby, A.M. 2012. Insulin-sensitizing effects on muscle and adipose tissue after dietary fiber intake in men and women with metabolic syndrome. *Journal of Clinical Endocrinology and Metabolism* 97 (9): 3326–32.

Robinson, S.M., Crozier, S.R., Borland, S.E., Hammond, J., Barker, D.J. and Inskip, H.M. 2004. Impact of educational attainment on the quality of young women's diets. *Eur J ClinNutr* 58:1174–80.

Rolland-Cachera, M.F. and Bellisle, F. 1986. No correlation between adiposity and food intake: why are working class children fatter? *Am J ClinNutr* 44: 779–87.

Rotimi, E.T. 1994. Hunger modulates the responses to gustatory stimuli of single neurons in the caudolateral orbitofrontal cortex of the macaque monkey. *Eur. J. Neurosci. 1*, 53-60.

Ruel, M.T. and Couillard, C. 2007. Evidences of cardio protective potential of fruits: the care of cranberries. *Mol Nutr. Food Res* 51(6):629-701.

Ruel, M.T. 2002. Is dietary diversity an indicator of food security or dietary quality? a review of measurement issues and research needs Food Consumption and Nutrition Division International Food Policy Research Institute 2033 K Street, N.W. Washington, D.C.

Ruel, M.T. 2003. Operationalizing Dietary Diversity: A Review of Measurement Issues and Research Priorities. *Journal of Nutrition* 133:3911-3926.

Ruel, M.T. 2005. The natural history of growth failure: importance of intrauterine and postnatal periods. In: Martorell R, Haschke F, eds. Nutrition and growth. Nestlé Nutrition Workshop Series, Pediatric Program, Vol. 47. Philadelphia, Pa, USA: Nestec, Vevey/Lippincott Williams and Wilkins:123–58.

Ruel, M.T. 2008. Age-based preventive targeting of food assistance and behavior change and communication for reduction of childhood undernutrition in Haiti: a cluster randomized trial. *Lancet*, 16: 588-95.

Sabate, J. 2003. Contribution of vegetarian diets to health and disease-a paradym shift? *Am J Clin Nut*. 78: 5025-75.

Sadiq, B. M., Tahir, N. M., Khan, M.K, Shabir, R. and Butt, M.S. 2008. Oat: unique among the cereals. *European Journal of Nutrition*, 47(2):68-79.

Salt Australia. 2011. Better health channel. Better health.vic.gov.au. retrieved 7 july 2011.

Sam, F.C. 2005. Food based approach to combating micronutrients deficiencies in children in developing countries in Traditional food processing and preparation practices to enhance bioavalability of micronutrients. G Charlotte and Nueman (EDs) longman Group Limited South Africa. Pp 1-5.

Samaha, F.F., Iqbi, N. and Seshadri, P. 2003. A low-carbohydrate as compared with a low-fat diet in severe obesity. *N. Engl. J. Med*, 348(21): 2074-81.

Samman, S., Sandstrom, B., Toft, M.B., Bukhave, K., Jensen, M., Sorensen, S.S. and Hansen, M. 2001. Green tea or rosemary extract added to foods reduces nonheme-iron absorption. *Am J Clin Nutr,* 73: 607-12.

Sandberg, A. 2002. Bioavailability of minerals in legumes. *British J of Nutrition,* 88:281-5.

Sandstead, H. H., Penland, J. G., Alcock, N. W., Dayal, H. H., Chen, X. C., Li, J. S., Zhoa, F. and Yang, J. J. 1998. Effects of repletion with zinc and other micronutrients on neuropsychologic preformance and growth of Chinese children. *Am. J. Clin. Nutr* 68:470-475.

Sandstorm, B. and Sandberg, A. S. 1996. Inhibiting effects of isolated inositol phosphates on zinc absorption in humans. *Journal of Trace element elec Health Diseases, 6:*99-103.

Sanusi, R.A. 2010. An assessment of dietary diversity in six Nigerian states. *Afr. J. Biomed. Re,s* 13: 161-167.

Sarafzadegan, N., Azadbakht, L., Mohammadifard, N., Esmaillzadeh, A., Safavi, M., Sajadi, F., Alikhasi, H., Maghroun, M. and Kelishadi, R. 2009. Do lifestyle interventions affect dietary diversity scores in the general population? *Public Health Nutrition,* 23:1-7.

Savy, M., Martin-Prével, Y., Sawadogo, P., Kameli, Y. and Delpeuch, F. 2005. Use of variety/diversity scores for diet quality measurement: relation with nutritional status of women in a rural area in Burkina Faso. *Eur J ClinNutr,* 59(5):703-16.

Sazawal, S., Bentley, M., Black, R. E., Dhingra, P., George, S. and Bhan, M. K. 1996. Effect of zinc supplementation on observed activity in low socioeconomic Indian preschool children. *PEDS,* 98:1132-1137.

Schmidhuber, J. and Shetty, P. 2005. Nutrition transition obesity and non-communicable diseases: Drivers, outlook and concerns. UN/SCN 29:13-19

Schmidl, M.K. and Labuza, T.P. 2000. Infant formula and Medical Foods. In Essential of functional foods. Aspen publishers. Pp. 137-164. Google Book search. Retrieved on November 7, 2009.

