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OBESITY AND HYPERTENSION AMONG ADOLESCENTS IN SENIOR HIGH SCHOOLS IN THE ASANTE AKIM NORTH DISTRICT, GHANA

BY

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OCTOBER, 2018

DECLARATION

I declare that this thesis is the result of my own research and has never been submitted for the award of any degree in any institution. References to other people's work have been duly acknowledged.

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DEDICATION

This dissertation is dedicated to my wife, Nihad Abdul- Aziz and mother, Hajia Ayisha Inusah for their love, support and inspiration throughout this programme.

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I am grateful to my supervisor, Dr. John Arko-Mensah for his unwavering guidance and support through this project. Despite his very busy schedule, he availed himself to guide me through every stage of this project.

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ABSTRACT

Introduction: Adolescent obesity and hypertension have reached alarming levels and their prevalence continues to rise to the extent that WHO has labeled them as epidemics. Adolescent obesity and hypertension are of importance because adolescents carry these diseases into adulthood and are likely to develop non-communicable diseases in their early years of adulthood. Despite this challenge, the burden of obesity among adolescents and its relationship with hypertension among adolescents in Ghana is unclear.

Objective: The aim of this study was to determine the prevalence of obesity and its relationship with hypertension among adolescents in senior high schools in Asante Akim North district.

Methods: This was a school-based cross-sectional study involving four hundred and twenty-nine (429) apparently well adolescents randomly selected from three (3) Senior High Schools in Asante Akim North district of Ashanti region. Height, weight, and blood pressure (SBP and DBP) were measured by standard methods and body mass index (BMI) for age and sex calculated. STATA 15 was used in data analysis. Descriptive statistics were used to describe anthropometric characteristics and blood pressure measurements. Chi-square, Pearson's correlation, logistic and linear regression analyses were used to assess the relationship between BMI and blood pressure.

Result: Four hundred and twenty-nine students (429) were recruited for the study comprising 170 males and 259 females. The prevalence of obesity was 2.6% (95% CI 1.3%, 4.5%) and the prevalence of overweight was 10.5%. All the obese participants were female. The prevalence of hypertension among the respondents was 12.8% (95% CI 9.8%, 16.4%) and the prevalence of pre-hypertension was 7.5%. BMI correlated positively with

SBP and DBP. From logistic regression analyses, BMI was significantly associated with high SBP (OR 3.39, 95% CI: 1.27–9.06, $p < 0.05$).

Conclusion: Adolescent hypertension and obesity were high among the study population in Senior High Schools in the Asante Akim North District in Ghana, with a prevalence of 12.8% and 2.6%, respectively. It is important that all relevant stakeholders should collaborate in implementing preventive strategies to curb adolescent obesity and hypertension. Findings from this study are expected to guide policy formulation.

Keywords: Obesity, Hypertension, Adolescents, Body Mass Index, Asante Akim North district

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LIST OF ACRONYMS

Acronym	Meaning
BMI	Body mass index
CDC	Center for disease control
CVD	Cardiovascular disease
DBP	Diastolic blood pressure
GHS	Ghana health service
NCD	Non-communicable disease
SBP	Systolic blood pressure
WC	Waist circumference
WHO	World health organization

DEFINITION OF TERMS

Adolescent	An individual typically between the ages of 13 and 19, considered to be in a transitional stage from childhood to adulthood.
Hypertension	Elevated systolic and/or diastolic blood pressure above the 95^{th} percentile for an individual's age and sex.
Obesity	Excess accumulation of body fat or an increase in body weight with BMI above the 95^{th} percentile for age and sex.
Overweight	BMI between the 85^{th} and 95^{th} percentile for sex and age.
Prehypertension	Blood pressure for sex and age between the 90^{th} and 95^{th} percentile.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Cardiovascular disease (CVD) is currently the first cause of mortality globally, including the developing countries (Estel & Conti, 2016). This clustering of cardiometabolic abnormalities termed metabolic syndrome (Alberti et al., 2005), is an established risk factor for CVD (Nilsson et al., 2007).

Adolescent hypertension and obesity have increasingly become a public health concern globally. Obesity is characterized by an increase in body weight and fat. According to WHO (2007), adolescent obesity refers to a body mass index (BMI) equal to or more than the 95th percentile for sex and age. Similarly, a value from 85th to 95th percentile is termed overweight while normal BMI ranges from 5th to the 85th percentile. Any individual with BMI for sex and age less than 5th percentile is classified as underweight. Excess consumption of calories over expended calories is the fundamental cause of overweight and obesity. Worldwide, increased high-fat diet consumption and reduced physical activity from sedentary lifestyles are major factors contributing to the increasing burden of obesity (WHO, 2016).

