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Prevalence of Obesity, Oxidative Stress and Perception of Body Image among Adults in the Wa Municipality, Ghana

By

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DECLARATION

I hereby declare that this thesis is the outcome of my own original research and that, it has neither in part nor whole, been presented for another degree in this university or elsewhere.

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DEDICATION

I dedicate this research work to my children, Erastus Wuntima Seidu and Casilda Zaanyaya Seidu

ABSTRACT

The rising prevalence of overweight and obesity globally and in Ghana is considered as a pandemic with public health implications because of the corresponding rising prevalence of diabetes, hypertension and other non-communicable diseases, which are known causes/risk factors of morbidity and mortality. In spite of this rising trend, little is known of the perception of body image in Ghana and how that contributes to the situation. With scanty data on national and regional level about overweight/obesity, hypertension and diabetes, a cross-sectional survey was conducted in Wa Municipality to determine the prevalence of overweight and obesity, oxidative stress among adults and how body image perception inform this. Multi-stage cluster sampling proportional to size was used to select 320 adult (≥18 years) participants living in 30 communities in the Wa Municipality, Ghana for the study. Anthropometry, blood pressure and fasting blood sugar levels were determined using standard instruments. Glutathione levels were determined in blood serum in the laboratory using the 5,5'-dithiobis (2-nitrobenzoic acid) method. A structured questionnaire was used to elicit responses on a single 24-hour dietary recall, general health knowledge of respondents and body image perception. Statistical Package for Social Sciences (SPSS) version 20 was used to analyze the data. Pearson Chi-square correlation, regression and cross tabulations were used to draw relationships between various variables. The study revealed a 9.1±0.72% obesity prevalence with a combined overweight and obesity prevalence of 32.2%. Male gender was protective against obesity (OR: 0.40 CI: 0.22 – 0.71), implying males have 60% less risk of being obese compared to females. Obesity was highest among age 40-59 years relative to other age groups, and urban dwellers were generally more obese (12.3%) compared to rural dwellers(4.0%) p=0.045. Few respondents (18%) had no knowledge about the causes of obesity whilst 30% had no knowledge about any adverse health effects associated with obesity. Close to 6 in 10 participants had a wrong perception of their BMI status. Moreover 8 in 10 overweight and 8.5 in 10 obese participants had a wrong perception of their BMI status. Contrary to these misrepresentations, most (70%) of the obese participants desired to lose weight. Participants who desired to lose weight had 6.73 increased odds of being obese (CI: 3.65 – 12.41). Multinomial logistics regression showed that kilocalories intake was a predictor of overweight/obesity with 1.7 (CI: 1.02 -2.13, p=0.049) and 1.5 (CI: 0.99 – 2.34, p=0.043) times higher risk for the upper and middle tertiles respectively. No significant variations were observed in serum glutathione (GSH) levels of respondents and their nutritional status although 4 in 10 participants had low GSH status. Systolic hypertension was high among overweight (21.6%) and obese (31.0%) respondents relative to the underweight (11.5%) and normal (7.5%). Similarly, hyperglycaemia was high among overweight (12.3%) and obese (17.2%) relative to the underweight (11.1%) and normal (5.5%). In this adult population in North Western Ghana, overweight/obesity prevalence was high, with high body image misconception. Overweight/obese participants had high calorie intake and are more likely to be hypertensive/hyperglycaemic. Further research to identify underlying causes of obesity and formulate effective public health interventions is recommended.

TABLE OF CONTENT

DECLARATION i
ACKNOWLEDGEMENT ii
DEDICATION iii
ABSTRACT iv
TABLE OF CONTENT v
LIST OF TABLES viii
LIST OF FIGURES x
ABBREVIATIONS xi
CHAPTER ONE 1
INTRODUCTION 1
1.1 Background 1
1.2 Problem Statement 5
1.3 Main Objective 6
1.4 Specific Objectives: 6
1.5 Justification 6
CHAPTER TWO 8
LITERATURE REVIEW 8
2.1 Conceptual Framework of the Study 8
2.2 Overweight and Obesity 9
2.3 Obesity Prevalence 11
2.4 Measuring Obesity 14
2.4.1 Body Mass Index 14
2.4.2 Waist Circumference and Waist-To-Hip Ratio (WHR) 14
2.5. Co-Morbidities of Overweight/Obesity 15
2.5.1 Hypertension and its Association with Obesity 16
2.5.2 Diabetes and its Association with Obesity 17
2.5.3 Oxidative Stress 18
2.5.3.1 Glutathione (GSH) and Oxidative Stress 20

2.6 Contributory Factors to Overweight/Obesity 21
2.6.1 Dietary and Nutrient Intake Estimation 21
2.6.2 Knowledge and Perceptions on Body Image 22
CHAPTER THREE 25
MATERIALS AND METHODS 25
3.1 Study Location 25
3.1.1 Population 25
3.1.2 Ethnicity, Social and Cultural Structure 25
3.1.3 Economy 26
3.2 Study Design 26
3.3 Participants 27
3.4 Sample Size and Sampling 27
3.4.1 Sample Size Calculation 27
3.4.2 Selection of Communities 28
3.4.3 Sampling of Subjects 31
3.5 Inclusion Criteria 31
3.6 Exclusion Criteria 31
3.7 Data Collection Tools 32
3.8 Data Collection Procedures 32
3.8.1 Anthropometry 32
3.8.2 Physiological Measurements 33
3.8.3 Dietary Record 35
3.8.4 Body Image Assessment 35
3.8.5 Pre-Testing of Questionnaire 35
3.9 Statistical Analysis 35
3.10 Ethical Approval 36
CHAPTER FOUR 37
RESULTS 37
4.1 Personal Data of Respondents 37
4.2 Nutritional Status Of Respondents by Sex, Age and Location 40
4.3 Knowledge on Causes and Adverse Health Effects of Obesity 42

4.4 Respondent's Nutrients Intakes 48
4.5 Oxidative Stress 51
4.6 Obesity Co-Morbidities 52
4.7 Energy and Nutrient Intake by Nutritional Status 56
4.8 Predictors of Obesity 58
CHAPTER FIVE 61
DISCUSSION 61
5.1 Discussion 61
5. 2 Limitations of the Study 68
CHAPTER SIX 69
6.1 Conclusions 69
6.2 Recommendations 70
REFERENCES 71
APPENDICES 1 -CONSENT FORM 83
APPENDICES 2- STUDY QUESTIONNAIRE 85
STUNKARD'S FIGURE RATING SCALE 91
APPENDICES 3 – MEAN NUTRIENTS INTAKE AND THEIR RDAs 92

LIST OF TABLES

Table 2.1 BMI classification by WHO. 14

Table 2.2 Waist circumference cut-off by WHO 15

Table 3.1 Selected communities and their proportional samples 30

Table 4. 1 Demographic Characteristics of Respondents 38

Table 4. 2 Mean BMI, SBP, DBP WC and WHR by Rural/Urban, Age and Sex 40

Table 4. 3 Nutritional Status of respondents by Body Mass Index (BMI) 41

Table 4. 4 Nutritional Status of respondents by WC and WHR 42

Table 4. 5 Respondents with High Blood Pressure and their Awareness Level of having High BP. 45

Table 4. 6 Perception of Respondents about their Body Image by Nutritional Status. 46

Table 4.7 Respondents' desire to lose weight 47

Table 4.8 Respondents body image perception and desire to lose weight. 48

Table 4. 9 Respondents mean intakes of energy, protein, fat, carbohydrates and fibre 49

Table 4. 10 Micronutrients intakes of respondents 50

Table 4. 11 Glutathione Analysis 51

Table 4.12. Correlation of glutathione with dietary anti-oxidants, energy and fibre intake. 51

Table 4. 13 Prevalence of normal, prehypertension and hypertension by SBP 53

Table 4. 14 Prevalence of normal, prehypertension and hypertension by DBP 53

Table 4.15 Prevalence of SBP according to Nutritional Status of Respondents 54

Table 4.16 Mean Fasting Blood Sugar level by Sex, Age and Location 55

Table 4.17 Prevalence of hyperglycaemia among respondents 56

Table 4.18 Mean intakes of energy, protein, fat, CHO and fibre by nutritional status 57

Table 4.19 Mean Micronutrient intake by Nutritional Status 58

Table 4.20 Odds ratio of some predictor variables for overweight/obesity.................................. 59

Table 4.21 Odds ratio of energy and some nutrients in predicting overweight/obesity 60

LIST OF FIGURES

Figure 2.1 Conceptual Framework of study 9

Figure 4. 1: Respondents Knowledge about the Causes of Obesity 43

Figure 4.2 Respondents knowledge about the effects of obesity.. 44

Figure 4.3 Perception of respondents about their body image.. 45

ABBREVIATIONS

AHA	American Heart Foundation
ANOVA	Analysis of Variance
BMI	Body mass index
BP	Blood pressure
CI	Confidence interval
CVD	Cardiovascular disease
FAO	Food and Agricultural Organization
NCDs	Non-communicable diseases
UNICEF	United Nations Children’s Fund
WC	Waist circumference
WHO	World Health Organization
OR	Odds Ratio
DALYs	Disability-Adjusted Life-Years
DBP	Diastolic Blood Pressure
DNA	Deoxyribonucleic Acid
FBS	Fasting Blood Sugar
FRS	Figure Rating Scale
GDHS	Ghana Demographic and Health Survey
GSH	Reduced Glutathione
GSS	Ghana Statistical Service
GSSH	Oxidized Glutathione
HC	Hip Circumference

HT	Hypertension
IDF	International Diabetes Federation
MUAC	Mid Upper Arm Circumference
NHANES	National Health and Nutrition Examination Survey
NHLBI	National Heart Lung and Blood Institute
NIDDM	Non-Insulin-Dependent Diabetes Mellitus
RAE	Retinol Activity Equivalent
ROS	Reactive Oxygen Species
SBP	Systolic Blood Pressure
SE	Standard Error
T2D	Type 2 Diabetes
WHR	Waist-to-Hip Ratio

CHAPTER ONE

INTRODUCTION

1.1 Background

Globally, the combined overweight and obesity prevalence rose by 27·5% for adults (18 years and above) and 47·1% for children between the years 1980 and 2013 and this translated to the number of overweight and obese persons increasing from 857 million in the year 1980, to about 2·1 billion in year 2013 (Marie *et al*., 2014). In 2014, obesity prevalence of between 4.9% and 16.8% was estimated for Ghana (WHO, 2014a). Another study conducted to determine obesity and body image perceptions among Ghanaian adults living in Accra, revealed 64.9% of the 2119 women sampled were either overweight or obese (Benkeser *et al*., 2012). However, using waist to hip ratio cut-off of 0.8 in that same study participants, an estimated obesity prevalence of 78.9% was recorded. In a study among adults in northern Nigerian population, overweight and obesity were found to be high at 1 in every 2 persons (53.3%) and 2 in every 10 persons (21.0%) respectively, with considerable higher prevalence among females than males (Wahab *et al*., 2011). Clearly, obesity is a major problem globally and in Sub-Sahara Africa, and Ghana is no exception.

Overweight/obesity is now considered a pandemic (Roth *et al*., 2004), with dire consequences. In the year 2010, an estimated 3·4 million deaths and 4% of disability-adjusted life-years (DALYs) across the globe were associated with overweight and obesity (Lim *et al*., 2012). Again, overweight and obesity are known to be major contributors to the burden of chronic disease in the population such as hypertension, back pain, diabetes, osteoarthritis and raised blood cholesterol (Guh et al., 2009; Kelishadi, 2007). These conditions tend to increase with increasing BMI.

It is projected that the prevalence of diabetes across the globe among adults (aged 20–79 years), which in 2010 was 6.4% (285 million adults) will rise to 7.7%, translating to 439 million affected adults by 2030. Again, it is projected that between 2010 and 2030, there will an almost 70% increase in numbers of adults with diabetes in the developing world and about a 20% increase in developed world (Shaw *et al*., 2010). In Ghana, the prevalence of diabetes rose from 0.2% in the late 1950s in a study in the Volta Region to 6.0% in 2009 in a study in Ashanti Region among men. Similarly in Accra, a 6.4% prevalence of diabetes was recorded in the 1990s among adults and 9.1% among civil servants in 2006 (De-Graft *et al.*, 2012) These increases could be attributed to the rising obesity/overweight trends.

Diabetes is not the only Non-Communicable Diseases (NCDs) on the rise due to obesity but hypertension also. Global prevalence of hypertension among the adult population is expected to increase from 26.4% in 2000 to 29.2% by 2025, with associated cardiovascular complications (Kearney *et al*., 2005). Hypertension is a condition of public health importance in urban areas of Ghana and even in the poorest rural communities (Williams *et al*., 2013; Awuah *et al*., 2014). For instance, in a recent survey on hypertension, Ghana had the highest prevalence among 11 countries in sub-Saharan Africa (27% in urban and 19% in rural areas) (Moran *et al*., 2013). The prevalence of hypertension ranged from 19% to 48% between studies (Addo *et al*., 2012a).

Many developing countries are currently experiencing a nutrition transition, characterized by a move to a more energy dense diet, high in fat and sugar yet low in essential nutrients and fruit and vegetables (Amuna & Zotor, 2008), and this is known to be one of the factors for the increases in obesity/overweight. Adoption of these unhealthy diets, which are high in calories from carbohydrates (sugars) and fats, high in salt, yet low in fruits and vegetables, coupled with a reduction in physical activity levels as the world became more urbanized are major contributors to the epidemiology of non-communicable diseases associated with obesity/overweight. The causes of hypertension are well established in literature and include: increasing age, family history of the condition, being of African/Caribbean origin, high intake of salty foods, low physical activity, being overweight or obese, smoking, high intake of alcohol, stress and other underlying conditions (Ott *et al*., 2013). With the inevitable increase in urbanization, psychosocial distress associated with migration to urban areas, dietary and physical activity changes, the prevalence of hypertension and diabetes will probably persist or even worsen (Steffen *et al*., 2006). A review of hypertension in Ghana was conducted through the 2008 Ghana demographic and health survey. Factors that were associated with hypertension included older age group, overweight/obesity and high alcohol consumption. As such, preventing obesity and these associated complications should be priority in Ghana and recommendations to achieve this should include healthy eating, regular physical exercises, maintaining a normal body weight, avoiding the use of tobacco and monitoring blood-sugar levels (WHO, 2014b).

The mechanism by which obesity leads to the development of chronic non-communicable disease has well been established (Gortmaker *et al*., 2011) and oxidative stress is a culprit (Vincent *et al*., 2007). Oxidative stress is a disturbance in the balance between the production of reactive oxygen species (ROS), also called free radicals and antioxidant defenses (Betteridge, 2000). The ROS has some negative influences on many physiological processes in the body including host defense, hormone biosynthesis, fertilization, and cellular signaling. Studies have shown that obese individuals are more oxidatively stressed and have increased risk of developing cardiovascular diseases from atherosclerosis.

One of the first steps to preventing and addressing obesity and its consequences is to make sure overweight/obese people are aware of their status. Whereas there was a trend towards improved awareness, treatment and control, among Ghanaian obese participants, it was reported that less than one-third of hypertensives were aware they had hypertension and less than one-tenth had their blood pressures controlled in most studies carried out in Ghana (Ghana Statistical Service, 2008). This means that many Ghanaians who have overweight/obesity and related NCDs are not aware of their status, and if this is the case, then it should be expected that the current trends are unlikely to change.

It is also reported that body image perception or perception of nutritional status is a predictor for the development of obesity (Nti *et al*., 2013). It is must be noted that an individual's perception about their body weight is not always right. For example, a cross-sectional study to estimate prevalence of obesity in urban and peri-urban districts in Accra, Ghana and also to assess the perceptions of participants about their body weight revealed that 87% of peri–urban participants who considered themselves to have a healthy body weight, 31% ($p<0.001$) were actually overweight/obese while 40.1% of 79.5% of urban respondents who considered their body weight as normal were also overweight/obese ($p<0.001$) (Nti *et al*., 2013). Knowledge on the disease, and perception of obese individuals of their status are therefore critical in its prevention and management (Nti *et al*., 2013) and with correct perception about their weight, overweight and obese women were significantly more likely than their normal counterparts to desire weight loss (OR: 10.12, CI: 8.04 – 12.72) (Benkeser *et al*., 2012). The study aimed at investigating prevalence of obesity and associated co-morbidities, as well as relationship between obesity, oxidative stress and body image perception among adults in the Wa Municipality of Ghana.