Scholz-Ahrens, K.E. and Schrezenmeir. J. 2007. Insulin and oligofructose and mineral metabolism: the evidence from animal trials. *J Nutr.* 137(1): 2513-2523.

Scholz-Ahrens, K.E. and Schrezenmeir. J. 2007. Insulin and oligofructose and mineral metabolism: the evidence from animal trials. *J Nutr,* 137(1): 2513-2523.

Scott, O., Galicia-Connolly, E., Adams, D., Surette, S., Vohra, S. and Yager, J.Y. 2012. The safety of cruciferous plants in humans: a systemic review. *Journal of Biomedical, Biotechnology* 50:32-41.

Shimakawa, T., Sorlie, P. and Carpenter, M.A. 1994. Dietary intake patterns and sociodemographic factors in the atherosclerosis risk in communities study. ARIC Study Investigators. *Prev Med* 23: 769–80.

Shrewy, P.R. 2003. Tuber Storage Proteins. *Annals of Botany*, 91: 755-769.

Seelig, M.S. 1981. Magnesium requirements in human nutrition. *Magnesium Bull* 3(1): 26-47.

Sen, A.K. 1981. Poverty and Famines. An Essay on Entitlement and Deprivation. Clarendon Press, Oxford, UK.

Serra-Majem, L., Ribas, L., Perez-Rodrigo, C., Garcia-Closas, R., Pena-Quintana, L. and Aranceta, J. 2007. Determinants of nutrient intake among children and adolescents: results from the enKid Study. *Ann Nutr Metab*, 46: 31–8.

Seymour, J., Calle, E., Flagg, E., Coates, R., Ford, E. and Thun, M. 2003. Diet quality index as a predictor of short-term mortality in the American Cancer society cancer prevention study 11 nutrition cohort. *Am. J Epidemiol*, 157: 980-988.

Shah, D. and Scahdev, H.P. 2006. Zinc deficiency in pregnancy and fetal outcome. *Nutriion Review*, *64*(1): 15-30.

Shatenstein, B., Kergoat, M.J. and Reid, I. 2007. Poor nutrient intakes during 1-year follow-up with community-dwelling older adults with early-stage Alzheimer dementia compared to cognitively intact matched controls. *J Am Diet Assoc*, 107: 2091-2099.

Shetty, P.S. 2002. Nutrition transition in India. *Public Health Nutrition*, 5: 175–182.

Shimbo, S, K., Kimura, K., Imai, Y., Yasumoto, K., Yamamoto, K., Kawamura, S., Watanabe, T., Iwami, O., Nakatsuka, H. and Ikeda, M. 1994. Number of food items as an indicator of nutrient intake. *Ecology of Food and Nutrition*, 32:197-206.

Shrewy, P.R. 2003. Tuber Storage Proteins. *Annals of Botany* 91: 755-769.

Siegenberg, D., Baynes, R.D., Bothwell, T.H., Macfarlane, B.J., Lamparelli, R.D., Car, N.G., MacPhail, P., Schmidt, U., Tal, A. and Mayet, F. 1991. Ascorbic acid prevents the dose-dependent inhibitory effects of polyphenols and phytates on nonheme-iron absorption. *Am J ClinNutr*, 53:537-41.

Siljeström, M., Westerlund, E., Björck, I., Holm, J., Asp, N.G. and Theander, 0. 1986. The effects of various thermal processes on dietary fibre and starch content of whole grain wheat and white flour. *Journal of Cereal Science*, 4: 315-323.

Silke, T., Mensink, G.B.M. and Beitz, R. 2003. Determinants of diet quality University of Kiel, Department of Food Economics and Consumption Studies. *Public Health Nutrition*, 7(1), 29–37.

Siri-Tarino, P.W., Sun, Q, Hu, F.B. and Krauss, R.M. 2010. Saturated fatty acids and risk of coronary heart disease: modulation by replacement nutrients. *Curr.Atheroscler Rep*, 12:384-90.

Slattery, M. T. Berry, J. Potter, C. and Caan, B. 1997. Diet diversity, diet composition and risk of colon cancer. *Cancer Causes and Control*, 8:872-882.

Smith, L. and Haddad, L. 2000. Explaining child malnutrition in developing countries: a cross country analysis. Research report 111. Washington, DC: International Food Policy Research Institute.

Smith, L.C. and Haddad, L. 2001. How important is improving food availability for reducing child malnutrition in developing countries? *Agricult Econ*, 91: 204-26.

Stacewicz-Sapuntzakis, M., Bowen, P.E., Hussain, E.A., Damayanti-Wood, B.I. and Farnsworth, N.R. 2001. Chemical composition and potential health effects of prunes: a functional food? *Crit Rev Food Sci Nutr*, 41 (4): 251-86.

Statistical Package for the Social Sciences inc. Released 2007. SPSS for windows, version 16.0. Chicago, SPSS Inc.

Steinke, W. 1992. New protein foods in human health: nutrition, prevention and therapy. CRC Press. 91–100.

Steyn, N.P and Nel, J.H. 2006. Dietary Intake of Adult Women in South Africa and Nigeria with a focus on the use of Spreads. Chronic Diseases of Lifestyle Unit Medical Research Council, South Africa.