In both developed and developing nations, there is currently an epidemic of obesity among all ages (Ofei, 2005; WHO, 2010). Worldwide, between 1980 and 2014, the obesity prevalence doubled. In 2015, there were in excess of 42 million overweight children less than age five, 25% of who lived in Africa (WHO, 2017).

Obesity, once thought to be a problem of developed countries, is currently on a steady increase particularly in urban settings in lower income countries. For example, between

1990 and 2014, there was doubling in the number of obese or overweight African children, from 5.4 million to 10.6 million (WHO, 2016).

The most crucial stage for the development of obesity occurs during childhood and adolescence due to changes in body fat composition. Therefore, if obesity develops during the childhood or adolescence stage, there is an elevated risk of obesity persisting into adulthood with its attending complications (Dietz, 1994). From age six years, about 50% of obese children grow to become obese adults. In contrast, only a tenth of non-obese children develop obesity as adults (Guo et al., 2002).

Ghana, like many other developing countries, is going through an epidemiologic and nutritional transition. This is a consequence of globalization and westernization of our diets, and improved socio-economic conditions with a gradual shift from the prevalence of predominantly communicable diseases to non-communicable diseases (NCDs) with the associated prevalence of obesity and obesity-related illnesses (WHO, 2009).

Non-communicable diseases like CVD and diabetes tend to occur earlier for overweight or obese children. Fortunately, overweight or obesity is preventable to a large extent. Therefore there is the need to highly prioritize prevention of obesity in childhood (WHO, 2017).

Worldwide, hypertension prevalence in adults is about 22% and results in an estimated 9 million deaths per year (WHO, 2014). Globally, in 2015, hypertension was a leading cause of disability-adjusted life years (DALYs) (Forouzanfar et al., 2016). Hypertension among adolescents is defined by the National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents (2004) as sex, age, and height specific systolic and/or diastolic pressure equal to or more than the 95th percentile on at least three different occasions. Also, any measurements from the 90th to 95th percentile or equal to or more than 120/80 mmHg is classified as prehypertension in adolescence or childhood. Systolic and/or diastolic blood pressure below the 90th percentile for height, age and sex is normal. Physical inactivity, obesity and overweight, together with elevated blood glucose, tobacco use and hypertension are leading global risks for mortality. These factors result in a heightened risk of CVD, malignancies and other chronic conditions worldwide (WHO, 2009). As a major CVD risk, it is crucial that adolescent hypertension is detected early to help control the burden of CVD in adulthood (Prabhajot et al., 2005).

Obesity is a documented critical part of the metabolic syndrome (Liu et al., 2013). Obesity may lead to metabolic conditions such like dyslipidaemia, hypertension, and diabetes mellitus type 2 by promoting excess free fatty acid (FFA) release, catecholamine overactivity, mineralocorticoid and lipase dysfunction and abnormal release of adipocyte factors, which are mediated through leptin. Through promoting fat-related metabolic diseases, obesity may indirectly lead to cardiovascular diseases (Bays & Ballantyne, 2017). It has become evident that obesity in the young plays a major part in the onset of major cardiometabolic diseases like coronary heart disease and hypertension, important components of metabolic syndrome in adulthood (Al-Bachir & Bakir, 2017).

Despite its limitations, BMI is the commonest index for the measurement of overweight and obesity. It is recognized that not all individuals with metabolic disease are obese, likewise, not all obese individuals suffer metabolic disease. It has also been established that BMI and metabolic disease are not always related directly (Bays & Ballantyne, 2017).

Establishing the relationship between metabolic disease and weight status is essential to understanding the mechanisms underlying fat-related metabolic disease (Bays et al., 2007). Also, early diagnosis and control of adolescent obesity and hypertension will significantly improve the long-term outcomes of cardiovascular diseases.