1.2 Problem Statement

Globally, about 39% of adults (40% of women and 38% of men) were overweight and 13% (15% of women and 11% of men) were obese in 2014 (WHO, 2014b). The story is not different in Ghana as 10.9% of Ghanaians in 2014 were obese (WHO, 2014a). Studies have concluded that trends in obesity prevalence have been increasing over the years and that has resulted in the prevailing prevalence. This increasing prevalence of overweight and obesity has been described as a pandemic (Roth *et al*., 2004) and comes with other health conditions with dire consequences. It is established that obesity lead to the development of chronic non-communicable diseases (Gortmaker *et al*., 2011) such as coronary heart disease, hypertension, ischemic stroke and type 2 diabetes mellitus and the effects are huge on society. For instance in 2010, overweight and obesity were associated with 3·4 million deaths, 4% of years of life lost, and another 4% of disability-adjusted life-years (DALYs) worldwide (Lim *et al*., 2012). In the estimation of the World Health Organization (2013), developing countries (particularly low- and middle-income nations) carry about 86% of the total burden of these premature deaths, resulting in huge economic losses close to US$7 trillion over the next 15 years and this has trapped many people in poverty.

Concerns about the health risk and/or burden associated with this high and rising prevalence of obesity has therefore become nearly universal, with WHO member states (Ghana inclusive) agreeing in 2013 to put in measures to stop the rise in obesity by the year 2025, including attempts to regularly monitor changes in its prevalence across all populations (WHO, 2013). To do this, the awareness level of the population about obesity, its co-morbidities and the dire consequences, as well as having the right body image perception about oneself are critical. Although research is advancing on overweight/obesity in Ghana, much of the work has focused on prevalence and in recent times on body image perceptions but very little of that has been carried out in the study area. More attention therefore needs to be given to understanding the relationship between awareness and perception of body image in obesity on one hand, and the consequences of overweight on the other.

1.3 Main Objective

The main objective of this study was to determine the prevalence of obesity, oxidative stress and perception of body image and how these are interrelated among adults in the Wa Municipality, Ghana.

1.4 Specific Objectives:

1. To determine obesity prevalence and its relationship with co-morbidities such as hypertension and hyperglycaemia.
2. To determine the level of oxidative stress and its relationship with overweight/obesity.
3. To assess the body image perceptions of respondents and how that relate to overweight/obesity.
4. To assess nutrient intake and how it relates to overweight and obesity status.
5. To determine other predictors of obesity and its co-morbidities.

1.5 Justification

Information from this research hopes to establish specifically the prevalence of obesity and it co-morbidities in Wa Municipality and highlight the gravity of the obesity problem. Such findings will serve as advocacy tool to bring actors in health service delivery together in bringing the situation under control.

Again, providing data on oxidative stress, perception of body image among respondents and how these are implicated in the development of obesity and its co-morbidities will inform policy direction in the fight against the menace of obesity and its related co-morbidities.

CHAPTER TWO

LITERATURE REVIEW

2.1 Conceptual Framework of the Study

Figure 2.1 is the conceptual framework of this study. It is divided into two broad areas. First part is about factors that contribute to the development of overweight/obesity and/or can influence an individual's willingness to lose weight. Second part is about the consequences or co-morbidities of obesity. In the first instance, the knowledge of an individual about the negative effects of obesity can influences their dietary intake/habits and body image perception. Dietary intake on the other hand can result in positive energy balance which is known to cause weight gain culminating into overweight/obesity. The perception of individuals about their body image does not only affect overweight/obesity but is also critical in their readiness and willingness to embrace healthy bodyweight interventions. In the other instance, overweight and obesity come with some co-morbidities some of which are hypertension and hyperglycaemia. It is believed from other studies that oxidative stress in obesity is what leads to the development of these co-morbidities. This study will assess the prevalence of overweight/obesity in the study area, the prevalence of the co-morbidities (hypertension and hyperglycaemia), knowledge and perceptions of respondents about their body image, dietary intake, oxidative stress using glutathione as a biomarker and the interrelationship that exist between these factors.

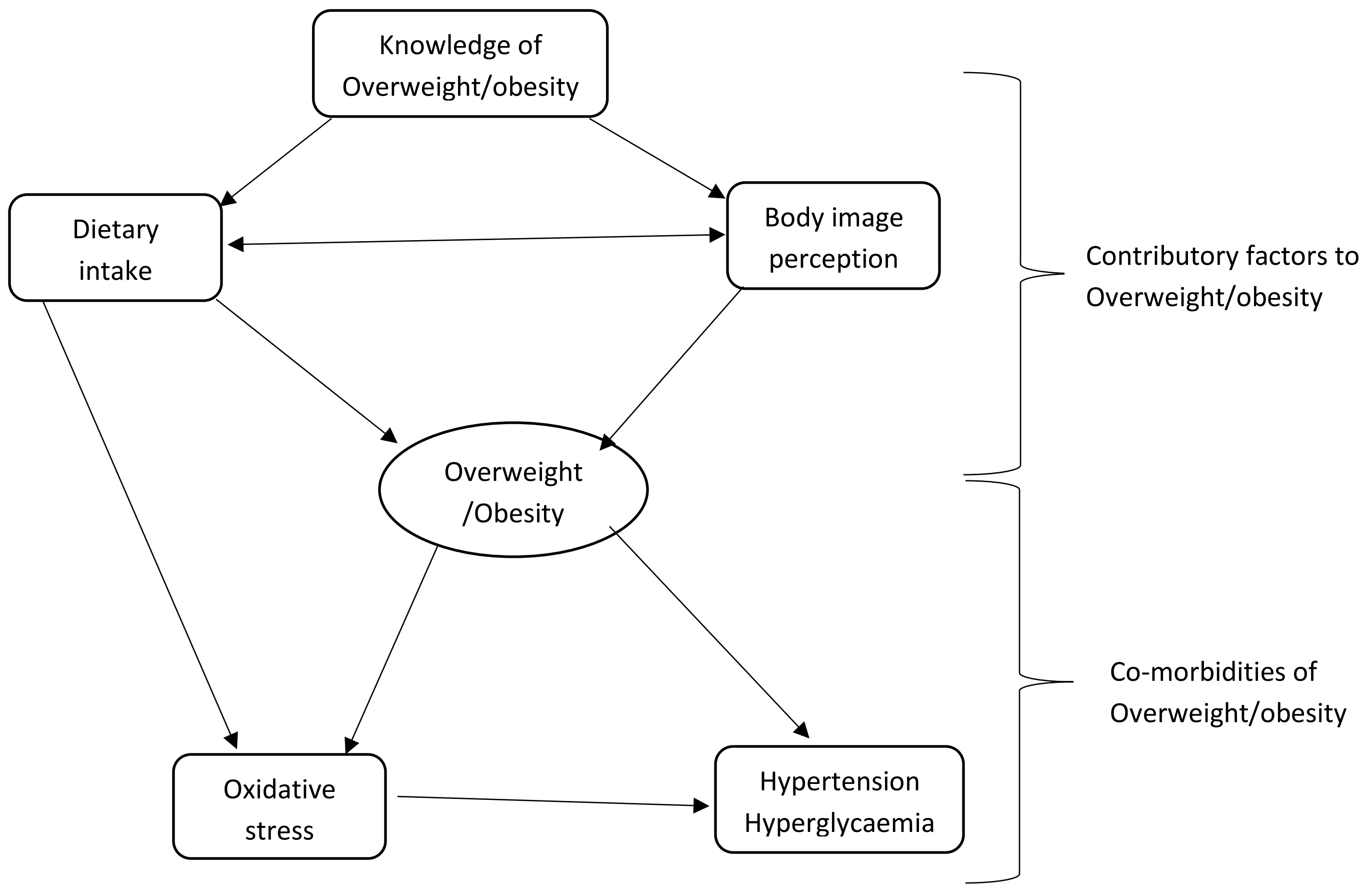

Figure 2.1 Conceptual Framework of Study

2.2 Overweight and Obesity

Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health (WHO, 2011). Body mass index (BMI); which is the weight in kilograms of an individual divided by the square of his/her height in meters: is the commonly used index to classify overweight and obesity in adults. By this index, overweight is classified as a BMI equal to or more than 25 but less than 30, and obesity as a BMI equal to or more than 30 (WHO, 2011). Overweight and obesity have become conditions of public health concerns due to the many health consequences that come with them. This has resulted in many studies into the causes, consequences, co-morbidities, best way to measure obesity, mechanism for the development of co-morbidities, body image perception and the implication of that to obesity development and management, among others.

Generally, there are many theories and hypotheses seeking to explain the cause of obesity in humans. This is in recognition of the complex and multifaceted nature of its causes. These theories are broadly divided into two categories. Genetic causes and environmental causes (Van *et al*., 2012). The genetic causes, also known as endocrinology hypothesis suggest biological underpinnings of lipogenesis. Believers of this hypothesis see obesity as an inherited biological condition that can take place even in malnutrition (Newburgh & Johnston, 1930). On the other hand, the proponents of the environmental cause to obesity (also known as the energy balance hypothesis) believe obesity is caused by environmental factors that result in positive energy balance in an individual (Newburgh & Johnston, 1930). Many specialists and researchers in the field of obesity agree to the latter being the reason for the rapid increase in the prevalence of overweight and obesity over the past few decades, as our modern day lifestyle is characterized by an excessive caloric intake, coupled with sedentary lifestyle, resulting in positive energy balance (WHO, 2000). Appreciating these two concepts is not only good for understand the cause of obesity but critical in managing its adverse health effects.

Obesity is also broadly divided into two groups depending on the area of the fat deposition. First among them is peripheral obesity which involves the deposition of fat in the hips, thighs and buttocks (Aras *et al*., 2015). This type is known to have lesser risk compared with the other. Next is central obesity, define as the accumulation of excess fat in the abdominal region. It also called abdominal obesity and this is established to be the most dangerous form of obesity as the fat accumulation is located closer to vital organs of the body such as heart, liver and their blood supply (Aras *et al*., 2015). It is established that BMI is best suited for measuring generalized obesity without any indication of the exact location of fat. Due to this, waist circumference and/or waist-to-hip ratio (WHR) are the preferred choice of many in measuring central obesity as they are deemed to be better measures of risk of disease in obesity than BMI (Lapidus *et al*., 1984).

2.3 Obesity Prevalence

Since the year 1975, obesity prevalence has been rising in every country in the world, without exceptions. This translates into the average adult today being three times more at risk of obesity compared to the year 1975 (Lancet, 2016). This rising trend, vary from country to country. At the low end, North Korea's obesity rates are up about 1% (from 1.6% in 1975 to 2.8% today) whilst island countries such as Samoa and Tonga saw their prevalence increase by more than 20% (Lancet, 2016). In 2014, close to 40% of adults above 18 years were overweight and 13% were obese translating into more than 1.9 billion adults being overweight and 600 million obese worldwide (WHO, 2016b). It is, therefore, not surprising that obesity prevalence have been described as a pandemic with public health consequences.

In Africa, similar rising trends of obesity are observed despite the continent battling with undernutrition. A study by Non-Communicable Diseases Risk Factor Collaboration team revealed that from 1980 to 2014, the age-standardized mean BMI in Africa increased from 21.0 kg/m^2 for men and 21.9 kg/m^2 for women to 23.0 kg/m^2 and 24.9 kg/m^2, respectively (NCD-RisC, 2017). And just like the mean BMI, prevalence have been rising in similar fashion. In Ghana, same trend of overweight and obesity prevails. In a review by Ofori-Asenso *et al*. (2016), 4 in 10 of Ghanaian adults were either overweight or obese with the national prevalence of overweight and obesity estimated as 25.4% (95% CI 22.2–28.7%) and 17.1% (95% CI = 14.7–19.5%), respectively. Prevalence of overweight (27.8% vs 21.8%) and obesity (21.9% vs 6.0%)

were also significantly higher in women than in men. A trend of higher prevalence of overweight and obesity across different studies are seen in the most recent years (2007 to 2016) compared to earlier years (1998 -2006) indicating a rising trend of obesity in Ghana (Ofori-Asenso *et al*., 2016). These trends tend to vary across regions in the country with the higher prevalence recorded in the more urbanized regions with higher income compared to the less urbanized regions with lesser income levels. For instance in 2014, Greater Accra region recorded the highest obesity rates of 28.5%, followed by Ashanti Region (16.7%) and Eastern Region (16.5%) compared with the lowest of 3.7% in Northern Region among women aged 15-49 years. Overweight trends were quite similar with Greater Accra Region recording rates of 28.8%, followed closely by Ashanti Region (28.7%), Brong Ahafo Region (28.3%) and Northen Region the least with 8.7%. The Upper West Region rates in the same survey was 15.6% for overweight and 5.1% for obesity (GDHS, 2014). The World Health Organization estimated for Ghana, a crude obesity prevalence of 10.9% in 2014 with females rates of 16.8% more than triple that for males (4.9%) (WHO, 2014a). Considering a prevalence of obesity of 16.1% in Greater Accra and virtually no obesity in the Upper East or Upper West regions in 2005 (Biritwum *et al*., 2005), the prevalence of obesity in Ghana is rising at a worrying rate.

Other dynamics of obesity worth mentioning includes the rural/urban prevalence, gender and age. Studies have agreed almost unanimously to a higher urban prevalence compared with rural, higher rates in females relative to men and an increasing trend of obesity with age, peaking before age 70 years. A study in Mozambique saw 39.4% of women in urban areas being overweight/obese compare to 9.2% in rural areas. This pattern did not change in men as 21.5% in urban were overweight/obese compared to 7.0% in rural settings (Gomes *et al*., 2010). Similar findings were produced in a study in India among school children and urban children were more overweight/obese relative to their rural colleagues (Bhargava *et al.*, 2016). Same pattern is established in Ghana in many studies. The Ghana Demographic and Health Survey recorded urban prevalence of obesity in women (20.7%) more than double that of rural dwellers (8.7%) (GDHS, 2014). A systematic review revealed a higher prevalence of overweight (27.2% vs 16.7%) and obesity (20.6% vs 8.0%) for urban than rural dwellers respectively (Ofori-Asenso *et al.*, 2016). Another research by Amoah (2003), conducted in rural and urban Accra showed the overall crude prevalence of overweight and obesity as 23.4 and 14.1%, respectively, among adults aged 25 years and above, and this increased with age up to 64 years. Other studies available are almost universal in revealing a higher prevalence of overweight/obesity in urban dwellers than their rural colleagues. Studies have attributed this difference to rural settings being primarily agrarian and made up of physically active individuals, hence are usually less vulnerable to overweight/obesity (Bhargava *et al*., 2016).

In terms of gender, findings are almost unanimous in Africa in revealing women being affected with obesity more than their male counterparts. Biritwum *et al*. (2005), in a study among adults in Ghana, found the prevalence of obesity to be more than 2 times higher among females (7.4%) compared to males (2.8%). In another study among adults 18 years and above across 53 African countries in 2014, the age-standardized mean BMI of 23.0 kg/m^2 (22.7–23.3) was recorded for men relative to 24.9 kg/m^2 (24.6–25.1) for women (NCD-RisC, 2017). These gender disparities in obesity rates are attributable to a dramatic reduction in physical activity patterns in developing countries over the years coupled with nutrition transition that resulted in an increased consumption of energy-dense foods high in refined carbohydrates and women appear more vulnerable to these effects than men (Kanter & Caballero, 2012).

2.4 Measuring Obesity

2.4.1 Body Mass Index

Body Mass Index (BMI), an index of weight-for-height defined as a person's weight (in kg) divided by the square of his/her height in meters (m2) is commonly used to measure generalized obesity (WHO, 2016b). It classifies underweight, normal weight, overweight and obesity using the cutoffs provided in Table 2.1.