Strychar, I. 2006. Diet in the management of weight loss. *CMAJ*, 174 (1): 56-63.

Sung-Yong, K., Rodolfo, M., Nayga, Jr. and Capps, O, Jr. 2000. Health Knowledge and Consumer use of Nutritional Labels: The Issue Revisited. *Agricultural and Resource Economics Review*, 30: 10–19.

Swindale, A. and Bilinsky, P. 2005. Household Dietary diversity Score (HDDS) for Measurement of Household food Access: Indicator Guide. Food and Nutrition Technical Assistance. *The Journal of Nutrition*, 138(12): 2448-53.

Tapiero, H. 2011. Iron: deficiencies and requirements. *Biomedicine and Pharmacotherapy*, 55, 324-332

Tarini, A., Bakari, S. and Delisle, H. 1999. The overall nutritional quality of the diet is reflected in the growth of Nigerian children. *Sante*, 9: 23–31.

Thacher, T.D., Aliu, O., Griffin, I.J., Pam, S.D., O'Brien, O,K., Imade, M E.G. and Abrams., A.S. 2010. Setting Dietarty reference intakes with the use of biovailability data: calcium. *American Journal of Clinical Nutrition*, 91: 1474-1477.

Tharanathan, R.N. 2002. Food derived carbohydrates-structural complexity and functional diversity. *Crit Rev Biotechnol*, 22(1): 68-84.

Thiam, I., Sambe, K. and Lavanga, D. 2006. Diet related chronic disease in the West African region. Standing Committee on Nutrition (SCN), 23: 6-10.

Thiele, S. and Weiss, C. 2003. Consumer demands for food diversity: evidence for Germany. *Food Policy*, 28: 99–115.

Thiele, S., Mensink, G.B. and Beitz, R. 2004. Determinants of diet quality. *Public Health Nutrition*, 7(1): 29-37.

Torheim, L.E., Ouattara, F., Diarra, M.M., Thiam, F.D., Barikmo, I., Hatloy, A. and Oshaug, A. 2004. Nutrient adequacy and dietary diversity in rural Mali: association and determinants. *Eur J Clin Nutr*, 58: 594-604.

Total Diet Assessment, Version 3.0. 2001. ESHA Research. Harcourt College Publishers, New York.

Trichopoulou, A., Kouris-Blazos, A., Wahlqvist, M., Gnardellis, C., Lagiou, P., Polychronopoulos, E., Vassilakou, T., Lipworth, L. and Trichopoulos, D. 1995. Diet and survival in elderly people. *BMJ*, 311: 1457-1460.

Tur, J.A., Colomer, M., Monino, M., Bonnin, T., Lompart, I.L. and Pons, A. 2005. dietary intake and nutritional risk among free-living elderly people in palma de Mallorca. *The Journal of Nutritional Health and Ageing* 9: 6-10.

Turrell, G., Hewitt, B., Patterson, C. and Oldenburg, B. 2003. Measuring socio-economic position in dietary research: is choice of socio-economic indicator important? *Public Health Nutr* 6:191–201.

U.S. Department of Agriculture Human Nutrition Information Service. 1992. Food Guide Pyramid: A Guide to Daily Food Choices. Home and Garden Bulletin. No. 249.U.S. Departments of Agriculture and Health and Human Resources, Washington, DC.

U.S. Department of Agriculture Human Nutrition Information Service. 1996. Center for Nutrition Policy and Promotion, The Food Guide Pyramid, Home and Garden Bulletin no. 252, 1996.

Underwood BA. 1998. A life cycle micronutrient perspective for women's health. Journal of *American Society for Clinical Nutrition.* 81 (5): 1188-1193.

United States department of agriculture. Report of the dietary guidelines advisory.The dietary guidelines foe Americans, 2010. Washington, DC: US dEpartment of Agric. (USDA); 2010. Report of the dietary guidelines advisory Committee on the Dietary Guidelines for Americans, 2010. Washington, DC: US Department of Agriculture. http://www.cnpp.usda.gov/dietaryguidelines.htm

USDA, 2000. Department of health and Human services, Nutrition and your health: Dietary Guidelines for Americans, home and Garden Bulletin no.232 (Washington, D.C.: 2000).

USDA, 2011. Empty Calories: How Many Empty Calories Can I Have?. Retrieved 2011-11-01. Jump back a section External links "Adequate Nutrients Within Calorie Needs". Dietary Guidelines for Americans 2005. Retrieved 2006-05-09.

USDA. 2008. National Nutrient Database for Standard Reference, Release 21. United States Department of Agriculture. Retrieved 2008-10-24.

USDA. 2010. Access to affordable and nutritious food: measuring and understanding food deserts and their consequences. United States Department of Agriculture.

USAID 2009. Essential nutrition action: prevention first. Available at http://report.usaid.gov/our_work/workshop_report/disaster_assistance/sectors/ retrieved 2011-3-9.

USAID 2012. Nutrition sector update. USAID/OFDA information products are available at http://transition.usaid.gov/our_work/humanitarian_assistance/disaster_assistance/sectors/ retrieved 2013-5-6.

Uzel, C. and Conrad, M.E. 1998. Absorption of heme iron. *Semin Hematol*, 35:27-34.