1.2 Problem statement

Worldwide, obesity is the most frequent cause of preventable morbidity and mortality. Obesity is linked with more mortalities than underweight and more than half the world's population are at risk (WHO, 2010). Globally, obesity is the fifth leading cause of death and is now at an epidemic level. About 2.8 million people die yearly from complications related to obesity (WHO, 2017). Generally, as body fat increases there is an increased risk of metabolic conditions like dyslipidaemia, hypertension, and diabetes mellitus (WHO, 2016). Metabolic syndrome is associated with CVD, which is the topmost cause of deaths worldwide (Liu et al., 2013), and therefore is of major concern.

Ghana, like many other developing countries, is going through an epidemiologic and nutritional transition. This is characterized by globalization and westernization of our diets and improved socio-economic conditions with a gradual shift from communicable diseases to non-communicable diseases and a rising prevalence of obesity and obesity-related conditions (Ofei, 2005; WHO, 2009).

Adolescents are susceptible to obesity or overweight in their transition to adulthood (Gordon-Larsen et al., 2010). Increasing prevalence of adolescent obesity is a major concern for developing countries, particularly because their obesity persists into adult life with its numerous co-morbidities (Nader et al., 2006) and affects economic growth and productivity negatively.

Non-communicable diseases tend to occur at a younger age for overweight or obese children. Obesity is preventable to a large extent, and prioritization of preventable measures are prerequisite for preventing childhood obesity (WHO, 2017). There is, therefore, an enormous strain on health care use and costs due to the increasing prevalence of obesity (Ofei, 2005).

1.3 Conceptual framework

The conceptual framework shows the major health effects of obesity. These include cardiometabolic diseases like diabetes mellitus, hypertension, and dyslipidaemia with its associated risk of mortality and morbidity. Other major effects of obesity on health include depression, cancers, respiratory difficulty, and musculoskeletal diseases. The framework also shows the risk factors that lead to obesity. The main risk factors which are dietary habits, physical inactivity, physiological or metabolic, socioeconomic factors and family history or genetics are responsible for obesity.