Table 2.1 BMI classification by the World Health Organization

Classification	BMI ($kg/m^{2)}$
Underweight	<18.5
Normal weight	18.5 – 24.9
Overweight;	25.0-29.9
Obese	>30

(WHO, 2017)

2.4.2 Waist Circumference and Waist-To-Hip Ratio (WHR)

Alternative measures that reflect abdominal adiposity (also referred to as abdominal fat mass, central or visceral obesity), such as waist circumference (WC) and waist–hip ratio (WHR), have been suggested as being superior in predicting cardiovascular disease risk in obesity than BMI (WHO, 2008) although combining BMI with abdominal obesity measures may improve their discriminatory capability (Huxley *et al*., 2010). This is based largely on the rationale that increased visceral adipose tissue is associated with a range of metabolic abnormalities, known to be risk factors for type 2 diabetes and CVD (WHO, 2008).

International Diabetes Federation (IDF) recommendation for measuring abdominal obesity among people of European origin using waist circumference should be ≥94 cm and ≥80 cm for men and women, respectively. The American Heart Association (AHA) and the National Heart Lung and Blood Institute (NHLBI) in contrast, recommended cut points of ≥102 and ≥88 cm, respectively for males and females (Alberti *et al*., 2009). Table 2.2 shows the recommendations by The World Health Organization (WHO).

Table 2.2 Waist circumference cut-off by World Health Organization

Indicator	**Cut-off points**	**Risk of metabolic complications**
WC (Waist circumference)	>94 cm (M); >80 cm (W)	Increased
WC (Waist circumference)	>102 cm (M); >88 cm (W)	Substantially increased
WHR (Waist–hip ratio)	≥0.90 cm (M); ≥0.85 cm (W)	Substantially increased

(WHO, 2008)

In view of the above recommendations, abdominal obesity is defined by The World Health Organization (WHO) as waist–hip ratio (WHR) above 0.90 and 0.85 for males and females respectively (WHO, 2008).

Recent reports by the World Health Organization states the need to develop sex-specific waist circumference (and by extension, waist-to-hip ratio) thresholds appropriate for different populations (WHO, 2008) but not much conclusive data pertaining to Ghana/Africa could be obtained.

2.5. Co-Morbidities of Overweight/Obesity

Overweight/obesity has gained a lot of attention in recent years because of dire health consequences that come with it. They are a threat to the health of populations in almost all countries. They are now so common that they have become the center of attention in health service delivery than the traditional undernutrition and infectious diseases (WHO, 2000). The link between obesity, ill-health and mortality is well researched and established and obesity is associated with increased likelihood of so many health conditions (WHO, 2014b). Indeed obesity is associated with the development of at least 18 co-morbidities and these together are the cause of several millions of deaths and other unacceptable health outcomes around the world (Marie *et al*., 2014; Djalalinia *et al*., 2015). Examples of these co-morbidities or their effects include Type 2 diabetes, some cancers (cancers of breast, endometrial, prostate, ovarian, colorectal, esophageal, kidney, pancreatic), hypertension, stroke, Coronary Artery Disease, Congestive Heart Failure, asthma, chronic back pain, osteoarthritis, pulmonary embolism, gallbladder disease, Years of Life Lost (YLL) and an increased risk of disability (Muennig *et al*., 2006; Ogden *et al*., 2007; Kelishada, 2007; Guh *et al*., 2009). Beyond the physical health consequences of obesity, obese individuals also suffer from stigmatization and unsatisfactory relationships (Kinzl *et al*., 2001). Obesity, therefore, presents a huge burden on the affected as well as the health service system across nations (Djalalinia *et al*., 2015)

2.5.1 Hypertension and its Association with Obesity

Hypertension (also called high blood pressure) is a condition in which the pressure in blood vessels is persistently raised beyond the acceptable limits and thus, put them under increased stress. In terms of measurement, individuals with systolic blood pressure (SBP) ≥ 140 mmHg and/or a diastolic blood pressure (DBP) ≥ 90 mm Hg is classified as hypertensive (WHO, 2016a). Like obesity, prevalence of hypertension has increased significantly over the years. In 2008, for instance, approximately 40% of adults aged above 25 were diagnosed with the condition globally, with the number of people suffering from it rising from 600 million in the year 1980 to 1 billion by 2008. Complications as a result account for not less than 9.4 million deaths yearly (WHO, 2010). This clearly indicates a high and rising prevalence of hypertension with huge health consequences.

Obesity is generally known to contribute to development of hypertension. Thus, a significant proportion of hypertensives in the population are overweight and obese relative to those who are normal weight. Obese hypertensive persons are at greater risk of coronary heart disease and mortality than those with obesity alone or hypertension alone (Chiang *et al.*, 1969). It is estimated that at least 7 out of 10 incidence of hypertension is directly attributable to obesity (AHA, 2005). A research conducted by National Health and Nutrition Examination Survey (NHANES) indicated that the prevalence of hypertension among obese individuals, defined by BMI $\geq$30 kg/m^2, was almost three times (42.5% vs 15.3%) compared with those who were normal (Wang & Wang, 2004). This established association is the reason why obesity and hypertension prevalence have risen concurrently in the last few decades.

2.5.2 Diabetes and its Association with Obesity

Diabetes is a chronic disease and occurs when the pancreas (the production center of insulin) does not produce enough insulin - the hormone that regulates blood glucose levels- or when the body fails in effectively using the insulin it produces resulting in raised blood glucoses levels called hyperglycaemia (WHO, 2010). Defined by fasting plasma glucose $\geq$7.0 mmol/L, the global age-standardized diabetes prevalence increased from 4.3% (2.4-17.0) for Men and 5.0% (2.9-7.9) for women in 1980 to 9.0% (7.2-11.1) and 7.9% (6.4-9.7) in 2014 respectively. This translates to the number of adults with diabetes in the world increasing by four folds from 108 million in 1980 (Zhou *et al*., 2016). In Ghana, the prevalence of diabetes was 3.95% (95% CI: 3.35–4.55) with significant difference in urban (6.19%) compared with rural (2.33%) areas. High prevalence was seen among overweight (4.48%) and obese (9.10%) than underweight (3.11%) and normal (1.52%) in a research by Gatimu *et al*. (2016). In another study by Agyemang *et al*. (2016), Type 2 Diabetes was low at 3.6 % and 5.5 % in rural Ghanaian men and women, respectively, and increased to 10.3 % (PR: 3.06; 1.73–5.40) and 9.2 % (PR: 1.81, 1.25–2.64), respectively for their unban colleagues.

In associating diabetes and obesity, evidence for a genetic basis for type 2 diabetes, the most prevalent type of diabetes, has been derived from various studies (Hitman & Sudagani, 2004). Despite this, environmental factors such as high calorie intake and inadequate physical activity level, translating into obesity playing a major role in the disease development have equally been substantiated (Field *et al*., 2004). This is substantiated by a strong and independent association established between obesity and the development of type 2 diabetes in a study in Augsburg, Germany (Meisinger *et al*., 2010). A study by Field *et al*. (2001), reported that persons with BMI of 35.0 were 20 times more at risk of developing diabetes than those with a normal BMI (18.5-24.9 kg/m^2). In an investigation from the Nurses' Health Study, BMI above 25kg/m^2 emerged as the most important predictor of type 2 diabetes among women 30–55years old (Hu *et al*., 2009). In terms of gender, the incidence of diabetes was found to be higher in men than in women for various anthropometric measures such as WC, WHR, and BMI, though the incidence increased with increasing BMI, WC, and WHR for both men and women (Meisinger *et al*., 2010). Findings were, however inconsistent and remains controversial as to which anthropometric measures of BMI, WHR and WC should be used for risk assessment of diabetes (Molarius *et al.,* 1999; Sargeant *et al*.,, 2002). This clearly explains the concomitant rising trend of both obesity and diabetes in recent years.

2.5.3 Oxidative Stress

Oxidative stress is an imbalance between the production of reactive oxygen species (ROS), also called free radicals and antioxidants resulting in positive ROS balance (Betteridge, 2000).

These Reactive Oxygen Species (ROS) are molecules that contain oxygen with an unpaired electrons or not, but are highly reactive in tissues and are capable of binding with other nearby molecules (Vincent & Taylor, 2006). This binding has negative influences on many physiological processes including host defense system, hormone biosynthesis, fertilization, and cellular signaling (Paravicini & Touyz, 2008)**.** To reduce these negative effects, the body uses antioxidants to mop up these reactive oxygen species and thus prevent them from binding to any nearby molecules. A condition where there is increased ROS production beyond the mopping capacity of the bodies available oxidants is termed "oxidative stress", and this has been implicated in various pathologies, including hypertension, atherosclerosis, diabetes, and chronic kidney disease (Paravicini & Touyz, 2008)**.**

Measuring free radicals/ROS levels in an attempt at estimating oxidative stress include the use of electron resonance or spin trapping that capture free radical reactions in real time but these methods are difficult and costly (Halliwell & Whiteman, 2004). Due to this, many studies have resorted to the use of biomarkers or end-products of free radical mediated oxidative processes in estimating oxidative stress (Vincent & Taylor, 2006). Examples are protein carbonyls, thiobarbituric reactive acid substances (TBARS), malondialdehyde (MDA), F2-isoprostanes, 8-isoprostanes and lipid hydroperoxides (PEROX) (Vincent & Taylor, 2006). Others used antioxidants such as glutathione.

Over the years evidence of obesity and how it induces oxidative stress in humans has been accumulating. A study by Van Gaal *et al*. (1998), that measured the oxidizability of low-density lipoproteins (LDL) and very low-density lipoproteins (VLDL) among different weight groups, found higher basal levels of MDA in lipoprotein samples in obese than in the non-obese individuals (3.13 vs 1.89 mmol/l). Many other studies have found evidence suggesting higher levels of oxidative stress in obesity compared to the non-obese persons (Skrha *et al*., 1999; Ozata *et al*., 2002; Dandona *et al*., 2013).

2.5.3.1 Glutathione (GSH) and Oxidative Stress

Glutathione is a simple tripeptide made up of glutamic acid, cysteine, and glycine and it is seen as the most important non-enzymatic antioxidant in the body. It is usually synthesized in the cytosol by two enzymes in the body: c-glutamyl cysteine ligase and glutathione synthase (Griffith & Meister, 1985; Marí *et al*., 2009). As an antioxidant, it prevents damage to important cellular components caused by free radicals in situations of oxidative stress (Pompella *et al*., 2003). Glutathione exists mainly in two forms: reduced state (GSH) and oxidized state (GSSG). When it is reduced, it is capable of neutralizing the damaging effects of reactive oxygen species (ROS) and this is what makes it an anti-oxidant. After donating an electron to neutralize ROS, glutathione itself becomes reactive and thus, readily reacts with another glutathione in same state to form glutathione disulfide (GSSG) (Kaplowitz, 1981). It is known to be in high concentration in body cells and plays a central role in maintaining the cell's redox state (Meister & Anderson, 1983). Even though reduced glutathione (GSH) may not be seen as a good biomarker of oxidative stress across tissue, many studies have identified reduced glutathione (GSH) level to be associated with several pathological conditions (Atkuri *et al*., 2007).

Thus, any condition associated with excessive or high levels of ROS will eventually decrease GSH levels or decrease the GSH/GSSG ratio (Frijhoff *et al*., 2015). Low levels of reduced glutathione could, therefore, be an indication of high levels of ROS and possible oxidative stress in the body.

Dietary antioxidants are also known to neutralize the effect of reactive oxygen species similar to what glutathione does in the body. In attempting to determine the association of dietary antioxidant, ascorbate (vitamin C) and glutathione, there was a strong positive correlation between glutathione and vitamin C intake ($r = 0.62$, $p < 0.001$). This findings established vitamin C and glutathione to have mutual sparing effect on each other (Lenton *et al*., 2000). In another study with hypertensive subjects, vitamin E administration significantly increased GSH/GSSG ratio from 1.10±0.07 to 1.65±0.11; ($p<0.01$) (Barbagallo *et al*., 1999). This is an indication of some association of glutathione and dietary antioxidants.

2.6 Contributory Factors to Overweight/Obesity

2.6.1 Dietary and Nutrient Intake Estimation

In assessing an individual's food intake, the methods used are usually two: the retrospective reporting of food intakes and the prospective recording of foods consumed. Diet History, Food Frequency and 24-Hour Recall make up the retrospective approach to dietary assessment while diet records and chemical analysis of duplicates make up the current intakes (FAO, 2002). The 24-Hour Recall has been used extensively in many research works due to some of the advantages that come with it. One of such notable advantages of it is the ease and speed of its administration as there is less burden on the respondent. Another critical advantage of this method is that illiteracy of the respondent is not a barrier. The interviewer simply administers and fills the questionnaire for the respondent by posing questions and eliciting responses. Thus, it can be used across population with ease. It does not alter the eating pattern or behavior of respondents because food are usually eaten before recall period (Thompson and Byers, 1994).

The main limitations, however, is that several recalls are needed to be able to establish the habitual eating of respondents. A single recall is inappropriate for estimating the usual/habitual eating pattern of respondents (Thompson and Byers, 1994). It is also observed that respondents with lower usual food intakes mostly over-report and vice versa (Madden *et al*., 1976).

In a research in Ghana by Nti *et al*. (2013), fruits and vegetables consumption was seasonal with most respondents (72-81%) recording occasional intake. Recommended intakes of other nutrients especially, micronutrients were not being met. However, meeting energy requirements was easy, as most Ghanaian foods consumed were carbohydrate based with 8 in 10 in women having adequate intakes of energy with the contribution of carbohydrates.

2.6.2 Knowledge and Perceptions on Body Image

Body image is an individual's view (mostly subjective) of their appearance and satisfaction with their body size. Many factors such as self-esteem, sense of belonging in social groups, job satisfaction/opportunities, productivity, economic growth among others influence this perception (Cash, 1993; Van Den Berg *et al*., 2002: Mintem *et al*., 2015). In the wake of increasing prevalence of obesity, studies have shown that body image perception of an individual is an important factor in weight control (Gualdi-Russo *et al*., 2012). Despite this, not many overweight and obese people see themselves as such. In a study of urban women in Accra, Ghana, 61.0% of women who were satisfied with their Current Body Image (CBI) were actually overweight or obese (Benkeser *et al*., 2012). In another study conducted in the Accra Metropolis and Upper Manya Krobo (Eastern Region), all peri-urban participants who considered they had a healthy body weight, 31% were overweight/obese ($p<0.001$), while 40.1% of urban respondents who considered their body weight as normal were overweight/obese ($p<0.001$)(Nti *et al*., 2013). In

Accra, a research involving 1164 non-pregnant women who considered themselves not to be obese saw 383 (representing 32.9%) being actually obese (Duda *et al*., 2007). It has emerged that in some cultures in Africa, bigger body size especially among women attracts positive appraisals. For instance, in two separate studies among African women, one of the major barriers relating to obesity management and prevention was the cultural differences in the perception of body image and some preference for nutritional status corresponding to bigger body sizes. These studies revealed that African women usually view these body sizes as a sign of adequate income levels, good living, attractiveness, marital harmony and a sign of food security (Mvo *et al*., 1999; Venter *et al*., 2009). Clearly, such women will hardly see anything wrong with their weight even if they are overweight or obese.

Beyond body image perception, knowledge about obesity and its adverse effects is critical in the management and control of it as well. This is in synch with the Health Belief Model (HBM) which says that an individual's perceived susceptibility to disease condition is a critical predictor of health behavior change. Studies have, however, revealed that not every person is aware of the negative health effects of obesity.