Vakili, M., Abedi, P., Sharifi, M. and Hosseini, M. 2013. Dietary Diversity and Its Related Factors among Adolescents: A Survey in Ahvaz-Iran. *Global Journal of Health Science*, 5: 2-10.

Van damme, E.J.M., Rouge, P. and Peumans, W.J. 2007. Carbohydrate intake and obesity. *European Journal of Clinical Nutrition*, 1: 75-99.

VanRossum, C.T., van de, M.H., Witteman, J.C., Grobbee, E. and Mackenbach, J.P. 2000. Education and nutrient intake in Dutch elderly people. The Rotterdam Study. *Eur J Clin Nutr*, 54:159–65.

Variyam, J. N., James, B. and David, S. 1998. Information Effects of Nutrient Intake Determinants on Cholesterol Consumption. *Journal of Agricultural and Resource Economics*, 23: 110–125.

Vereecken, C.A., Inchley, J., Subramanian, S.V., Hublet, A. and Maes, L. 2005. The relative influence of individual and contextual socio-economic status on consumption of fruit and soft drinks among adolescents in Europe. *Eur J Public Health*, 15: 224–32.

Vernon, Y. and Peter, P. 1994. Plant proteins in relation to human protein and amino acid nutrition. *American Journal of Clinical Nutrition*, 59: 1203-12.

Wahlqvist, M.L., Lo, C.S. and Myers KA. 1989. Food variety is associated with less macro vascular disease in those with type II diabetes and their healthy controls: *J Am Coll Nutr,* 8:515-523.

Walravens, P.A. and Hambidge, K.M. 1976. Growth of infants fed a zinc supplemented formula. *Am. J. Clin. Nutr* 29: 1114-1121.

Walravens, P.A. Kreb, N.F. and Hambidge, K.M. 1983. Linear growth of low income preschool children receiving a zinc supplement. *Am. J. Clin. Nutr,* 38: 195-201.

Walravens, P.A., Hambidge, K.M. and Koepfer, D.M. 1989. Zince supplementation in infants with a nutritional pattern of failure to thrive: a double-blind, controlled study. *Pediatrics,* 83: 532-538.

Washi, S.A. and Ageib, M.B. 2010. Poor diet quality and food habits are related to impaired nutritional status in 13- to 18-year-old adolescents in Jeddah. *Nutr Res*, 30(8): 527-34.

Weaver, C.M. and Heaney. R.P. 1991. Isotopic exchange of ingested calcium between labeled sources: evidence that ingested calcium does not form a common absorptive pool. *Calcif Tissue Int*, 49: 244-7

Weaver, C.M., Proulx, W.R. and Heaney. R.P. 1999. Choices for achieving adequate dietary calcium with a vegetarian diet. *Am J Clin Nutr* 70: 543-8.

Weickert, M.O. and Pfeiffer, A.F. 2008. Metabolic effects of dietary fiber consumption and prevention of diabetes. *J Nutr* 138 (3): 439–42.

Weisburger, J. H. 2000. Prevention of cancer and other chronic diseases worldwide based on sound mechanisms. *Biofactors* 12:73-81

Welsh, S., Davis, C. and Shaw, A. 1992. Development of the Food Guide Pyramid. *Nutr. Today* 27: 12–23.

Woolf, P.J., Fu, L.L. and Basu, A. 2011. Protein: Identifying Optimal Amino Acid Complements from plant-based foods. In Haslam, Niall James. PLos ONE 6 (4): e18836.

Worsley, A., Blashe, R. and Crawford, D. 2003. Income differences in food consumption in the 1995 Australian National Nutrition Survey. *European Journal of Clinical Nutrition 57,* 1198-1211.

Willett, W.C., Sacks, F. and Trichopoulou, A. 1995. Mediterranean diet pyramid: a cultural model for healthy eating. *American Journal of Clinical Nutrition* 61: 1402–6.

Willett, W.C. 1994. Diet and health: what should we eat? *Science* 264:532–7.

William, C. 2003. Lipid analysis: isolation, separation, identification, and structural analysis of lipids. Ayr, Scotland: Oily Press.

William, R.J.P. 1989. An introduction to the biochemistry of zinc. Mills, C.F. eds. Zinc in human bology, 15-31 springer-Verlag berlin, Germany.

Wolever, A., Blasche, R., Ball, K. and Crawford, D. 2003. Income differences in food consumption in the 1995. Australian National Nutrition Survey. *European Journal of Clinical Nutrition* 57: 1198–211.

Wolever, T.M.S., Jenkins, D.J.A., Kalmusky, J., Giordano, C., Guidici, S., Jenkins, A.L., Thompson, L.U., Wong, G.S. and Josse, R.G. 1986. Glycemic response to pasta: effect of surface area, degree of cooking and protein enrichment. *Diabetes Care,* 9: 401.

Wong, F., Kim, B.E., Dufner-Beattie, J., Petris, M.J., Andrews, G. and Eide, D.J., 2006. Acrodermatitis enteropathica mutations affect transport activity, localization and zinc-responsive trafficking of the mouse zip4 zinc transporter. *Hum. Mol. Genet*. 13: 563–571.

Wong, J.M., De Souza, R., Kendell, C.W., Emam, A. and Jenkins, D.J. 2006. Colonic health: fermentation and short chain fatty acids. *J.Clin. Gastroentrol,* 4(3):235-43.