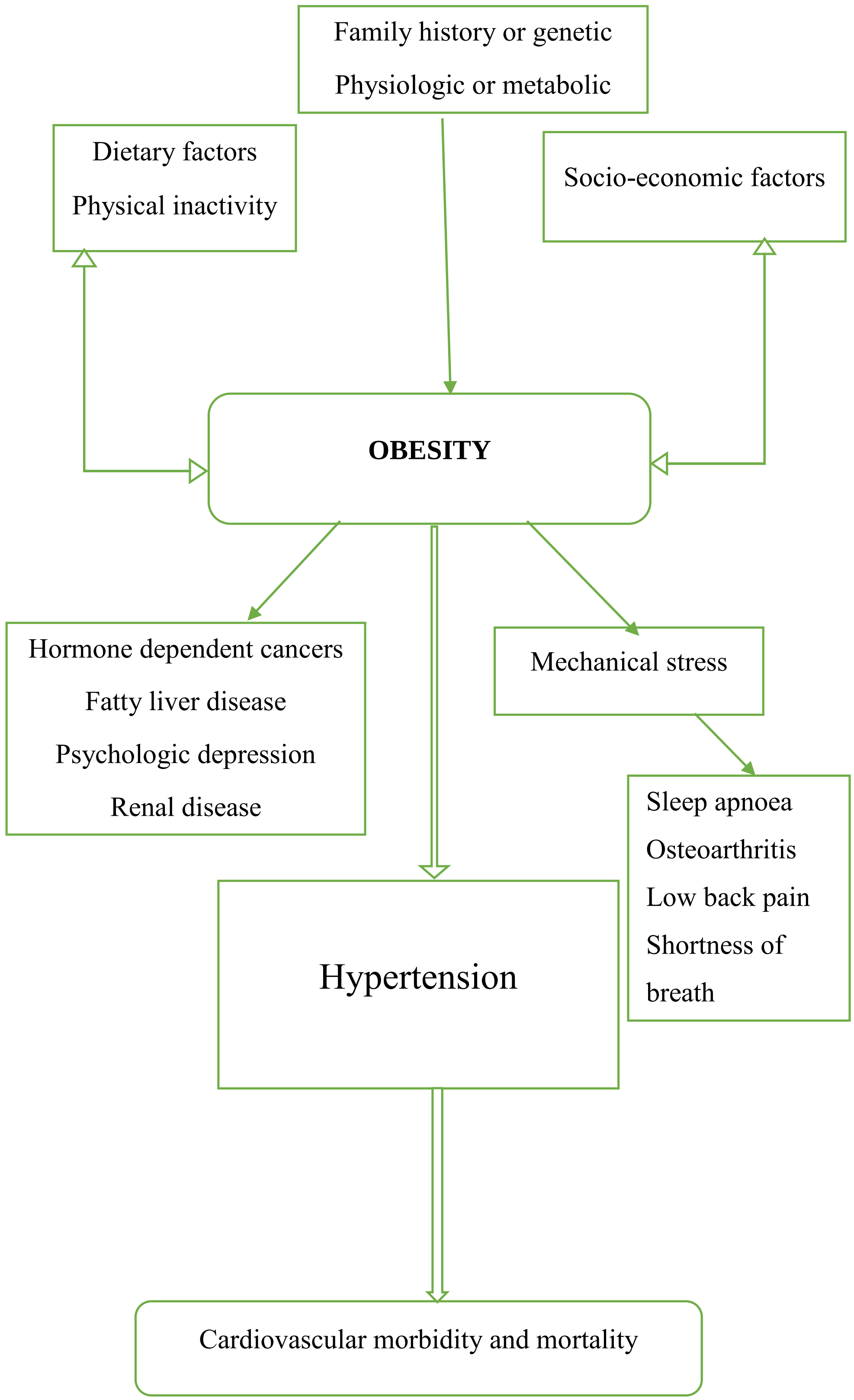

Figure 1: Conceptual framework

1.4 Justification

Obesity and hypertension have become major issues of public health concern globally. In the past decade, the percentage of individuals with metabolic syndrome risk factors has doubled (Franco et al., 2009). Data on obesity in adults in Ghana is available. In contrast, there is not much data on obesity and its relationship with hypertension among adolescents. This study is thus expected to provide data to fill in the data gap and to encourage further studies on obesity and hypertension among adolescents. The result of the study is to help guide all stakeholders and policymakers in the Asante Akim North district, particularly high school heads and youth pressure group leaders and Ghana at large on the burden of obesity and hypertension so as to come up with appropriate preventive measures. This study will also provide an opportunity to screen adolescents to detect any cases of hypertension and obesity so that early referral and intervention can be sought.

1.5 Objectives

1.5.1 General Objectives

To determine the prevalence of obesity and its relationship with blood pressure among adolescents in senior high schools in Asante Akim North district.

1.5.2 Specific Objectives

1. To determine the prevalence of obesity among adolescents in Senior High Schools in Asante Akim North district.
2. To determine the prevalence of hypertension among adolescents in Senior High Schools in Asante Akim North district.

3. To determine the relationship between BMI and blood pressure among adolescents in Senior High Schools in Asante Akim North district.

1.5.3 Research Questions

1. What is the prevalence of obesity in adolescents in Senior High Schools in Asante Akim North district?
2. What is the prevalence of hypertension among adolescents in Senior High Schools in Asante Akim North district?
3. What is the relationship between BMI and blood pressure among adolescents in Senior High Schools in Asante Akim North district?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Background

Obesity is an excessive or abnormal accumulation of body fat that may impair health (WHO, 2016). A more than double increase in the obese population around the world since 1980 has been documented, with over 600 million adults out of 1.9 billion overweight adults being obese in 2014 (WHO, 2016).

Hypertension is a major risk factor for cardiovascular disease (CVD) (Bo et al., 2009). Worldwide, hypertension ranks in the three topmost causes of mortality (WHO, 2002). Of the risk factors for CVD, hypertension is most prevalent globally (Lurbe et al., 2005). Though hypertension is commoner in adults than children, its prevalence has increased among adolescents in some developed countries in the past decade. This is largely due to increasing obesity prevalence among such populations (McNiece et al., 2007; Santi et al, 2015). Additionally, evidence supports the tracking of childhood hypertension into adulthood. About half of hypertensive adults developed such elevated blood pressures when they were children (Redwine et al, 2012; Chiolero et al., 2013).

Overweight and obesity, together with hypertension, tobacco use, physical inactivity and diabetes mellitus are the major global risk factors for death. These factors result in increased risk CVD, malignancies and other chronic conditions worldwide (WHO, 2009).

Epidemiologic data on the prevalence of obesity and its relationship with hypertension in Ghanaian children and adolescents is scant even though there is a lot of such information among adults.