For instance, a research in the USA involving adult Blacks and Hispanics, revealed respondents were quite knowledgeable about the risk and association of obesity with diabetes (96%), hypertension (94%), joint pains/arthritis (89%), sleep apnea (89%) and high cholesterol (91%). Further findings from the same research revealed 1 in every 2 post-menopausal women were aware of the high risk of breast cancer in obesity among women (Winston *et al*., 2014). In a study in Malaysia on patients' aged 20-59 years, knowledge about obesity was low. Sixty-three (15%) did not see obesity to be bad for their health, 88 (21%) failed to mention either diet or lack of exercise as the cause of obesity. Thirty-two (8%) rather associated "being happy" as a cause of obesity (Jackson *et al*., 1996). Further findings from that study revealed participants did not think foods high in fat (11% participants) and high in sugar (40% participants) were risk factors to the development of obesity (Jackson *et al*., 1996). In another study by Muhammad *et al*. (2013), about 93.3% of respondents revealed they heard about obesity and 6.7% did not hear about it. The consequences according to respondents in that study were sleep apnea, high cholesterol, shortness of breath, daytime sleepiness and pain in joints. These respondents could associate the causes of it to fatty food choices, sedentary lifestyle, eating habits, physical inactivity. It is, therefore, clear that knowledge and awareness about obesity vary from place-to-place, time-to-time and this knowledge is critical in obesity management and prevention.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Location

The study was conducted in the Wa Municipality in the Upper West Region, found in the northern part of Ghana. The municipality is one of the eleven (11) municipalities/districts in the region and is located in the southern part of the region. Wa Municipality has its capital as Wa, which also serves as the regional capital of the Upper West Region. It has a land area of approximately 579.86 square kilometres, which is about 6.4% of the Region. It shares administrative boundaries with Nadowli/Kaleo District to the north, Wa East District to the east and to the west and south is Wa- West District (Wa Municipal Assembly, 2015).

3.1.1 Population

The Ghana 2010 Population and Housing Census put the population of the municipality at 107,214 across its 128 communities. Projections made from this census give a 2016 population of 120,031 (Ghana Statistical Service, 2013).

3.1.2 Ethnicity, Social and Cultural Structure

The 2010 Population and Housing Census reported that 80.4% of the people living in the Wa Municipality are from the Mole-Dagbani group with the Waalas as the indigenous people. Dagaabas and the Sissalas are the other two major ethnic groups. Due to inter-marriages and the long stay together over the years, language barriers especially among the Dagaabas and Waalas have been reduced to linguistic and semantic variations. Peaceful co-existence is further enhanced by commerce and education (Wa Municipal Assembly, 2015). However, the Waalas are predominantly Muslins while the Dagaabas are predominantly Christians. Other ethnic groups found in the Municipality include the Frafra, Akan, Ewe, Ga, Dagombas, Grushi, Gonja and Moshies who are there mainly for secular work and commercial activities (Ghana Statistical Service, 2013; Wa Municipal Assembly, 2015).

3.1.3 Economy

The economic structure of the Municipality, in years past, was mainly the agricultural sector (Municipal Assembly, 2015). However, the situation changed in the year 2010 when the Population and Housing Census was undertaken, with the service sector employing about 51.3 percent of the working population, while agriculture reduced to 30.2 percent and industry 18.4 percent (Ghana Statistical Service, 2013). Other key sectors of the economy are transport, tourism, communication and energy (Wa Municipal Assembly, 2015). Under the agriculture sector, most of the farmers are engaged in peasant farming and the main crops grown include millet, sorghum, maize, rice, cowpea and groundnut cultivated on subsistence basis. However, soya beans, groundnuts, bambara beans are produced as cash crops. Economic trees within the municipality include sheanuts, dawadawa, mango, baobab, and teak among others (Wa Municipal Assembly, 2015).

The peasant farmers depend on rainfall for their farming activities. However, the municipality lies in the savannah zone with one of the shortest raining seasons (May to October each year). This negatively affects their farming activities and subsequently food and nutrition security as farmers cannot farm for a greater part of the year (Wa Municipal Assembly, 2015).

3.2 Study Design

A quantitative cross-sectional survey design was employed in carrying out this research. This was the best method as the study was a prevalence study. In this study design, data was collected at a single point in time for the study to examine various associations between disease conditions and other variables of interest.

This provides a point prevalence of disease and health related characteristics in the study population at that given point in time. This method is suitable in assessing the burden of disease and/or health needs of a population. This is particularly useful in planning and allocating scare resources for maximum health outcomes. This design comes with some strengths as well as some weaknesses. It can estimate the prevalence of all variables of interest and multiple outcomes and exposures can be studied concurrently (Goldberg *et al.*, 2013). This study design, however, is susceptible to a number biases, including information, response, and selection bias, (Goldberg *et al.*, 2013).

3.3 Participants

The participants were free-living adult males and females age 18 years and above recruited from urban and rural areas of Wa Municipality who had consented to participate in the study.

3.4 Sample Size and Sampling

3.4.1 Sample Size Calculation

The sample size used to be representative of the Municipality was 329. The following parameters were used to compute the sample size:

- Margin of error (e) = 5%
- Population prevalence (p) = 10.9% Estimated prevalence for Ghana by WHO
- Z score or reliability coefficient $Z_{\propto/2}$ = 1.96
- Design effect = 2

The formula used for the sample size calculation is:

n = $\{\frac{z^2_{\alpha/2}}{e^2}\ p(1-p)\}$

Thus, n = $\{\frac{1.96^2}{0.05^2}\ X\ 0.109(1-0.109)\}$ x2

n = (298.47)

n = 298.47

The sample was further increased by 10% to account for non-response. Thus, the required sample size is: N = n+ n x 0.1 = 298.47 x 1.1 = 328.32 ≈ **329**

3.4.2 Selection of Communities

The sampling of communities for the study was done using Probability Proportional to Size (PPS) sampling method. This method was carried out by creating cumulative list of community populations in the Wa Municipality and a systematic sample was drawn from a random start. Based on EPI methods, 30 clusters or communities were chosen and the total population (120,031) of all the 128 communities was divided by 30 clusters to obtain the sampling interval (4001).

A random number between 1 and 4001 was chosen using random number table. The first random number picked was 2465. This was fitted into position in the cumulative list to identify Jinkpang as the first community in the sample. To identify the second community systematically, the sampling interval was added to the initial random number, that is, 4001+2465=6466 and so the second community chosen was Boli. This systematic process was continued until 30 communities were eventually chosen.

Furthermore, proportional allocation was employed to allocate representative sample size to each community selected. Thus, the population of a selected community was divided by the total population of all the 30 selected communities and the resultant multiplied by the required sample size.

For example*:*

The total population of the 30 selected communities is 39754 (N) and the required minimum sample size (n) is 317 and the population of Jonga is 1749

The proportional sample allocation for Jonga $= \frac{1749}{39754} * 317$ = 13.947 ≈14.

This calculation for proportional allocation was repeated for all the 30 selected communities. To ensure gender balance and correct gender influence on the results, community samples were further given gender allocations. Male to female proportion in Wa Municipality is 49% to 51% (Ghana Statistical Service, 2013) respectively was used for the gender allocation. Further details are shown in Table 3.1.

Table 3.1 Selected communities and their proportional samples

No.	SubDistrict	Community Name	Population	Proportional Sample	Proportion		**Urban or Rural**
					Male	Female	
1	Bamahu	Jinkang	288	2	1	1	Rural
2	Bamahu	Boli	2003	16	8	8	Rural
3	Bamahu	Bamahu	1452	12	6	6	Urban
4	Busa	Busa	4129	33	16	17	Rural
5	Busa	Jonga	1749	14	7	7	Rural
6	Charia	Zingu	899	7	3	4	Rural
7	Charia	Dopeini	945	8	4	4	Urban
8	Charia	LowCost	744	6	3	3	Urban
9	Charia	77 area	1341	11	5	6	Urban
10	Charingu	Kpamkole	268	2	1	1	Rural
11	Charingu	Goli	1036	8	4	4	Rural
12	Charingu	Kperisi	2000	16	8	8	Rural
13	Kambali	Dandafuuro	824	7	3	4	Rural
14	Kambali	Kambali No 1	1446	12	6	6	Urban
15	Kambali	Kambali - Kore	548	4	2	2	Urban
16	Kambali	Kpaguri /Saughter Hse	1159	9	4	5	Urban
17	Kambali	Kpongu No 1	1851	15	7	8	Rural
18	Wa Sub	Banungoma	1666	13	6	7	Urban
19	Wa Sub	Watahiriyiri	522	4	2	2	Urban
20	Wa Sub	Tambilezu No 1	779	6	3	3	Urban
21	Wa Sub	Fongu	1771	14	7	7	Urban
22	Wa Sub	Zongo Daily Market	1112	9	4	5	Urban
23	Wa Sub	Dondoli	2176	17	8	9	Urban
24	Wa Sub	Sembeleyiri	474	4	2	2	Urban
25	Wa Sub	Old Mission	2710	22	11	11	Urban
26	Wa Sub	Jejedayiri	1775	14	7	7	Urban
27	Wa Sub	Konta South	497	4	2	2	Urban
28	Wa Sub	Koroyiri	2122	17	8	9	Urban
29	Wa Sub	Market	253	2	1	1	Urban
30	Wa Sub	Jengbeyiri	1216	10	5	5	Urban
	Total		39754	318	154	164	

3.4.3 Sampling of Subjects

Within each community, the central point was located. Standing at that location, a field worker spun a pointed object. The angle the object took determined the direction that was followed. Houses from that point to the boundary of the community was then counted and one house randomly selected from that list to become the first house that was entered. One respondent was simple randomly recruited from each household. Male and Female quotas were met by alternating between the two genders after the first person was randomly recruited. Upon exiting a house, the house whose entrance directly faced the one being exited from was entered and the house level selection process repeated until participant and gender numbers were met in a selected community.

3.5 Inclusion Criteria

Any adult (18 years and above) resident in the 30 selected communities out of the 128 in the Wa Municipality and had consented to participate in the research was eligible.

3.6 Exclusion Criteria

Excluded in this study were:

1 Residents in selected communities who were below 18 years.

2 Resident with physical deformities because of the difficulties in getting accurate anthropometric measurements

3 Those with mental impairment with inability to understand and answer questions.

3.7 Data Collection Tools

A quantitative questionnaire with structured questions was used to collect the data. Information elicited included demography, weight, height, waist circumference, hip circumference, blood sugar level, blood pressure, knowledge and perception on obesity. Dietary data was also collected using a 24-hour recall table. Standardized Stunkard Figure Rating Scale (FRS) was also employed to measure knowledge and perceptions of participants on ideal body image. Anthropometric measurements were taken at the participant's home by a trained field officer at the same time of questionnaire administration. Glutathione levels and blood sugar levels required taking blood samples from participants. Trained health staff and laboratory technicians were used to carry out this exercise.

Weighing scale, stadiometer, non-extensible tape measure, digital sphygmomanometer and glucometer were the equipment used in collecting the information.

3.8 Data Collection Procedures

Data collection was undertaken by trained staff of Ghana Health Service. Intra-researcher reliability was achieved through prior training on all data collection tools including repeated assessments of measurements to ensure consistency. Data collection was undertaken by face-to-face interview using a structured questionnaire and the above stated measurements tools. The questionnaire was administered by the trained health staff who completed the responses on behalf of the participants. Questions were asked in the local dialect.

3.8.1 Anthropometry

Anthropometry is the use of body measurements such as weight, height and mid-upper arm circumference (MUAC), in combination with age and sex, to measure growth or failure to grow (UNICEF, 2012). In this study, anthropometric measurements taken were height, weight, waist circumference and hip circumference. Field officers took these measurements with respondents wearing lightweight clothing after the interview. Height was measured with a stadiometer to the nearest 0.1 cm with subject standing upright. Weight was measured on a separate calibrated digital scale to the nearest 0.1kg. Waist and hip circumferences were measured using non-extensible measuring tape with participant wearing light clothing. Waist circumference (WC) was measured at the naval region to the nearest 0.1 cm while hip circumference (HC) measured at the level of the greater trochanter to the nearest 0.1 cm. Waist -to-hip ratio (WHR) was later calculated by dividing WC by HC. Cut-offs for obesity defined by WHR and WC was >0.85 and >88 cm respectively for females, 0.90 and 102cm respectively for males as recommended by WHO were used.

Body mass index (BMI) was calculated based on WHO criteria as weight (kg) divided by height squared (m^2), and weight categories defined following the WHO standard. Namely, <18.5 kg/m^2 as underweight; 18.5 – 24.9 kg/m^2 as normal weight; 25.0-29.9 kg/m^2 as overweight; and >30 kg/m^2 as obese.

3.8.2 Physiological Measurements

Upper arm arterial blood pressure was measured using digital sphygmomanometer. Repeated measurements were taken in triplicate in five minutes intervals and averages determined and recorded. Blood pressure diagnostic guidelines used as follows:

For systolic BP, ≤120mmHg was normal; 121 to 139 mmHg as pre-hypertensive and ≥140mmhg as hypertensive (NIH, 2003)

For diastolic; ≤80mmHg was normal; 81 to 89 mmHg as pre-hypertensive and ≥90mmhg as hypertensive. Respondents with both systolic and diastolic hypertension (BP≥140/90mmhg) were classified as hypertensive (NIH, 2003).

Fasting blood sugar level was measured using digital glucometer. Only subjects who were still fasting from the previous night had their fasting blood sugar levels measured that morning up to 9:00 am. After 9:00am, blood sugar levels of subjects who were interviewed were not measured immediately. Arrangements were made with such subjects to assess the fasting blood sugar level the following day, not later than 9:00am. Based on current WHO criteria, any fasting plasma glucose level measurement >6.1 mmol/l) was considered as hyperglycemic (WHO, 2006).

Determination of Reduced Glutathione Levels (GSH)

Serum was separated from blood samples taken from respondents. A 100 µL water and 100 µL calibrator was transferred into wells of a clear-bottom 96-well plate. A 200 µL water was pipetted into the Blank and Calibrator wells. Serum samples were diluted 20-fold with water prior to the assay (*n* = 20). A 120 µL sample with 120 µL Reagent A was then mixed in 1.5-mL centrifuge tubes. A 200 µL sample/Reagent A mixture was transferred into wells of the 96- well plate and 100 µL Reagent B was added. Plate was tapped lightly to mix and incubated for 25 min at room temperature. OD_{412nm} was read afterwards and calculated as follows.

$$= (OD_{SAMPLE} - OD_{BLANK})/(OD_{CALIBRATOR} - OD_{BLANK}) \times 100 \times n\ (\mu M)$$

Conversions: 1 mg/dL glutathione equals 32.5 µM.

Glutathione levels below 1.02mg/dl was classified as inadequate and level greater than or equal to 1.02mg/dl as normal.

3.8.3 Dietary Record

Dietary and nutrient intakes were also assessed using 24-hour recall table. Foods eaten in the last 24 hour to the time of the interview were recalled and quantities estimated in portion sizes. The estimated portion sizes were later converted into actual nutrients consumed for analysis. Institute of Medicine and National Institute of Health Recommended Daily Allowance (RDA) of each nutrient was determined and used to compare with intakes.

3.8.4 Body Image Assessment

Stunkard's Figure Rating Scale (FRS), a silhouette scale was used to measure participant's body image perception. The Stunkard FRS consists of a series of nine silhouette images of both men and women whose weight ranges from underweight to morbidly obese. These images do not represent, directly, any anthropometric measurements.

3.8.5 Pre-Testing of Questionnaire

Pre-testing of questionnaire was done prior to the actual data gathering exercise in Kabanye community of the municipality to ensure clarity, uniform understanding of questions by field staff and to avoid ambiguous questions.

3.9 Statistical Analysis

Data was entered and analysed using SPSS version 20 (Statistical Package for Social Sciences, SPSS Inc.). Descriptive statistics (percentage, means and standard deviations) were computed for age, sex, height, weight, height circumference, waist circumference, waist-to-hip ratio and BMI of respondents interviewed. Comparison of means was used to established difference or otherwise for male and female, rural and urban data among others. Means of more than two variables (such as age groups) was compared using ANOVA test. Post hoc analysis was done to determine the statistical significance between groups. Cross tabulations, correlations and regressions that established important relationships or association between variables were done using Chi-square statistics. Correlation co-efficients and odds ratios with 95% CI were estimated with their p-values where necessary. A p-value <0.05 was considered as statistically significant.