Wood, R. 2000. Assessing marginal zinc deficiency: where are we now and where are we going in the future?. *J. Nutr,* 130:1350-1354.

World Health Organization (WHO), 2003. Food and Agriculture Organization (FAO), Diet, Nutrition and Prevention of Chronic Diseases. Report of a joint WHO/FAO expert consultation. Report no. 916. World Health Organization: Geneva, Switzerland.

World Health Organization. 2000. The management of Nutrition in Major Emergencies Malta publishers Hong Kong. Pp 26-31.

World Health Organization, Anthro. 2005. Anthrpometric calculator, individual assessment, nutritional survey (cross-sectional) Beta version, Feb 17th 2006.

World Health Organization, 2005. Preventing chronic diseases: A vital investment, WHO, Geneva.

World Health Organization, 2013. Obesity and overweight. Fact sheet.

World Health Organization. 1996. Preparation and Use of Food-Based Dietary Guidelines. WHO Technical Report, Series 880. Report of a Joint FAO/WHO Consultation.World Health Organization, Geneva, Switzerland.

World Health Organization, 2006. Nutrition for health and development: challenges. Department of nutrition for health and development: World Health

Organization, Geneva. http://www.who.int/nutrition/challenges. retrieved 2010-4-7.

World Health Organization, 2013. April 7. Hypertensive Nigerians.

World Health Organization/FAO Expert Consultation. 2003. "Diet, Nutrition and the Prevention of Chronic Diseases (WHO technical report series 916)". World Health Organization. pp. 81–94.

World Health Organization/ Food and Agriculture Organization. 2003. Diet, Nutrition and the Prevention of Chronic Disease. Report of a joint World Health Organization/FAO expert consultation. Geneva: World Health Organization.

Xie, B., Gilliland, F.D., Li, Y.F. and Rockett, H.R. 2003. Effects of ethnicity, family income, and education on dietary intake among adolescents. *Prev Med*, 36: 30–40.

Yamaguchi, S., Miura, C., Kikuchi, K., Celino, F.T, Agusa, T, Tanabe S. and Miura T, 2009. Micronutrients. *Proc Natl Acad Sci*, 10859-64.

Yeagle, P.L .1991. "Modulation of membrane functions by cholesterol". *Biochimie,* 73 (10): 1303–10.

Zhang, W., Wang, H., Zhang, Y. and Yang, Y. 2007. Effects of resistant starch on insulin resistance of type 2 diabetes mellitus patients. *Chinese Journal of Preventive Medicine*, 2 (2): 101–104.

APPENDIX 1

INSTITUTE FOR ADVANCED MEDICAL RESEARCH AND TRAINING (IAMRAT)

COLLEGE OF MEDICINE, UNIVERSITY OF IBADAN. IBADAN, NIGERIA.

Director: Prof. A. Ogunniyi, B.Sc(Hons), MBChB, FMCP, FWACP, FRCP (Edin), FRCP (Lond)

Tel: 08023038583, 08038094173

E-mail: aogunniyi@comui.edu.ng

UI/UCH EC Registration Number: **NHREC/05/01/2008a**

NOTICE OF FULL APPROVAL AFTER FULL COMMITTEE REVIEW

Re: An Assessment of Diet Quality and Diversity of Diets in the South East Geo-Political Zone of Nigeria

UI/UCH Ethics Committee assigned number: UI/EC/13/0065

Name of Principal Investigator: **Gertrude N. Onyeji**

Address of Principal Investigator: Department of Human Nutrition,
College of Medicine,
University of Ibadan, Ibadan

Date of receipt of valid application: 04/03/2013

Date of meeting when final determination on ethical approval was made: **16/05/2013**

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 16/05/2013 to 15/05/2014. 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 expescted that you submit your annual report as well as an annual request for the project renewal to the UI/UCH EC early in order to obtain renewal of your approval 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
16 MAY 2013
APPROVED
COLLEGE OF MEDICINE, U.I.

Profess[illegible]
Director, IAMRAT
Chairman, UI/UCH Ethics Committee
E-mail: uiuchirc@yahoo.com

▪ Drug and Cancer Research Unit ▪ Environmental Sciences & Toxicology ▪ Genetics & Cancer Research ▪ Molecular Entomolog

APPENDIX II

THE INFORMED CONSENT FORM FOR RESPONDENTS

IRB Research Approval Number

This approval will elapse on:

Title of the research: Assessment of diet quality and diet diversity of diets in the South East Geopolitical Zone of Nigeria.

Name(s) and affiliation(s) of researcher(s) of applicant(s): This study is conducted by Department of Human Nutrition, Faculty of Public Health University of Ibadan, Ibadan.

Sponsor(s) of research: This study is Self Sponsored.

Purpose of research: The purpose of this research is to assess the diet quality and diet diversity of diets in the South East Geopolitical Zone of Nigeria.

Procedure of the research: A total of 1,200 women of reproductive age with under-5 children will be recruited for this study. Interviewer/ semi-structured questionnaire will be used by the principal investigator and the research assistants to collect information on your social economic status and on the foods and snacks consumed within the past 24 hour. The height and weight measurements of the mothers and their children will be taken. The interview will be conducted in their houses.