2.2 Obesity among adolescents

Adolescents are susceptible to overweight or obesity in their transition to adulthood (Gordon-Larsen et al., 2010). Changes in the composition of body fat occur during childhood and adolescence. These stages are critical to the development of obesity. An individual who develops obesity during these formative ages has a heightened risk of obesity persisting into adulthood with its associated complications (Dietz, 1994).

2.2.1 Definition of adolescent obesity

Body mass index (BMI) is recommended as an index for the assessment of body weight status by professional societies such as the American Health Association (Rastogi et al., 2012). According to WHO (2016), a person is said to be obese if his/her BMI is above or equal to 30 kg/m^2. An individual with BMI above or equal to 25 kg/m^2 is classified as overweight. These definitions, however, are applicable to adults and may not be appropriate for adolescents.

A number of BMI reference charts are utilized in practice. The charts are age and gender-specific. The Center for Disease Control (CDC) chart (Kuczmarski et al., 2002), International Obesity Task-Force reference data (Cole et al., 2000) and WHO reference data (de Onis et al., 2007) are the most widely used reference data charts**.**

According to WHO (2007), obesity among adolescents is BMI for sex and age equal to or above the 95th percentile. BMI between 85th and 95th percentile is termed overweight while individuals with BMI between 5th and 85th percentile are classified as normal. Underweight refers to BMI below the 5th percentile for sex and age.

2.2.2 Prevalence of obesity among adolescents

Obesity is a major public health issue. There is currently a global epidemic of obesity in all ages (WHO, 2010). From 1980 to 2014, the worldwide prevalence of obesity doubled. In 2015, more than 40 million children less than 5 years of age were obese or overweight, 25% of who lived in Africa (WHO, 2017).

Adolescent obesity has dramatically increased in prevalence in recent times. According to Gelbrich et al. (2008), 10% of children and adolescents globally are obese. Childhood and adolescent obesity or overweight has recorded a huge increase in prevalence in the developed world. Lobstein et al. (2004) reported that Europe, South America, and North America had a childhood and adolescent obesity prevalence of over 20%. Also, about 22.6% of females and 23.8% of males were obese or overweight in 2013 (Ng et al., 2014).

In developing countries, the prevalence of obesity among young adults ranges between 2.3 and 12%, and overweight almost 30%. This is consistent with rates of between 22 to 35% in developed countries such as the United Kingdom and United States (Poobalan & Aucott, 2016).

High adolescent obesity prevalence has been documented in developing countries, with 13.4% in females and 12.9% for males in 2013 (Ng et al., 2014). In sub-Saharan Africa 2% of children and adolescents are obese (Lobstein et al., 2004).

Among students in universities in low and middle-income countries, Peltzer et al. (2014), reported a 22% prevalence of obesity or overweight. Also, they identified that overweight or obese males were younger than obese or overweight females.

According to Ejike & Ijeh (2012), among young adult Nigerians, the prevalence of obesity and overweight was 1.3% and 19.4% respectively. In South-western Nigeria, Durazo-Arvizu et al. (2008) also found 5% and 20% obesity and overweight prevalence, respectively. An obesity prevalence rate of 0.7% was reported by Solomon et al. (2017) among adolescents in Ado-Ekiti. Oduwole et al. (2012), in their study in Lagos, showed that overweight had a prevalence of 13.8% and obesity, 9.4% among adolescents. Obesity prevalence in Dar es Salem, Tanzania was reported as 19.2% (Shayo & Mugusi, 2011) while in the Republic of Benin, it was reported to be 18% (Sodjinou et al., 2008).

In Ghana, Amoah (2003) in his study in Accra revealed prevalence of obesity of 14.1% and 23.4% overweight prevalence in adults over 25 years of age. Mohammed & Vuvor (2012) in their study among pupils of a primary school in Accra found a prevalence of obesity of 10.9% among the participants with the prevalence higher among girls than boys. A study by Kumah et al. (2015) showed that 13% of students in Kumasi aged 10 to 20 years were obese or overweight. Kullah (2015) reported a 1% prevalence of obesity among adolescents in the Wa municipality.

2.2.3 Risk factors for adolescent obesity

There is a lot of data on the causes and risk factors of overweight and obesity. Many risk factors have been identified. According to the WHO (2016), excess consumption of calories over calories expended is thought to be the underlying cause of obesity and overweight. This results in excess accumulation of energy. The increased consumption of high fat, energy-rich foods and decreased physical activity level due to the adoption of a sedentary lifestyle is described to be contributory to obesity globally. Urbanization and other societal and environmental modification are significant factors in the changes in physical activity level and dietary patterns. According to Heber (2010), consumption of certain diets can lead to abnormal metabolism and promote obesity. These diets, referred to as obesogenic, include foods with certain fats and sugars.