3.10 Ethical Approval

Approval for this research was given by the Committee on Human Research Publication and Ethics (CHRPE) of the School of Medical Sciences/Komfo Anokye Teaching Hospital on the 18th of April, 2016 for a period of one year (Ref: CHRPE/AP/193/16).

CHAPTER FOUR

RESULTS

4.1 Personal Data of Respondents

Table 4.1 presents demographic characteristics of respondents. A total of 320 respondents were used in this study. The age category of 18-39 years had the highest number of respondents (44.7%). The least was the age category of 70+ with 10.3%. The combined age of the elderly population (60+) was 25.9%. Females were more than males with 52.8% and 47.2% respectively. Respondents were mainly uneducated with 46.9% having no formal education and 8.4% with only primary education. Married people were predominant and represented 68.4% of respondents and divorcees were the least with 2.2%. Waalas were the majority ethnic group in the study area and that showed in their representation in the ethnic group category. They represented 67.5% of the respondents, followed by Dagaabas (26.6%) and Sissala the least with 0.9%. Respondents were more urban dwellers (60.9%) than rural (39.1%).

Table 4. 1 Demographic Characteristics of Respondents

	Frequency (n=320)	Percent
Age Categorisation		
18-29	83	25.9
30-39	60	18.8
40-49	58	18.1
50-59	36	11.3
60-69	50	15.6
70+	33	10.3
Sex of Respondents		
Male	151	47.2
Female	169	52.8
Educational Level		
None	150	46.9
Primary	27	8.4
JHS	59	18.4
SHS/Voc	43	13.4
Tertiary	35	10.9
Others	6	1.9
Marrital Status		
Married	219	68.4
Single	56	17.5
Divorce	7	2.2
Deceased Spouse	38	11.9
Ethnicity		
Waali	216	67.5
Dagao	85	26.6
Sissali	3	.9
Others	16	5.0
Location		
Rural	125	39.1
Urban	195	60.9

A summary of the anthropometric and physiological measurements can be found in Table 4.2. Mean BMI for females was 24.7 ±5.0 and that of males was 22.6 ±3.9 (p <0.01). In terms age, mean BMI was highest in age group 40-59 yeas 25.4±5.2 and lowest in age 70 years and above (p <0.05). Comparison in mean BMI between age group 18-39 years and 60-69 as well as 60-69 years and 70+ years was not significant. Significant variations (p<0.05) in mean BMI was recorded in age groups 18-39 years (23.3±4.2) and 40-59 years (25.4±5.2), 40-59 years (25.4±5.2) and 60-69 years (23.3±4.2) as seen in Table 4.2. Urban dwellers recorded mean BMI of 24.3 (±5.0) compared to rural dwellers with 22.8 ±3.7, p=0.003. Mean SBP for females of 123.6±20.3 was higher than that for males (120.3 ±15.0), p= 0.102. Age group 60-69 years and 70+ years recorded the highest mean SBP of 132.5±21.4 and 129.5±18.2, respectively. The lowest was 18 -39 years with a mean SBP of 116.0±13.6. Mean DBP was high among females 77.4±11.5 than males (76.2±10.1, p=0.309. Urbans dwellers recorded a higher mean SBP of 77.7±11.0 compared with their rural counterparts (75.5±10.6) p=0.077. However, in terms of mean WHR, rural respondents had same mean (0.9±0.1) as the urban dwellers (p=0.03)

Table 4. 2 Mean BMI, SBP, DBP WC and WHR by Rural/Urban, Age and Sex

	BMI(kg/m^2)	SBP(mmHg)	DBP(mmHg)	WC(cm)	WHR
Sex					
Male (n=151)	22.7±3.9	120.3±15.0	76.2±10.1	83.7±11.3	0.9±0.1
Female (n=169)	24.7±5.0	123.57±20.3	77.4±11.5	87.10±13.6	0.9±0.1
p-value	0.000	0.102	0.309	0.018	0.665
Age					
18-39yrs (n=143)	23.3±4.2[a]	116.0±13.6[ab]	74.2±9.8 [ab]	81.6±10.5[ab]	0.9±0.1 [ab]
40-59 (n=94)	25.4±5.2d[e]	122.9±18.7d	77.6±11.2	89.5±13.1 [e]	0.9±0.1d
60-69 (n=50)	23.3±4.2	132.5±21.4	81.3±12.5	89.6±14.4	1.0±0.1
70+ (n=33)	21.6±3.9[c]	129.5±18.2[c]	79.0±9.5 [c]	84.5±12.0[c]	0.9±0.1 [c]
p-value	0.000	0.000	0.000	0.000	0.000
Location					
Rural(n=125)	22.8±3.7	120.2±15.4	75.5±10.6	83.0±9.4	0.9±0.1
Urban(n=195)	24.3±5.0	123.2±19.6	77.7±11.0	87.0±14.1	0.9±0.1
p-value	0.003	0.161	0.077	0.006	0.030
Total(n=320)	23.73(±4.61)	122.01(±18.08)	76.82(±10.89)	85.47(±12.70)	0.898(±0.100)

Different symbols were used to represent mean significance ($p<0.05$) when different age groups were compared as follows. 'a' for age group 18-39 years and 40-59years,'b'for age groups 18-39 years and 60-69 years,'c'for age groups 18-39 and 70+ years, 'd' for age groups 40-59 years and 60-69 years, 'e' for age groups 40-59 years and 70+ years, 'f' for age groups 60-69 years and 70+ years. Absence of the symbol on any of the groups being compared is indicative of no significant difference in the two groups being compared ($p>0.05$).

4.2 Nutritional Status Of Respondents by Sex, Age and Location

Table 4.3 presents the nutritional status of respondent using BMI. The prevalence of obesity was 9.1% whilst the combined overweight/obese figure was 32.2%. More males were normal (73.5%) compared to females (52.1%). This translated in more females being overweight (29.0%) and obese (13.0%) compared to 16.6% and 4.6% for males respectively (p=0.001). More urban dwellers were obese (12.3%) and overweight (24.1%) compared to rural dwellers (4.0% and 21.6% respectively). Obesity prevalence was highest in 40-59 years age group (16%).

The aged (70years or more) were more underweight whilst age 60-69 years recorded the highest normal BMI.

Table 4. 3 Nutritional Status of respondents by Body Mass Index (BMI)

	Underweight	Normal	Overweight	Obese	P-value
Sex n (%)					
Male	8 (5.3)	111(73.5)	25 (16.6)	7 (4.6)	0.001
Female	10 (5.9)	88 (52.1)	49 (29.0)	22(13.0)	
Age n (%)					
18-39	8(5.6)	92(64.3)	34(23.8)	9(6.3)	0.005
40-59	2(2.1)	51(54.3)	26(27.7)	15(16.0)	
60-69	2(4.0)	34(68.0)	11(22.0)	3(6.0)	
70+	6(18.2)	22(66.7)	3(9.1)	2(6.1)	
Location n (%)					
Rural	6(4.8)	87(69.6)	27(21.6)	5(4.0)	0.045
Urban	12(6.2)	112(57.4)	47(24.1)	24(12.3)	
Total	18(5.6)	199(62.2)	74(23.1)	29(9.1)	

In reference to Table 4.4, eighty four respondents representing 26.3% had waist circumference outside the normal range. More females 73 (43.2%) than male 11 (7.3%) had their waist circumference above the normal range (p=0.00). Age group 40-59 years recorded the highest proportion (44.7%) of above normal waist circumference whilst 18-39 years recorded the lowest (14.7%). No statistically significant difference was seen between rural and urban dwellers using waist circumference. Waist-to-hip ratio (WHR) saw more females (48.5%) than males (43.0%) recording a waist-to-hip ratio above the normal range but this was not statistically significant (p=0.327). Age group 60-69 years recorded the highest (80.0%) of all respondents within that group having a higher than normal waist-to-hip ratio. A total of 147 respondents (representing 45.9%) had above normal waist-to-hip ratio. Rural and urban dwellers recorded 51.2% and 41.6% waist-to-hip ratios respectively (p=0.13).

Table 4. 4 Nutritional Status of respondents by WC and WHR

	Waist Circumference (WC)			Waist-to-Hip Ratio (WHR)		
	Normal WC	High WC	P-value	Normal WHR	High WHR	P-value
Sex n (%)						
Male	140(92.7)	11(7.3)	0	86(57.0)	65(43.0)	0.327
Female	96 (56.8)	73(43.2)		87(51.5)	82(48.5)	
Age n (%)						
18-39	122(85.3)	21(14.7)[a]	0	111(77.6)	32(22.4)[a b]	0
40-59	52(55.3)	42(44.7)d e		42(44.7)	52(55.3)d	
60-69	36(72.0)	14(28.0)		10(20.0)	40(80.0)	
70+	26(78.8)	7(21.2)		10(30.3)	23(69.7) [c]	
Location n (%)						
Rural	99(79.2)	26(20.8)	0.076	61(48.8)	64(51.2)	0.130
Urban	137(70.3)	58(29.7)		112(57.4)	83(42.6)	

Symbols for p-values: a for age group 18-39 years and 40-59years,'b'for age groups 18-39 years and 60-69 years,'c'for age groups 18-39 and 70+ years, 'd' for age groups 40-59 years and 60-69 years, 'e' for age groups 40-59 years and 70+ years, 'f' for age groups 60-69 years and 70+ years. Absence of the symbol on any of the groups being compared is indicative of no significant difference in the two groups being compared (p>0.05).

4.3 Knowledge on Causes and Adverse Health Effects of Obesity

A summary of the causes of obesity mentioned by respondent is shown in Figure 4.1. Forty two (42) respondents representing 18% had no idea what causes obesity when asked. Fifteen (15%) associated the cause of obesity to lack of exercise whilst 36% associated it to over eating. A further 17% attributed the development of obesity to genetic factors and others (14%) associated obesity development to having 'peace of mind' or 'being happy'.

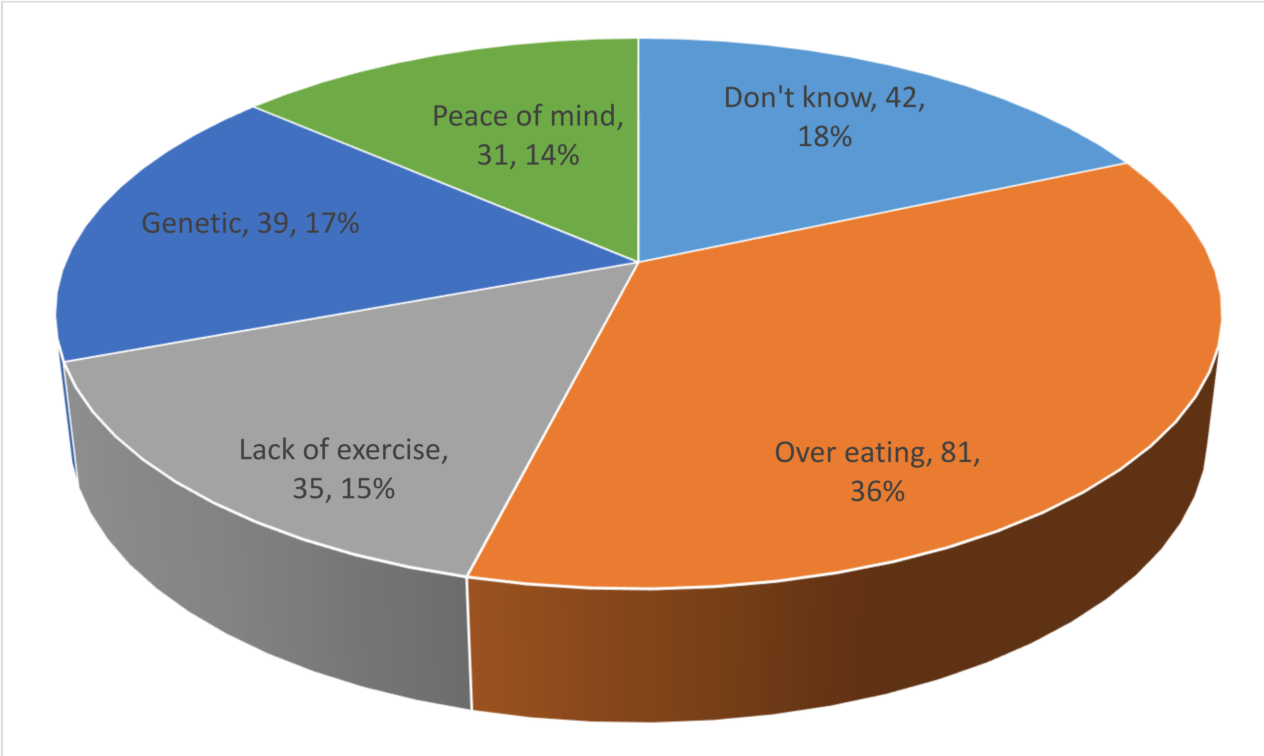

Figure 4. 1: Respondents Knowledge on the Causes of Obesity

Figure 4.2 displays respondents’ knowledge about the effects obesity. It showed that 30.5% of respondents could not tell any adverse health effect of obesity while 20.7% gave non-health reasons (for example ‘obese people not being fashionable, attractive) as the effects of obesity. Thus, a total of 51.2% could not relate obesity to any health challenge. However, 48.8% could give very specific health reasons such as hypertension, diabetes, stroke, birth complication and others as the adverse effects of obesity.

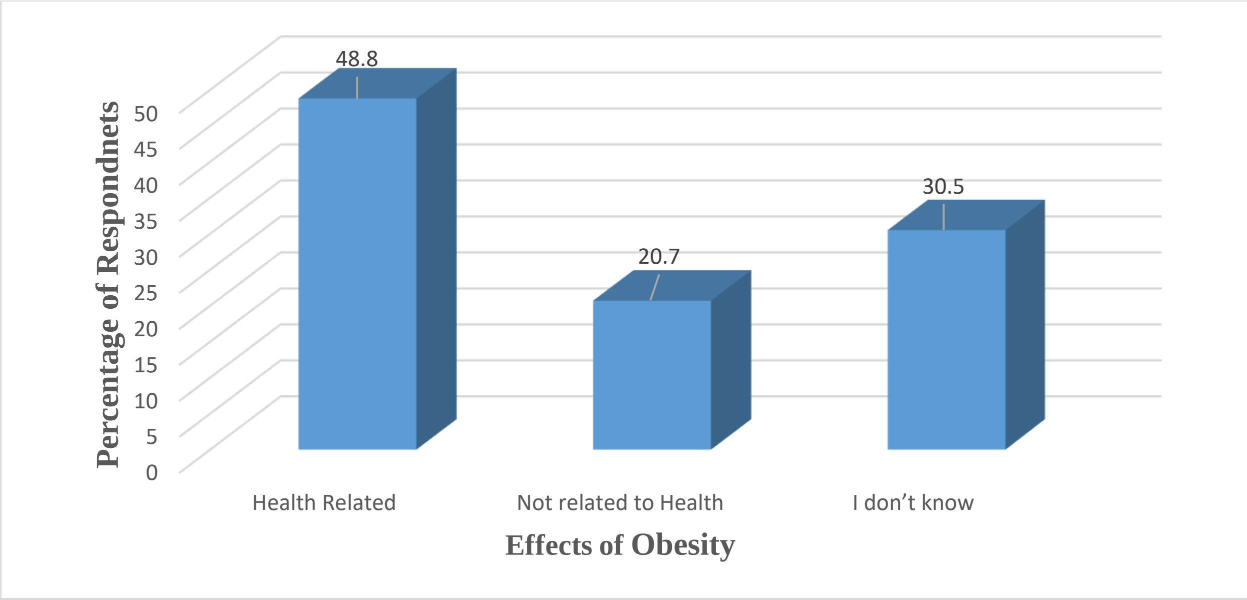

Figure 4.2 Respondents knowledge about the effects of obesity

Table 4.5 is a summary of respondent identified with high blood pressure and their awareness level of having high BP. Forty two (42) respondents had high BP using systolic blood pressure measurement alone. Of the 42 respondents, 22 (representing 52.4%) were aware of their high BP status. Using diastolic BP measurements, 25 respondents had high BP and 12 out the 25 (48%) respondents were aware of their high diastolic BP status. Eighteen (18) respondents recorded high systolic and diastolic BP and 11 (representing 61.1%) were aware of their high BP status. The remaining 38.9% were not aware they had abnormal blood pressure levels. This translated to a total of 47.1% of all hypertensives (by systolic and/or diastolic BP) being unaware of their high BP status.