Expected duration of research and of participant(s)' involvement: Each respondent will spend 20-30 minutes in filling of the questionnaire.

Risk(s): There are no physical risks associated with participating in this study However, if you feel uncomfortable with some of the questions being asked, you may decide not to answer any questions you feel uncomfortable about.

Costs to the participants: Your participation in this research will not cost you anything.

Benefits: This study will benefit the participants individually as each person will obtain more useful information from the outcome of the study that will help improve their family health. It will also be of benefit to the community, local government, the senatorial zones, states and Nigeria at large.

Confidentiality of Data: Data collected will be handled confidentially and information obtained will not in any way be disclosed. It is also important to note that the questionnaires even though will ask for names but will only bear numbers during analysis for identification purposes. Your responses will not be linked to you in any way. Your name will not be used in any publication or report. However as part of my responsibility in the conduct of this research, members of the researchers' staff and representative from the UCH Ethical committees may have access to the study records. They are required to keep your identity confidential. Results of this study may be used for research publication, or presentations at scientific meetings, but your personal results will never be discussed as an individual.

Voluntariness: Participation in this study is completely voluntary. Anyone may decide not to participate at any time during the study. Respondents are at liberty not to answer any question they may feel is uncomfortable to answer. You will not be penalized in any way if you decide not to participate, or to stop participating. The respondents and their household members are allowed to ask questions at any time about the study and can do so before they agree to participate, or at any time during the participation.

Statement of Persons Obtaining Informed Consent:
I have fully explained this research to …………………………………………… And have given sufficient information, including about risks and benefits, to make an informed decision.

DATE…………………………. SIGNATURE…………………………………

NAME……………………………………………………………………..

Statement of Person giving the permission

I have read the description of the research. I understand that my participation is voluntary. I know enough about the purpose, methods, risks and benefits of the research study to judge that I want to take part in it. I understand that I may freely stop being part of this study at any time. I have received a copy of this consent form and additional information sheet to keep for myself.

DATE: ……………………… SIGNATURE: …………………….....

NAME: ………………………………………….

APPENDIX III

No------

SURVEY QUESTIONAIRE

ASSESSMENT OF DIETARY QUALITY AND DIETARY DIVERSITY OF DIETS IN SOUTH EAST GEO POLITICAL ZONES OF NIGERIA

Department of Human Nutrition

University of Ibadan

Assessment of Dietary Quality and Dietary Diversity of Diets in South East Geo Political Zone of Nigeria 2010

SECTION ONE: Respondent's Profile

A. Household Identification

Date: ……………………………………………………………

Name of Household: ……………………………………………..

No. of persons in household ……………………………………

Address: …………………………………………………………

Community/Area……………………………………………………..

Ward…………………………………………………………………

Location (rural/urban)………………………………………..

Local Government Area……………………………………………

Senatorial Zone: ……………......

State: ……………………

B. Household Composition

	Name	Sex	Age	Relation to Head of H/H	Martial Status
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

Sex: Male = 1, Female = 2

Age: in years

Relationship to Head of H/H: Head of Household = 1, Wife=2, Son=3, Daughter=4, relation = 5 others = 6.

Marital Status: Married = 1, Single/Not married = 2, Widowed=3, Divorced = 4. Separated = 5

Assessment of Dietary Quality and Dietary Diversity of Diets in South East Geo Political Zone of Nigeria 2010

SECTION TWO: Socio-economic Characteristics of Households (Respondent):

No.		Options	Choice (code)
1.	Religion	Christianity (1) Islam (2) Traditional Religion (3) Others Specify (4)	
2.	Ethic group	Yoruba (1) Ibo (2) Hausa (3) Other –specify (4)	
3.	Highest Educational level attained by the head of household	University degree (1) Polytechnic degree/diploma(2) Secondary completed (3) Secondary not completed (4) Primary School Completed (5) No formal education (6)	
4.	Primary occupation of head of household	Farmer (1) Trader (2) Civil Servant (3) Artisan (4) Religious leader (5) Professional (6) Unemployed (7) Others-specify (8)	
5	Highest Educational level attained by respondent	University degree (1) Polytechnic degree/diploma(2) Secondary completed (3) Secondary not completed (4) Primary School Completed (5) No formal education (6)	
6.	Primary Occupation of respondent	Farmer (1) Trader (2) Civil servant (3) Artisan (4) Religious leader (5) Professional (6) Unemployed (7) Others-specify (8)	
7.	Primary source of domestic lighting	Lantern/Candle (1) Personal Generator (2) PHCN/NEPA (3) Solar (4) Others-specify (5)	

8.	Primary source of water for domestic use	Pond/Lake (1) Spring/River (2) Well (3) Bore hole (4) Pipe-Borne (5) Rain water harvest (6) Sachet water regularly (7) Others-specify (8)	
9.	Refuse disposal Method	Bush (1) Refuse Dumps (2) City service (3) Others-specify (4)	
10.	Type of Toilet	Bush (1) Pit latrines (2) VIP Latrines (3) Water system (4) Rivers (5) Others-Specify (6)	
11.	Estimated Monthly Income of HHH	#5,000 – 14,999 (1) #15,000-24,999 (2) #25,000-34,999 (3) #35,000-54,000 (4) #45,000 – 54,000 (5) #55,000 and above (6) don't know (7) No income (8)	
12.	Estimated Monthly Income of respondent	5,000 – 14,999 (1) #15,000-24,999 (2) #25,000-34,999 (3) #35,000-54,000 (4) #45,000 – 54,000 (5) #55,000 and above (6) don't know (7) No income (8)	
13.	House Ownership	Self (1) Family (2) Rented (3) Others-specify (4)	
14.	Source of fire for cooking	Fire wood (1) Kerosene stove (2) Electric stove (3) Gas (4) Microwave (5) Others-specify (6)	
15.	Household equipment	Refrigerator (1) Freezer (2) Radio (3) Television (4) Video (5) DSTV (6)	