Also, biological and physiological factors contribute to the emergence of obesity and overweight. These factors include insulin resistance with an associated hyperinsulinism, abnormal regulation of satiety and the genetic make-up of an individual (Codogno & Meijer, 2010).

Also, obesity in young adults has a link with gestational and early developmental factors. Association between BMI and maternal anthropometry, fetal nutrition insufficiency, birth weight, birth order, and early child growth, has been established (Adair, 2007).

Regarding underlying factors, socioeconomic status is positively associated with obesity, whereas physical activity is reported to be protective (Sodjinou et al., 2008; Muhihi et al., 2013). Kumar & Kelly (2017) also revealed that social and economic issues are significant risk factors for obesity and overweight.

Unhealthy lifestyle habits which comprises lack of physical activity, unhealthy eating patterns (that is consumption of more calories than your body can use, eating of too much saturated and trans fats and foods high in added sugar), inadequate sleep and high amounts of stress, can be changed by an individual. On the other hand, factors like genetics and family history, sex, age, ethnicity, and race cannot be changed (National Heart Lung and Blood Institute & National Institutes of Health, 2017).

In a systematic review of obesity and overweight among young adults in developing countries, lifestyle changes were seen to have resulted in the increasing obesity prevalence and its associated cardiovascular risk. It also showed that urban-dwelling young adults have significantly higher BMIs than their rural counterparts. This may not only be as a result of their environment but also its influence on their lifestyles (Poobalan & Aucott, 2016).

2.2.4 Consequences of adolescent obesity

Obesity is the most frequent cause of preventable illnesses and death globally. It is associated with more deaths compared to underweight and as many as 65% of the world's population are at risk (WHO, 2010). Globally, an estimated 2.8 million people die yearly from obesity-related complications (WHO, 2017). Generally, obesity is associated with an increased risk of cardiometabolic diseases like hypertension and diabetes mellitus, as well as non-cardiovascular diseases like gallbladder disease, osteoarthritis, and cancers notably endometrial, breast, prostate and colon cancers. As the BMI increases, the risk of non-communicable diseases also increases. There are also serious effects of obesity on the psychosocial health of an individual. It is therefore important to assess obese or overweight individuals for the presence of co-morbid conditions (Ofei, 2005; WHO, 2016).

Liu et al. (2010) revealed that overweight and childhood obesity are risks for metabolic syndrome with its attendant cardiovascular complications in adulthood. Childhood obesity is a major public health challenge because of its rapidly increasing prevalence. Obese children have an increased risk of obesity, premature death, and disability in their adulthood. Increased risk of fractures, respiratory difficulties, elevated blood pressures, insulin resistance, premature onset of cardiovascular diseases and psychological effects may also occur in these obese children (WHO, 2016). Non-communicable diseases such as cardiovascular diseases tend to occur at a younger age for children who are overweight or obese (WHO, 2017).

In both young and elderly population, many comorbidities are associated with obesity. In addition to cardiovascular diseases, problems with vision, impairment of hepatic function, cancers and other diseases, as well as the financial burden on controlling these diseases, have been described (Wang et al., 2011). Psychological effects have also been recognized in obese and overweight individuals, as they are often stigmatized and described as indecent, dirty and unwilling to work (Puhl & Heuer, 2010).

2.3 Hypertension among adolescents

In both developed and developing countries, hypertension among adults is a major issue of public health concern and it has been established as a major risk factor for cardiovascular disease and premature deaths (Sharma et al., 2010). Adolescents are generally well and therefore hypertension usually goes undiagnosed and is only discovered when they fall ill and visit a hospital. It has therefore been recommended that blood pressure measurements be done routinely among adolescents (NHBPEP, 2004).

2.3.1 Definition of adolescent hypertension

Hypertension refers to persistently elevated arterial blood pressure above a defined normal cut-off (Moura et al., 2004). Childhood and adolescent hypertension cannot be defined by a single cut -off value. Definition of childhood and adolescent hypertension differ in various reports. This has evolved over the past 30 years (Vogt, 2001). In adults, a standard cut – off of 140/90 has traditionally been used. This may not be applicable to children and adolescents.