Table 4. 5 Respondents with High Blood Pressure and their Awareness Level of having High BP.

Variable	Respondents Aware		Respondents Not Aware		Total
	Number	Percentage	Number	Percentage	
Systolic	22	52.4	20	47.6	42
Diastolic	12	48	13	52	25
Systolic/Diastolic	11	61.1	7	38.9	18
Total	45	52.9	40	47.1	85

Figure 4.3 is a summary of respondents' perception about their body weight. Compared with their BMI, 178 (representing 57.2%) out of 311 respondents had a wrong perception about their body image. Only 133 respondents (representing 42.8%) had a correct perception about their body weight.

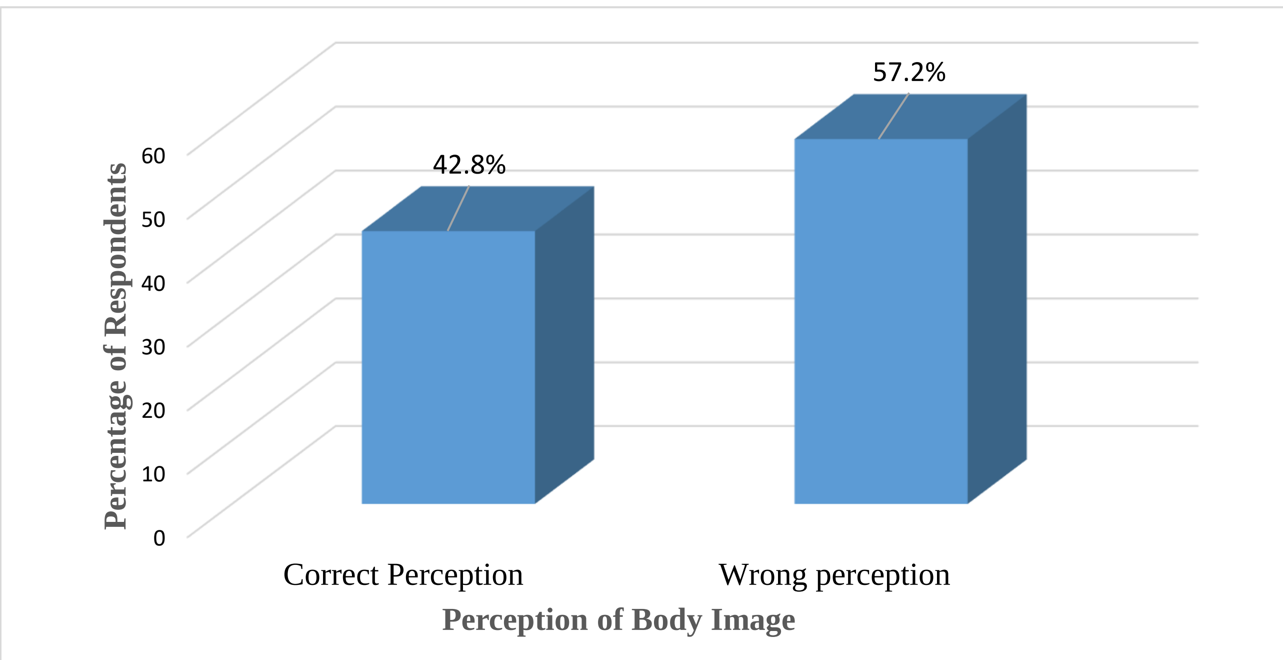

Figure 4.3 Perception of respondents about their body image.

Table 4.6 is a comparison of respondent's body image perception and their actual BMI. Results indicated wrong perception of body image was quite high among respondents. No statistical difference was observed between underweight and normal weight group that recorded 43.8% and 44.2% respectively. Overweight (80.3%) and obese (85.2%) respondents had wrong body image perception close to double that of the underweight and normal groups. Differences were statistically significant between underweight and normal weight groups on one side and overweight obese groups on the other.

Table 4. 6 Perception of Respondents about their Body Image by Nutritional Status

	Correct Perception		Wrong perception		
Nutritional Status	Number	%	Number	%	P-value
Underweight	9	56.2	7	43.8b[c]	0.00
Normal	110	55.8	87	44.2[de]	
Overweight	14	19.7	57	80.3	
Obese	4	14.8	23	85.2	

Post hoc test was used to compare the significance between groups. P-value below 0.05 was considered significant. 'a' was used for underweight and normal. ,'b' for underweight and overweight,'c' for underweight and obese, **'d'** for normal and overweight, **'e'** for normal and obese, **'f'** for overweight and obese. Absence of the symbol on any of the groups being compared is indicative of no significant difference in the two groups being compared (p>0.05).

Table 4.7 illustrates respondents' desire to lose weight. The highest desire to lose weight of 72.4% was observed among the obese group. Overweight was the next highest with 40.5% of respondents desiring to lose weight. The least was recorded in the underweight group (5.6%) while 11.6% was recorded for the normal weight. Clearly, respondents desire to lose weight increases with BMI.

Table 4.7 Respondents' desire to lose weight

BMI		Respondent's desire to lose weight	
		Yes	No
Underweight	Number	1	17
	Percent	5.6	94.4
Normal	Number	23	176
	Percent	11.6	88.4
Overweight	Number	30	44
	Percent	40.5	59.5
Obese	Number	21	8
	Percent	72.4	27.6

Table 4.8 is a summary of respondents' body image perception and their desire to lose weight. It showed 11.1% of underweight respondents with correct body image perception and none (0%) with wrong body image perception desired to lose weight, p=0.362. For respondents with normal BMI, fewer respondents with correct body image perception (7.3%) desired to lose weight than those with wrong perception (16.3%). Nine out of ten overweight respondents with correct perception about their body image desired to lose weight. In contrast, 3 in 10 overweight respondents with wrong perception of their body image desired weight reduction. Similarly,

75.0% of obese respondents with the right body image perception desire to lose weight compared with 69.6% of those with wrong perception. Clearly, having the right body image perception increases the chances of the right desire to lose weight.

Table 4.8 Respondents body image perception and desire to lose weight.

BMI Categorization		Desire to lose weight		p-value
		Yes %	No %	
Underweight	Correct perception	11.1	88.9	0.362
	Wrong perception	0.0	100.0	
Normal	Correct perception	7.3	92.7	0.050
	Wrong perception	16.3	83.7	
Overweight	Correct perception	85.7	14.3	0.000
	Wrong perception	29.1	70.9	
Obese	Correct perception	75.0	25.0	0.826
	Wrong perception	69.6	30.4	
Total	Correct perception	17.6	82.4	0.055
	Wrong perception	26.9	73.1	

4.4 Respondent's Nutrients Intakes

Table 4.9 displays respondents mean intakes of energy, protein, fat, carbohydrates and fibre using 24-hour recall. The mean energy intake was 2251.77 and 1833.25 kilo calories for male and females, respectively. These were seen to be below the recommended daily allowance (RDA) for a moderately active adult though some individual's consumption was so much beyond their daily recommendation. A statistically significant positive correlation of 0.291 (P value=0.000) was seen between BMI and energy intake. In percentage terms, 29.53% of males and 31.33% of females met their minimum daily recommendation of energy intake. Carbohydrates intake saw the highest number of respondents meeting their recommended daily allowance with 98.0% and 94.6% for males and females, respectively. Mean fibre intake was 36.83g for males and 27.47g for females

Table 4. 9 Respondents mean intakes of energy, protein, fat, carbohydrates and fibre

	Sex	Mean intake	Minimum intake	Maximum intake	% meeting RDA
Energy (kcal)	Male	2251.1	680.8	5689.0	29.5
	Female	1833.2	591.4	4992.6	31.3
protein (g)	Male	81.6	12.8	342.0	65.1
	Female	59.0	5.9	180.5	60.2
Total fat (g)	Male	38.8	4.7	133.7	16.4
	Female	36.9	4.8	109.0	11.4
Carbohydrates (g)	Male	402.0	102.3	1038.5	98.0
	Female	323.6	55.8	928.4	94.6
Fibre (g)	Male	36.8	8.7	160.4	45.6
	Female	27.5	2.2	104.5	45.8

Table 4.10 is the mean micronutrients intake by respondents using 24 hour recall. The analysis showed manganese had the highest percentage of respondents meeting their daily allowance with 91.3% and 92.2% for males and females, respectively with a mean intake 6.01 for males and 4.80 for females. Vitamin A_RAE (Retinol Activity Equivalents) had the lowest percentage of respondents meeting their daily allowance. No respondent met the minimum recommended daily allowance for vitamin_RAE. Iron saw great disparity between males and females with 92.6% of males meeting their daily allowances as compare to females (34.9%).

Table 4. 10 Micronutrients intakes of respondents

Nutrient	Sex	Mean intake	Minimum intake	Maximum intake	% meeting RDA
Calcium (mg)	Male	534.6	84.9	1663.8	10.7
	Female	468.7	29.5	1495.5	18.7
Iron (mg)	Male	23.1	4.5	119.1	92.6
	Female	16.8	1.7	57.0	34.9
Magnesium (mg)	Male	553.5	123.5	2843.9	59.7
	Female	401.7	31.6	1627.5	53.6
Phosphorus (mg)	Male	1548.9	425.9	6563.7	88.6
	Female	1139.6	104.3	4133.3	80.1
Potassium (mg)	Male	3154.3	595.3	16352.9	16.1
	Female	2161.4	344.4	8930.1	5.4
Sodium (mg)	Male	2752.0	84.4	7469.6	73.8
	Female	2394.5	131.6	6467.0	83.1
Zinc (mg)	Male	13.5	3.1	51.6	62.4
	Female	9.5	0.9	32.3	52.4
Copper (mg)	Male	2.2	0.4	12.2	89.9
	Female	1.5	0.3	6.1	73.5
Manganese (mg)	Male	6.0	1.0	22.4	91.3
	Female	4.8	0.7	13.3	92.2
Total Vitamin C (mg)	Male	71.8	0.4	297.4	22.8
	Female	61.6	0.4	268.7	34.3
Thiamin (mg)	Male	2.3	0.4	12.4	77.2
	Female	1.7	0.1	5.9	68.1
Riboflavin (mg)	Male	1.5	0.2	4.1	49.0
	Female	1.2	0.1	3.4	47.6
Niacin (mg)	Male	21.5	3.9	61.2	60.4
	Female	18.4	1.8	56.9	63.3
Vit B-6	Male	1.8	0.4	6.0	65.8
	Female	1.4	0.3	5.0	46.4
Folate (mcg) Total	Male	891.6	55.3	8757.3	55.0
	Female	512.7	28.4	3645.4	40.4
Vit B-12 (mcg)	Male	1.0	0.0	8.1	10.7
	Female	0.7	0.0	5.4	4.2
Vit A mcg_RAE	Male	88.5	0.0	571.8	0.0
	Female	73.3	0.0	331.2	0.0
Vit. E (mg)	Male	5.0	0.6	20.6	2.7
	Female	4.7	0.4	16.2	1.2

4.5 Oxidative Stress

A total of 58.7% of respondents had normal level of glutathione while the rest (41.3%) had low glutathione levels as shown in Table 4.11.

Table 4. 11 Glutathione Analysis

Glutathione level	Frequency	Valid Percent
Low glutathione levels (blow 1.02mg/dl)	117	41.3
Normal Glutathione levels (≥ 1.02mg/dl)	166	58.7
Total	283	100.0

Fibre intake recorded a weak negative correlation (-0.123) with serum glutathione level (p=0.04). Energy (Kilo calories) intake also recorded a weak negative correlation of -0.007 with serum glutathione (p=0.095). Iron, zinc, copper and vitamin C all recorded very weak negative correlation with glutathione (p=0.108, 0.116, 0.102 and 0.930, respectively). Vitamin A_RAE (Retinol Activity equivalent), Retinol and Vitamin E recorded very weak positive correlation (Table 4.12).

Table 4.12. Correlation of glutathione with dietary anti-oxidants, energy and fibre intake.

		Kcal	Fibre	Iron	Zinc	Copper	Vit_C	Vit_A_RAE	Retinol	Vit_E
GSH (mg/dl)	Correlation	-0.007	-0.123	-0.097	-0.094	-0.098	-0.005	0.027	0.04	0.032
	P-value	0.095	0.04	0.108	0.116	0.102	0.939	0.653	0.507	0.599

4.6 Obesity Co-Morbidities

Tables 4.13 and 4.14 provide analysis of systolic blood pressure (SBP) and diastolic blood (DBP) of respondents, respectively. It showed males had a higher normal BP in both systolic (68.9%) and diastolic (78.8%) compared with females (p-values >0.05). Age group of 18-39 years had the highest normal SBP (80.4%) and DBP (82.5%) while age group 60-69 years recorded the highest number of hypertensive cases in both SBP and DBP. Seventy (70) years and above had the highest pre-hypertensive cases in both SBP (36.4%) and DBP (27.3%). In terms of urban/rural segregation, rural dwellers had pre-hypertensive rate of 23.2% SBP and 15.2% DBP compared to 20.5% and 19.0% for urban dwellers, respectively. Rural dwellers had 68.0% normal SBP and 81.6% normal DBP compared with 63.6% and 70.3% for urban dwellers respectively (p=0.023). The combined pre-hypertensive/hypertensive (above normal BP) was highest in urban dwellers (SBP=36.4% and DBP=29.8%) in urban settings compared to rural settings (SBP=32.0% and DBP=18.4%).

Table 4. 13 Prevalence of normal, prehypertension and hypertension by SBP

	Normal BP	Pre-hypertensive	Hypertensive	P-value
Sex n (%)				
Male	104(68.9)	32(21.2)	15(9.9)	0.248
Female	105(62.1)	37(21.9)	27(16.0)	
Age n (%)				
18-39	115(80.4)	21(14.7)	7(4.9)	0.000
40-59	58(61.7)	22(23.4)	14(14.9)	
60-69	22(44.0)	14(28.0)	14(28.0)	
70+	14(42.4)	12(36.4)	7(21.2)	
Location n (%)				
Rural	85(68.0)	29(23.2)	11(8.8)	0.182
Urban	124(63.6)	40(20.5)	31(15.9)	
Total	209(65.3)	69(21.6)	42(13.1)	

Table 4. 14 Prevalence of normal, prehypertension and hypertension by DBP

	Normal BP	Pre-hypertensive	Hypertensive	P-value
Sex n (%)				
Male	119(78.8)	21(13.9)	11(7.3)	0.239
Female	120(71.0)	35(20.7)	14(8.3)	
Age n (%)				
18-39	118(82.5)	21(14.7)	4(2.8)	0.003
40-59	70(74.5)	16(17.0)	8(8.5)	
60-69	30(60.0)	10(20.0)	10(20.0)	
70+	21(63.6)	9(27.3)	3(9.1)	
Location n (%)				
Rural	102(81.6)	19(15.2)	4(3.2)	0.023
Urban	137(70.3)	37(19)	21(10.8)	
Total	239(74.7)	56(17.5)	25(7.8)	

Table 4.15 presents the prevalence of SBP among underweight, normal weight, overweight and obese groups using BMI. Hypertension was highest among the obese (31.0%) and lowest among the normal weight group. Underweight group recorded 11.1% and overweight 21.6%. Obese group (31.0%) had the highest prevalence of pre-hypertension, followed by the overweight group (25.7%). The highest number of respondent with normal SBP (88.9%) was in the underweight group. The normal weight group (71.9%) was the second highest in normal SBP.