		Car (7) Motorcycle (8) Bicycle (9) GSM (10)	

SECTION THREE: ANTHROPOMETRIC MEASUREMENT

		CHILD
INDICES	**MOTHER**	**TICK:** Male ( ) Female ( )
Age	**(Years)**	**(Months)**
Weight (kg)		
Height/length (cm)		

Assessment of Dietary Quality and Dietary Diversity of Diets in South East Geo Political Zone of Nigeria 2010

SECTION FOUR A: TWENTY FOUR-HOUR DIETARY RECALL FOR THE MOTHER

Date: …………………………………………………………

Day of the week ……………………………………………..

Questionnaire No[1]……………………………………………

Name of subject: ……………………………………………..

Now I would like you to tell me everything you ate or drank after you woke up yesterday morning. Include everything you ate and drank at home and away even snacks, tea, or coffee.

Item No. (a)	Food/Drink (b)	Description of food or Drink (use volume, size or price) (c)	Place Taken (d)	Time (e)	Amount (how much did you actually eat/drink?) (f)	Weight equiv..[2] (g)

1. Was food intake usual? (Y/N) If NO, how was it unusual? 2. Was it a feat day? (Y/N)7	4. Probe for supplements (iron, antimalaria, vitamins, other supplements) Y/N If yes, specify
3. Probe for sickness (Y/N): if yes, did sickness affect appetite Y/N) If yes, how? Increase or decrease	5. Probe for fermented beverages consumed

[1] Should come from page 1 of questionnaire (Questionnaire No.)

[2] Do not fill this column of the form

Assessment of Dietary Quality and Dietary Diversity of Diets in South East Geo Political Zone of Nigeria 2010

SECTION FOUR B: TWENTY FOUR-HOUR DIETARY RECALL FOR THE MOTHER

Date: ……………………………………………………………

Day of the week ………………………………………………..

Questionnaire No[1]………………………………………………

Name of subject: ………………………………………………..

Now I would like you to tell me everything you ate or drank after you woke up yesterday morning. Include everything you ate and drank at home and away even snacks, tea, or coffee.

Item No. (a)	Food/Drink (b)	Description of food or Drink (use volume, size or price) (c)	Place Taken (d)	Time (e)	Amount (how much did you actually eat/drink?) (f)	Weight equiv..[2] (g)

1. Was food intake usual? (Y/N) If NO, how was it unusual?	4. Probe for supplements (iron, antimalaria, vitamins, other supplements) Y/N If yes, specify
2. Was it a feat day? (Y/N)7	
3. Probe for sickness (Y/N): if yes, did sickness affect appetite Y/N) If yes, how? Increase or decrease	5. Probe for fermented beverages consumed

[1] Should come from page 1 of questionnaire (Questionnaire No.)

[2] Do not fill this column of the form

Assessment of Dietary Quality and Dietary Diversity of Diets in South East Geo Political Zone of Nigeria 2010

State: …………………………………………………………………………

Name of Interviewer: ………………………………………………………….

Name of Supervisor: ………………………………………………………...

Signature of Supervisor: …………………………………………………….

Date: …………………………………

APPENDIX IV

Table 3.3: Imo State Population in Nigeria according to 2006 Census

LGA	BOTH SEXES	MALE	FEMALE
Aboh-Mbaise	194,779	98,480	96,299
Ahiazu-Mbaise	170,824	86,326	84,498
Ehime-Mbano	130,575	65,237	65,338
Ezinihitte	168,767	84,725	84,042
Ideato North	156,161	78,753	77,408
Ideato South	159,654	81,125	78,529
Ihitte/Uboma	119,419	60,492	58,927
Ikeduru	149,737	75,025	74,712
Isiala-Mbano	197,921	100,835	97,086
Isu	164,328	84,299	80,029
Mbaitolu	237,474	118,959	118,515
Ngor-Okpala	157,858	78,829	79,029
Njaba	143,485	72,401	71,084
Nkwerre	80,270	40,845	39,425
Nwangele	127,691	65,022	62,669
Obowo	117,432	58,204	59,228
Oguta	142,340	72,549	69,791
Ohaji/Egbema	182,891	92,604	90,287
Okigwe	132,701	67,660	65,041
Orlu	142,792	69,632	73,160
Orsu	120,224	60,490	59,734
Oru East	111,743	56,148	55,595
Oru West	115,704	59,108	56,596
Owerri North	176,334	87,094	89,240
Owerri West	101,754	49,968	51,786
Owerri Municipal	125,337	60,882	64,455
Umuimo	99,368	50,779	48,589
Imo State	**3,927,563**	**1,976,471**	**1,951,092**