Table 4.15 Prevalence of SBP according to Nutritional Status of Respondents

			SBP			
			Normal BP	Pre-hypertensive	Hypertensive	Total
Nutritional Status	Underweight	Count	16	0	2	18
		%	88.9	0.0	11.1	100.0
	Normal	Count	143	41	15	199
		%	71.9	20.6	7.5	100.0
	Overweight	Count	39	19	16	74
		%	52.7	25.7	21.6	100.0
	Obese	Count	11	9	9	29
		%	37.9	31.0	31.0	100.0
	Total	Count	209	69	42	320
		%	65.3	21.6	13.1	100.0

Table 4.16 is a summary of the mean fasting blood sugar level by sex, age and rural/urban communities. Males (4.8mMol) and females (4.9mMol) recorded no significant differences in mean FBS (p=0.388). The mean FBS did not also defer significantly among different age groupings. Urban dwellers, however, had a statistically significant higher mean FBS (5.1mMol) than rural dwellers, 4.4mMol (p=0.00).

Table 4.16 Mean Fasting Blood Sugar level by Sex, Age and Location

	Mean FBS (Mmol)	SD	P-value
Sex			
Male	8.8	1.3	0.388
Female	4.9	1.2	
Age			
18-39	4.7	0.8	0.573
40-59	5.2	1.7	
60-69	4.7	1.1	
70+	5.0	1.4	
Location			
Rural	4.4	1.1	0.000
Urban	5.1	1.4	

Table 4.17 is a summary of the prevalence of high blood sugar level (hyperglycaemia) among respondents. Percentage of males who were hyperglycaemic was 10.0% compared to 7.1% for females though this difference was not statistically significant (p=0.355). Urban respondents recorded a higher hyperglycaemic percentage of 10.3 compared to rural dwellers who recorded 5.6% (p=0.141). Though not statistically significant (p=0.083), obese respondents using BMI had a higher rate of hyperglycaemia (17.2%) compared with overweight (12.3%), normal weight (5.5%) and underweight (11.1%). The overall rate of hyperglycaemia was 8.46% (27 out of 319).

Table 4.17 Prevalence of hyperglycaemia among respondents

Community	Normal FBS	Hyperglycemic	P-value
Sex n (%)			
Male	135 (90.0)	15 (10.0)	0.355
Female	157(92.9)	12 (7.1)	
Location n (%)			
Rural	118 (94.4)	7(5.6)	0.141
Urban	174(89.7)	20(10.3)	
BMI n (%)			
Underweight	16(88.9)	2(11.1)	0.083
Normal	188(94.5)	11(5.5)	
Overweight	64(87.7)	9(12.3)	
Obese	24(82.8)	5(17.2)	
Total	292(91.5)	27(8.5)	

4.7 Energy and Nutrient Intake by Nutritional Status

In reference to Table 4.18, mean energy intake (kilocalories) was lowest (1622.48±530.65) among the underweight group using BMI and highest (2756.8±923.47) among the obese group. The overweight group mean of 2224.32kcal (±987.92) was also higher than the normal group that recorded 1894.39±799.47 (p=0.000). This showed a general rising trend of energy intake from the underweight group through to the obese group and these differences were significant except that between the underweight and normal weight groups. Similar trend was observed in the mean protein intake with the underweight (56.35±24.81) recording the lowest mean protein intake, followed by the normal group (65.45±16.42), overweight (73.64±18.51) and highest being the obese group (97.84±18.68). This order of mean nutrient intake increasing with nutritional status was the same in mean intakes of total fat, carbohydrates, fibre and sugar as shown in Table 4.18. Differences in the mean intake of obese group were statistically significant compared with underweight and normal groups in all of energy, protein, fat, carbohydrates, fibre and sugar.

Table 4.18 Mean intakes of energy, protein, fat, CHO and fibre by nutritional status

	BMI				
	Underweight	Normal	Overweight	Obese	P-value
Energy (Kcal)	1622.48(±530.65)b	1894.39(±799.47) de	2224.32(±987.92) f	2756.8(±923.47)c	0.00
Protein(g)	56.35(±24.81)	65.45(±16.42) e	73.64(±18.51) f	97.84(±18.68) c	0.00
Total Fat (g)	26.22(±12.92) b	35.43(±1250) de	43.16(±16.26)	47.81(±16.09) c	0.002
CHO(g)	295.51(±50.91) b	335.33(±43.56) de	394.1(±87.42) f	494.67(±98.76) c	0.00
Fibre (g)	25.55(±8.19) b	30.04(±15.77) de	35.25(±22.41)	40.41(±15.44) c	0.006
Sugars (g)	38.85(21.00)	43.20(30.21) e	57.82(31.23) f	102.28(50.56) c	0.040

To determine the significance of the differences seen in mean intakes between underweight, normal, overweight and obese, different symbols were used. a for underweight and normal, b for underweight and overweight,'c'for underweight and obese, 'd' for normal and overweight, 'e' for normal and obese, 'f' for overweight and obese. The absence of the symbol on any of the BMI groups being compared is indicative of no significant difference in the two groups being compared ($p>0.05$). CHO=Carbohydrates, g=gram

Table 4.19 displays the mean micronutrient intake of respondents based on their BMI categories. Data showed a general order of mean nutrient intake increasing from the underweight group through normal and overweight to obese groups in iron, sodium, zinc, copper, vitamin C, thiamine, folate, vitamin A and E though some variations were not significant. Obese respondents had a significantly higher mean intake in iron, sodium, zinc, copper and thiamine compared with the underweight and normal weight respondents ($p<0.05$). Only normal and obese group showed significant difference in mean calcium intakes. Differences in underweight (3.052mg) and overweight (5.70mg), normal (4.59mg) and overweight (5.70mg) as well as underweight (3.052mg) and obese (5.67mg) in mean vitamin E intake were significant. Vitamin

C, folate vitamin A-RAE and retinol showed no statistically significant variation among underweight, normal, overweight and obese BMI groups.

Table 4.19 Mean Micronutrient intake by Nutritional Status

Nutrient	Underweight	Normal	Overweight	Obese	P-value
Calcium	489.98	462.26 [e]	538.83	670.11	0.005-
Iron	16.69	18.48 [e]	21.37	26.8 [c]	0.006
Sodium	2371.97	2433.85 [e]	2655.21[f]	3364.04 [c]	0.005
Zinc	8.72 [b]	10.81 [e]	12.00[f]	15.24 [c]	0.011
Copper	1.40	1.68 [e]	1.93	2.36 [c]	0.019
Vitamin C	45.81	65.72	71.48	71.78	0.251
Thiamine	1.69	1.83 [e]	2.14	2.67 [c]	0.011
Folate	572.01	636.25	766.16	969.36	0.24
Vitamin_A_RAE	55.58	81.28	82.46	85.37	0.543
Retinol	0.92	11.82	7.77	9.06	0.786
Vitamin E	3.052 [b]	4.59d	5.70	5.67 [c]	0.011
Cholesterol	24.96	52.81	52.21	82.53 [c]	0.089

To determine the significance of the differences seen in mean intakes between underweight, normal, overweight and obese, different symbols were used. a for underweight and normal, b for underweight and overweight,'c'for underweight and obese, 'd' for normal and overweight, 'e' for normal and obese, 'f' for overweight and obese. The absence of the symbol on any of the BMI groups being compared is indicative of no significant difference in the two groups being compared (p>0.05).

4.8 Predictors of Obesity

Reference to Table 4.20, sex of respondents and their desire to lose weight were significant predictors of overweight and obesity. Males were less likely to become overweight/obese compared to females (OR: 0.40, 95% CI: 0.22- 0.71). Respondents who wished to lose weight were significantly more likely to be overweight/obese compared to those who did not want to lose weight (OR: 6.7, 95% CI: 3.65-12.41).

Table 4.20 Odds ratio of some predictor variables for overweight/obesity

Variable		OR	95% CI Lower	95% CI Upper	P-value
Sex	Male	0.40	0.22	0.71	**0.00**
	Female	1.00			
Age (years)	18-39	1.47	0.48	4.53	0.50
	40-59	1.95	0.61	6.18	0.26
	60-69	1.08	0.31	3.80	0.90
	70+	1.00			
Community type	Rural	0.66	0.37	1.17	0.15
	Urban	1.00			
Desire to lose weight	Yes	6.73	3.65	12.41	**0.00**
	No	1.00			

Table 4.21 measure predictors of obesity by some nutrients in tertiles of high intake, moderate intake and low intake. It showed only energy was a significant predictor of overweight/obesity. The odds of the upper tertile (high intake) and the middle tertile (moderate intake) in predicting overweight/obesity was 1.69 (CI: 1.02-2.13) and 1.46 (CI: 0.99 – 2.34), respectively compared to the lower percentile (low intake).

Table 4.21 Odds ratio of energy and some nutrients in predicting overweight/obesity

Variable		OR	95% CI Lower	95% CI Upper	P-value
Energy	High intake	1.69	1.02	2.13	**0.049**
	Moderate intake	1.46	0.99	2.34	**0.043**
	Low intake	1.00			
Protein	High intake	1.57	0.62	3.94	0.338
	Moderate intake	1.05	0.48	2.26	0.908
	Low intake	1.00			
Total fat	High intake	1.33	0.62	2.84	0.464
	Moderate intake	1.17	0.58	2.37	0.663
	Low intake	1.00			
Carbohydrates	High intake	3.03	0.48	19.30	0.240
	Moderate intake	2.47	0.51	11.95	0.261
	Low intake	1.00			
Fibre	High intake	0.34	0.11	1.06	0.063
	Moderate intake	0.64	0.27	1.54	0.322
	Low intake	1.00			
Sugar	High intake	1.03	0.48	2.18	0.941
	Moderate intake	1.92	0.99	3.73	0.054
	Low intake	1.00			

CHAPTER FIVE

DISCUSSION

5.1 Discussion

The World Health Organization defines overweight as a body mass index (BMI) of 25 kg/m^2 or greater and obesity as a BMI >30 kg/m^2. This study revealed the prevalence of overweight and obesity in Wa Municipality as 23.1% and 9.1%, respectively. This finding is in line with a 10.9% prevalence of obesity for Ghana recorded by the World Health Organization (WHO, 2014a). Other studies in the country revealed varied prevalence of overweight and obesity among adults with a reported overweight and obesity prevalence ranging from 5.8% -54.0% and 1.6% -63.8% respectively (Ofori-Asenso *et al*., 2016). For example, in Greater Accra among workers of financial institutions, a prevalence of overweight of 37.8% and obesity of 17.8% was recorded (Addo *et al*., 2015). Compared with Accra, obesity in Wa Municipality is half. In Ashanti region, among adults in rural (Jachie-Pramso) and Urban (Kumasi) the combined prevalence of overweight (33.9%) and obesity (36.2%) was 70.1% ($p<0.05$) (Obirikorang *et al*., 2015). Accra and Kumasi are more urbanized relative to Wa Municipal and this could explain the disparities. Though obesity prevalence is lower in this study compared to studies in Accra and Kumasi, overweight and obesity were virtually not present in Upper West region few years ago (Biritwum *et al*., 2005). This clearly indicates that overweight/obesity prevalence has increased globally and locally over the years and will continue to increase unless measures are put in place to curb it.

This study also revealed a higher prevalence of overweight (24.1%) and obesity (12.3%) in urban areas as against 21.6% and 4.0% respectively in rural areas (p = 0.045). This urban/rural difference is in conformity with the GDHS (2008) finding of which 4.6% of the rural population were obese against 14.0% of the urban settings. Another research by Amoah (2003) conducted in rural and urban Accra showed the overall crude prevalence of overweight and obesity as 23.4% and 14.1% respectively among adults aged 25 years and above and increased with age up to 64 years. Many other studies carried out in Africa have reported higher prevalence of obesity and overweight in urban areas (Amoah, 2003; Choi *et al*., 2010) and the findings of this research has affirmed that position. Implicated in the rural/urban difference in obesity prevalence is the obesogenic environment provided by urban settings in the nature of nutrition transition into energy dense diet with high fat coupled with lesser physical activity levels.

Further findings from this study revealed a higher prevalence of overweight (29.0%) and obesity (13.0%) among women than men who recorded 16.6% and 4.6%, respectively. Thus, the combined risk of overweight and obesity (42%) among females was twice that of males (21.2%) ($p<0.05$). This outcome was further supported by men recording a significantly reduced odds (OR: 0.40 CI: 0.22 – 0.71) of becoming overweight/obese compared to females (Table 4.21). The higher prevalence seen among women compared to men is similar to what Escalona *et al*. (2004), found in a study of adults in Accra. They found that overweight/obesity prevalence in females (48.6%) was about twice the prevalence in males (28.1%). Many other studies have put the prevalence of overweight/obesity in women to be higher compared to men. Reasons for the gender disparities in the prevalence of overweight/obesity can be many and varied. For example, it is believed that physical activity patterns in developing countries like Ghana have dramatically reduced over the years with a concomitant nutrition transition that resulted in an increased consumption of energy-densed foods high in refined carbohydrates and women appear more vulnerable to the effects of these than men (Kanter & Caballero, 2012).

Knowledge of the population about the causes of obesity, the adverse health effects and the right perception about their body image are known to be determinants of people's willingness to lose weight and to embrace any intervention therein. Therefore obese and overweight persons need to have the right body image perception in order to reverse the rising trend of the prevalence. This research revealed 52% of respondents had wrong perception about their body weight with overweight (80.3%) and obese (85.2%) groups significantly higher than the underweight (43.8%) and normal weight (44.2%). Some respondents (18%) had no knowledge what causes obesity when asked. The rest could give at least one cause of obesity (excessive energy intake =36%, lack of exercise=15%, peace of mind/being happy =14% genetic factors=17%). On the effects of obesity, 30.5% of respondents could not tell any adverse health effect (co- morbidities) of obesity while 20.7% gave non-health reasons relating to fashion. However, 48.9% could give very specific health reasons such as hypertension, diabetes, stroke, birth complication among others as the adverse effects of obesity. A comparative study in Accra and Manya Krobo, both in Ghana among civil and public servants, revealed that 36.6 – 42.5% of respondent had no knowledge about the cause of obesity and 44.1– 47.3% did not know about any adverse health effects of obesity (Nti *et al*., 2013). This was in contrast with similar research in the US among Black and Hispanic adults where knowledge level on the effects/risk of obesity was considerably high (hypertension, 94%; diabetes, 96%; sleep apnea, 89% etc) (Winston *et al*., 2014). Ethnic/racial differences and the populations used could account for the differences observed above. For health promotional purposes, individuals with wrong body image perception and no knowledge about the causes and effects of obesity pose a greater challenge in promoting healthy body weight in the population and these finding should be a worry to actors in the health service delivery.

The average energy intake using a 24-hour recall table was seen to be 2251.77 and 1833.25 kilo calories for males and females, respectively. These are seen to be below the recommended daily allowance (RDA's) (2900 for males and 2200 for females) for a moderately active adult though some individual's consumption was so much beyond their daily recommendation. A similar study conducted at Manya Krobo District revealed the mean energy intake was 1966Kcal/day, resulting in 89% of respondents meeting their Reference Nutrient Intake (RNI) (Nti *et al*., 2013). The results of this study were low (with about 30% meeting their RDAs) because the data was gathered in the lean season. Despite this, a statistically significant positive correlation of 0.291 (P value=0.000) was seen between BMI and energy intake. This gives credence to the fact that higher energy intakes without a commensurate energy expenditure will result in increases in body weight.

Carbohydrates intake saw the highest number of respondents meeting their recommended daily allowance with 98.0% and 94.6% for males and females, respectively as seen in Table 4.10. Foods crops high in carbohydrates are mainly grown and eaten in the study area and this might have accounted for the ability of respondents to meet their carbohydrates needs. Meeting the energy requirements is not difficult in a Ghanaian population as most of the foods consumed are mostly carbohydrate based. But inadequate intake of fat resulted in less respondents meeting their daily energy requirements. Despite this, mean energy intake was high among the overweight (2224.32kcal) and obese (2756.80kcal) relative to the underweight (1622.48kcal) and normal weight (1894.39kcal) groups. This clearly shows that the overweight/obese persons are eating more calories and this could explain their overweight/obese nutritional status as supported by the energy balance hypothesis.

Manganese intake had the highest percentage of respondents meeting their daily allowance of 91.3% and 92.2% for males and females, respectively. Vitamin A_RAE (Retinol Activity Equivalents) had the lowest percentage of respondents meeting their daily allowance. No respondent met the minimum recommended daily allowance for vitamin_RAE. The season that the data taken (dry season) could account for the low intake of some nutrients usually found in fruits and vegetables.

Iron saw great disparity between males and females with 92.6% of males meeting their daily allowances (Mean=23.13mg) as compared to 34.9% of females having a mean intake of 16.77mg, which might have accounted for the high prevalence of anaemia among adult women (36.0%) for the Upper West Region and 42% for the Ghana in the last GDHS report (GSS & GDHS, 2014).

Oxidative stress is a disturbance in the balance between the production of reactive oxygen species (ROS), also called free radicals and antioxidant defenses (Betteridge, 2000). Reduce glutathione (GSH), the bodies most common antioxidant, was used as a biomarker for measuring respondents' susceptibility to oxidative stress, which has been implicated in various pathologies including hypertension and diabetes (Paravicini & Touyz, 2008). Findings revealed 41.3% of the respondent had low levels of reduced glutathione relative to minimum amounts required to prevent the negative effects of free radicals. No correlation could be established in the glutathione levels of different BMI groupings of underweight, normal, overweight and obese. However, Keaney *et al*. (2003), suggested that obesity is independently associated with oxidative stress and the close associations of obesity with other conditions such as hypertension and diabetes could be caused by increased oxidative stress. This begs the question as to the correct biomarker to use in measuring oxidative stress and if glutathione is one. According to Keaney *et* *al*. (2003), association between oxidative stress and obesity (and other conditions such as diabetes and hypertension) has been established, however, consensus is limited about reliable markers of oxidative stress and this research could not establish glutathione as one.

This study also found wrong body image perception to be high at 57.2% with the overweight (80.3%) and obese (85.2%) being the worst affected relative to the underweight (43.8%) and normal weight (44.2%). Nti et al. (2013), found similar high figures of wrong body image perceptions among peri-urban (31%) and urban (40.1%). This can be as a result of lack of knowledge about body weight, obesity and its health implications (Nti et al., 2013). It can also be a defensive strategy against stigmatization as some individuals try can view themselves as normal just to dispel the impact of such stigmatization against overweight and obese persons as revealed by Puhl and Heuer (2009).

This study revealed that 13.1% of respondents were hypertensive in systolic blood pressure and 7.8% by diastolic blood pressure. A prevalence (BP>140/90mmHg) of 8.1% was recorded for the Upper West Region in 2014 by Ghana Demographic and Health Survey (GDHS, 2014). Teenagers between 15 -18 years were part of this GDHS survey and could have accounted for some of the difference in prevalence seen. In contrast, many other studies found prevalence of hypertension in Ghana and parts of Ghana to be higher with an increasing trend (Addo *et al*., 2012b) compared to this study. For example, prevalence for hypertension measured by SBP≥140mmHg and/or DBP≥90mmHg was 23.1% recorded for Ghana in 2014 (WHO, 2014b). Another study in Ashanti region among rural and peri-urban respondent revealed an overall prevalence of hypertension of 28.7% (95% C.I. 26.0 to 31.6). This establishes the fact that hypertension prevalence in the Wa Municipal is lower than what is reported from other parts of Ghana though with an increasing trend. On the measure of BMI against the occurrence of hypertension, overweight (21.6%) and obese (31.0%) group recorded the highest prevalence of hypertension relative to underweight (11.1%) and normal weight (7.5%). This is an indication of a rising trend of hypertension with increasing BMI and with an established upward trend of obesity, hypertension can only be expected to increase. Being a male and living in a rural settings provided some protection against hypertension. The age most at risk of hypertension was 60-69 years.

The other co-morbid condition assessed in the study was hyperglycaemia. Findings showed an 8.5% overall prevalence rate for hyperglycaemia. This is higher relative to a 5.6% recorder for Ghana in 2014 (WHO, 2014b). In another study in the Ashanti region of Ghana, prevalence of hyperglycaemia was 5.03% (Lyman *et al*., 2016). These differences could be attributable to the differences in methodology and type of population used. Irrespective of the differences, the results showed an emerging upward trend of hyperglycaemia in the study area (and Ghana in general) considering the almost non-existence of hyperglycaemia in the past. This emerging upward trend of obesity and hyperglycaemia is partly due to increasing prevalence of obesity in the population and this is in line with a WHO (2010) finding that revealed that the risk of developing heart diseases (including hypertension) and diabetes increase with an increasing Body Mass Index (BMI). A holistic approach to healthy lifestyle through health promotion activities to the population should therefore be encouraged as the evidence points to not only a rising trend of obesity, but also of hypertension and hyperglycaemia. The approach should take into consideration the identified predictors and groups mostly vulnerable to obesity in designing any healthy living intervention and tailoring health promotion messages appropriately. For instance, urban dwellers are highly vulnerable to overweight/obesity relative rural dwellers who have a reduced odds of 0.66 (CI: 0.37 – 1.17) suffering from the condition. Similarly, male gender provides some protection against overweight and obesity with a reduced odds of 0.4 (CI 0.22 -0.71) compared with women.

5. 2 Limitations of the Study

The major limitation of a cross sectional survey is its inability to determine causation. Causation could therefore not be established in this study between obesity and its comorbidities. Additionally, a single 24-hour recall cannot be used to characterize the usual food intake of a respondent though that was used to measure respondent's nutrients intake. The work of Non-Governmental organizations in the areas in supplementary food programs could influence respondents to under report food intakes. The data was gathered in the dry season. This could influence the fruit and vegetable intake of respondents. Taking blood pressure at a single occasion irrespective of the 5 minutes allowed in taking the repeated measure could still results in false positive or false negative classification of hypertension.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The aim of this research was to determine the prevalence of obesity, oxidative stress and perception of body image among adults in Wa Municipal. Other variables of interest were dietary intake of respondents and how that related to obesity, general knowledge of respondents on obesity and co-morbidities of obesity. Below are the conclusion reached after the study.

- The prevalence of overweight and obesity in Wa Municipality were 23.1% and 9.1%, respectively.
- Females were more overweight/obese with more suffering hypertension compared to males. However, no significance difference was observed in hyperglycaemia.
- Respondents living in urban settings were more at risk of overweight/obesity, hypertension and hyperglycaemia relative to in rural areas.
- Hypertension and hyperglycaemia were observed to be higher in obese persons compared to the non-obese.
- Reduced glutathione (GSH) as biomarker of oxidative stress showed no significant variation among different BMI categories.
- Respondent who desire to lose weight are six times more likely to be overweight or obese.
- Overweight/obese persons are two times more likely to have a wrong perception about their body image relative to the normal weight group and with the right perception of their BMI status, overweight/obese persons are more likely to desire to lose weight.
- High nutrient intake had a positive association with overweight/obesity.

- Being a female, desiring to lose weight and high energy intakes were predictors of obesity among respondents.

6.2 Recommendations

- The co-morbidities of obesity used in this study were hypertension and hyperglycaemia. It is recommended that metabolic syndrome is used in similar studies to expand the scope of obesity co-morbidities in the study area.
- The study design used was Cross-Sectional. It was therefore difficult to established causation between obesity and it co-morbidities. It is recommended that prospective study design is employed in further studies to establish causation.
- It is also recommended that prevalence of childhood obesity and it dynamics be included in further studies as that is seen to be emerging in the Wa Municipality.

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APPENDICES 1 -CONSENT FORM

Statement of person obtaining informed consent:

I have fully explained this research to ____________________________________ and have given sufficient information about the study, including that on procedures, risks and benefits, to enable the prospective participant make an informed decision to or not to participate.

DATE: _____________________ NAME: _________________________________

Statement of person giving consent:

I have read the information on this study/research or have had it translated into a language I understand. I have also talked it over with the interviewer to my satisfaction.

I understand that my participation is voluntary (not compulsory).

I know enough about the purpose, methods, risks and benefits of the research study to decide that I want to take part in it.

I understand that I may freely stop being part of this study at any time without having to explain myself.

I have received a copy of this information leaflet and consent form to keep for myself.

NAME:____

DATE: ____________ SIGNATURE/THUMB PRINT: ___________________

Statement of person witnessing consent (Process for Non-Literate Participants):

I ______________________________(Name of Witness) certify that information given to

______________________________(Name of Participant), in the local language, is a true reflection of what l have read from the study Participant Information Leaflet, attached.

WITNESS' SIGNATURE (maintain if participant is non-literate): ____________________

MOTHER'S SIGNATURE (maintain if participant is under 18 years): ________________

MOTHER'S NAME: ____

FATHER'S SIGNATURE (maintain if participant is under 18 years): _________________

FATHER'S NAME: ____

APPENDICES 2- STUDY QUESTIONNAIRE

Topic: The prevalence of obesity and oxidative stress among adults in Wa Municipal.

Sub-district   Community: Participant Code

Rural   Urban: Date:

Part A: Demographic characteristics

1. Age (Years) ☐   2. Gender: Male ☐   Female ☐

3. Educational level – what is your highest level of education achieved?

A. None ☐   B. Primary ☐   C. JHS/JSS ☐   D.SHS/Voc/Tech ☐

E. Tertiary ☐   E. Other please state ……………………………………………………………………

4. What is your Occupation?

……………………………………………………………………………………………

5. Marital Status

A. Married ☐   B. Single ☐   C. Divorced ☐   D. Widowed ☐

6. Ethnicity

A.Waale ☐   B. Dagao ☐   C. Sissale ☐   D. Others ☐

Specify:

Part B: Anthropometric measurements

A. Height(cm):………   B. Weight(Kg)……   C. Waist circumference(cm)……

D. Hip circumference(cm)………………

Part C: Physiological measurements

A. Blood Pressure (mmHg) ..in triplicate in five minute intervals.

I. II. III.

B. Fasting blood sugar (Mmol) …… C. Glutathione level (μM)…………………

Part D: Body image assessment

For each figure selected, write the number beneath the picture in the space provided

1. Which of these do you consider your current weight to be? a. Underweight ☐

b. Normal Weight ☐ c. Overweight ☐ d. Obese ☐ e. Don't Know ☐

2. What image do you think most closely resembles the way you look currently? ☐

3. Which image best describes how you ideally wish to look? ☐

4. Which image represents the way you think your spouse should look? ☐

5. Do you desire to lose weight? Yes ☐ No ☐

If Yes, Why?...

………
…………………………………..

Part E: Dietary data – 24-hour recall

Menu Type	Time	Type of meal/dish or ingredients	Estimated portion sizes	Cooking method	Home-made or purchased
Breakfast					
Lunch					
Super					
Snack 1					

Snack2					

Part F: General health / knowledge and perception questions

1. Have you ever being diagnosed of any chronic disease? Yes ☐ No ☐

If yes, what kind of disease? ……………………………………………………….

2. Do you drink alcohol? Yes ☐ No ☐

3. Do you smoke? Yes ☐ No ☐

4. How often do you engage in active exercising?
……..

………

………

5. What do you understand by obesity (If no, skip to question 9)……………………………………………………….

………

……..

6. What causes obesity?
………

………
………………………………………

………
……………………………………………………………………………………

7. What are some of the adverse health effects associated with obesity?..

………
…………………………………………………………….

………
………………………………………………………………………………….

8. Do you know how to lose weight? Yes ☐ No ☐

If yes, what would you do to lose weight?
………
……….

………
………………………………………………………………

………
…………………………………………………………………………………

9. Do you know about Hypertension? Yes ☐ No ☐ (If no, skip to question 11)

If yes, what causes hypertension?
………
……………………..

………
…………………………………………………………….

………
………………………………………………………………………………..

10. Do you know how to reduce/manage hypertension? Yes ☐ No ☐

If yes, what would you do?
………
……………………………………

……
…………………………………………………………..

……
…………………………………………………………………………….

11. Do you also know anything about diabetes? Yes ☐ No ☐

If yes, what causes diabetes?
……
…………………………………..

……
…………………………………………………………..

……
……………………………………………………………………………..

12. Do you know anything on how to prevent/manage diabetes? Yes ☐ No ☐

If yes what would you do?
……
………………………………………..

……
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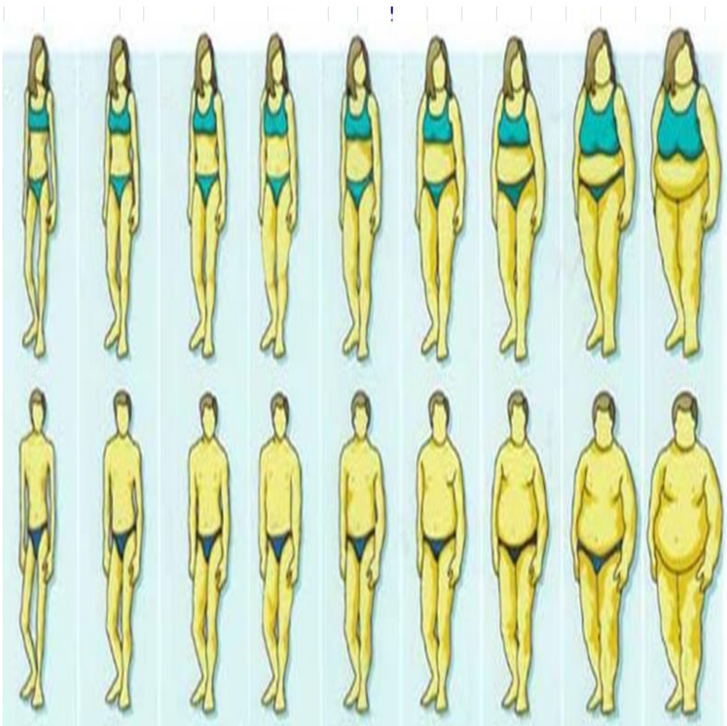
STUNKARD'S FIGURE RATING SCALE



This is the end of our questions. Thank you for your time!!

APPENDICES 3 – MEAN NUTRIENTS INTAKE AND THEIR RDAs

Nutrient	Mean	Minimum	Maximun	RDAs for adults		Remarks
				Males	Females	
kcal	2030.9209	591.39	5688.97	2,900	2,200	2.300 for 51+(M) 1,900 for 51+(F)
protein (g)	69.6839	5.91	342.00	56	46	
Total fat (g)	37.7718	4.73	133.71	65	65	
Carbohydrates(g)	360.6518	55.77	1038.53	130	130	
Dietary Fibre (g)	31.8957	2.21	160.36	38	25	30 for 50+(M), 21 for 50+(F)
Sugars (g) total	51.5439	1.33	687.95			
Calcium (mg)	499.8215	29.51	1663.84	1000	1000	1200 for 71+ (M), 1200 for 51+(F)
Iron (mg)	19.7749	1.70	119.09	8	18	
Magnesium (mg)	473.5014	31.60	2843.89	400	310	430 for 31+(M), 320 for 31+(F)
Phosphorus (mg)	1333.2077	104.28	6563.71	700	700	
Potassium (mg)	2631.0910	344.44	16352.86	4700	4700	
Sodium (mg)	2563.5939	84.36	7469.60	1,500	1,500	1300 for 51+(M & F)
Zinc (mg)	11.3547	.88	51.64	11	8	
Copper (mg)	1.7806	.25	12.24	0.9	0.9	
Manganese (mg)	5.3724	.73	22.42	2.3	1.8	
Vitamin C (mg)	66.4355	.39	297.42	90	75	
Thiamin (mg)	1.9692	.11	12.40	1.2	1.1	
Riboflavin (mg)	1.3111	.08	4.12	1.3	1.1	
Niacin (mg)	19.8567	1.81	61.19	16	14	
Vit B-6	1.6099	.33	5.96	1.3	1.3	1.7 for 50+(M), 1.3 for 50+(F)
Folate (mcg) Total	691.8840	28.44	8757.30	400	400	
Vit B-12 (mcg)	.8373	0.00	8.13	2.4	2.4	
Vit A mcg_RAE	80.4421	0.00	571.84	900	900	
Vit. E (mg)(alpha-tocopherol)	4.8510	.37	20.56	15mg	15mg	

Sources of RDAs: National Institute of Health (NIH) and Institute of medicine.