Source: National Population Commission (2010)

Table 3.2: Enugu State Population in Nigeria according to 2006 Census

LGA	BOTH SEXES	MALE	FEMALE
Aninri	136,221	66,225	69,996
Awgu	197,292	96,132	101,160
Enugu East	277,119	131,214	145,905
Enugu North	242,140	118,895	123,245
Enugu South	198,032	93,758	104,274
Ezeagu	170,603	84,466	86,137
Igbo-Etiti	208,333	105,262	103,071
Igbo-Eze North	258,829	126,069	132,760
Igbo-Eze South	147,364	72,619	74,745
Isi-Uzo	148,597	72,497	76,100
Nkanu East	153,591	75,008	78,583
Nkanu West	147,385	72,706	74,679
Nsukka	309,448	149,418	160,030
Oji-River	128,741	61,719	67,022
Udenu	178,687	88,381	90,306
Udi	238,305	117,914	120,391
Uzo-Uwani	127,150	63,759	63,391
Enugu State	**3,267,837**	**1,596,042**	**1,671,795**

Source: National Population Commission (2010)

Table 3.4: Anambra State Population in Nigeria according to 2006 Census

LGA	BOTH SEXES	MALE	FEMALE
Aguata	369,972	187,262	182,710
Anambra East	152,149	77,539	74,610
Anambra West	167,303	85,833	81,470
Anaocha	284,215	142,961	141,254
Awka North	112,192	57,219	54,973
Awka South	189,654	96,902	92,752
Ayamelum	158,152	81,065	77,087
Dunukofia	96,517	49,476	47,041
Ekwusigo	158,429	80,053	78,376
Idemili North	431,005	219,223	211,782
Idemili South	206,816	105,830	100,986
Ihiala	302,277	152,200	150,077
Njikoka	148,394	73,869	74,525
Nnewi North	155,443	77,517	77,926
Nnewi South	233,362	118,532	114,830
Ogbaru	223,317	115,678	107,639
Onitsha North	125,918	61,588	64,330
Onitsha South	137,191	71,348	65,843
Orumba North	172,773	84,996	87,777
Orumba South	184,548	93,199	91,349
Oyi	168,201	85,694	82,507
Anambra State	**4,177,828**	**2,117,984**	**2,059,844**

Source: National Population Commission (2010)

APPENDIX V

Age Range of Children Crosstabulation

			CHILDRANGE					
			0-12 MONTHS	12.01-24 MONTHS	24.01-36 MONTHS	36.01-48 MONTHS	48.01-60 MONTHS	Total
age_range	15-19	Count	32	3	2	0	1	38
		% within age_range	84.2%	7.9%	5.3%	.0%	2.6%	100.0%
	20-24	Count	182	32	22	14	11	261
		% within age_range	69.7%	12.3%	8.4%	5.4%	4.2%	100.0%
	25-29	Count	319	75	37	16	11	458
		% within age_range	69.7%	16.4%	8.1%	3.5%	2.4%	100.0%
	30-34	Count	183	37	29	20	11	280
		% within age_range	65.4%	13.2%	10.4%	7.1%	3.9%	100.0%
	35-39	Count	67	20	5	13	9	114
		% within age_range	58.8%	17.5%	4.4%	11.4%	7.9%	100.0%
	40-44	Count	21	7	3	2	1	34
		% within age_range	61.8%	20.6%	8.8%	5.9%	2.9%	100.0%
	45-50	Count	8	3	2	1	1	15
		% within age_range	53.3%	20.0%	13.3%	6.7%	6.7%	100.0%
Total		Count	812	177	100	66	45	1200
		% within age_range	67.7%	14.8%	8.3%	5.5%	3.8%	100.0%

Correlations

		BMI of mother	Calorie Intake	protein Intake
BMI of mother	Pearson Correlation	1	.034	.008
	Sig. (2-tailed)		.234	.770
	N	1200	1200	1200
Calorie Intake	Pearson Correlation	.034	1	.175**
	Sig. (2-tailed)	.234		.000
	N	1200	1200	1200
protein Intake	Pearson Correlation	.008	.175**	1
	Sig. (2-tailed)	.770	.000	
	N	1200	1200	1200

**. Correlation is significant at the 0.01 level (2-tailed).

NUTRIENT ADEQUACY MEAN INTAKE

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Calorie Intake	1200	16.24	6321.92	2464.7167	678.21535
protein Intake	1200	17.84	2208.08	94.2547	91.67292
Carbohydrate Intake	1200	13.09	3765.71	423.2159	188.89951
Fat Intake	1200	7.21	1161.23	65.3120	58.86360
Calcium Intake	1200	24.00	3687.56	371.8099	249.00671
Phosphorus Intake	1200	10.00	5690.00	630.2722	373.62168
Sodium Intake	1200	8.94	12353.95	1279.9602	885.06479
Potassium Intake	1200	3.34	16665.47	1110.2409	902.06466
Zink Intake	1200	2.26	96.65	12.4190	5.16498
Iron Intake	1200	3.75	3550.04	54.3354	183.84239
Magnesium Intake	1200	14.98	26209.66	214.2374	756.85172
vitc	1200	.00	736.21	50.0044	88.26994
Valid N (listwise)	1200				