In 1977 National High Blood Pressure Education Program (NHBPEP) Working Group on Children and Adolescents first defined hypertension as blood pressure above the 95th percentile for gender and age. These percentile charts were developed for American children and adolescents. Subsequent updates on the initial definition resulted in the addition of height- specific percentile to the age and gender percentiles curves. Currently, the fourth report of the NHBPEP is being used. According to this report, SBP and/or DBP equal to or more than age, gender and height specific 95^{th} percentile on more than 2 occasions depicts hypertension. Also, any measurements from the 90^{th} to 95^{th} percentile or equal to or more than 120/80mmHg is classified as prehypertension in adolescence. They defined normal blood pressure as SBP and/ or DBP less than the 90^{th} percentile for age, gender, and height (NHBPEP, 2004).

2.3.2 Prevalence of hypertension among adolescents

Childhood and adolescent hypertension is of serious concern due to its rising prevalence. Though high blood pressure is more common in adults than children, in the past decade, its prevalence has increased among adolescents in some developed countries. This has been attributed to increasing prevalence of obesity among such populations (McNiece et al., 2007; Santi et al., 2015). Several studies have reported the prevalence of hypertension among adolescents. These rates range from 1.3% to 21.6% (Soudarssanane et al, 2006; Mijinyawa et al., 2008).

Globally, differences in the prevalence of hypertension in children and adolescents exist between countries and regions. Generally, the rates are higher in the USA, Middle East and Europe (Ogboye, 2012). A study in Quebec, Canada reported a prevalence of 12-23% among adolescents (Paradis et al., 2004). In Asia and the Middle East, Merhi et al. (2011) in their study among Lebanese children and adolescents reported hypertension prevalence rates of 10.5%. Also, Durrani & Waseem (2011) reported a hypertension prevalence of 9.4% among Indians aged 12 to 16 years. In their study, the prevalence was similar among both sexes. In another study in India, Sharma et al. (2010) showed that the prevalence of hypertension among adolescents was 5.7%. The prevalence was 6.8% among females and 4.7% among males.

Though hypertension was not common in Africans, recently, its prevalence and complications has steadily increased among African populations, due to poor diets, decreased physical activity and obesity (Zhou et al., 2017). In a systematic review of studies among African populations, it was revealed that the prevalence of hypertension was high among African adolescents, and an important risk factor for this high prevalence was obesity (Noubiap et al., 2017). They reported a prevalence of hypertension (SBP or DBP ≥95th percentile) of 5.5% (95% CI 4.2%, 6.9%) among children and adolescents in Africa.

In urban Egypt, Abolfotouh et al. (2011) reported a hypertension prevalence of 4% among children and adolescents aged 11 to 19 years. In their study, the prevalence was 4.5% among males and 3.6% among females. Monyeki et al. (2008) in their study in South Africa among children aged 7 to 13 years also reported a prevalence rate of 5.3%

In a study in Zaria state, Nigeria, a hypertension prevalence of 3.7% among adolescents was reported by Bugaje et al. (2005). A hypertension prevalence rate of 10.1% was reported among in-school adolescents in Ekiti state, Nigeria (Emmanuel et al., 2017). Ejike et al. (2010) also reported a prevalence of hypertension of 10.1% among school-going adolescents in urban and suburban populations in Nigeria. A study by Solomon et al. (2017) revealed a hypertension prevalence rate of 6.1% among adolescents in secondary schools in Ado-Ekiti, Nigeria.

In Ghana, a study by Kullah (2015) reported a prevalence of diastolic hypertension of 10.9% and systolic hypertension of (7.2%) among adolescents in Wa municipality. In a similar study among 14 to 19-year-old adolescents in Senior High Schools in the Ashanti region of Ghana, a 9.1% prevalence of hypertension was reported (Sekyere, 2017). These prevalence data suggest that the rates in developing countries are fast approaching rates in developed countries.

2.4 Relationship between adolescent obesity and hypertension

An association between hypertension and obesity among adolescents and adults has traditionally been established (Ejike et al, 2008; Nguyen et al, 2008). Though the mechanism is not well understood, BMI and blood pressure have been found to be positively correlated among adolescent populations (Agyemang et al., 2005; Ejike et al, 2008). Metabolic disease exists at all levels of BMI, though increased BMI is largely associated with a significant increment in prevalence of dyslipidaemia, diabetes mellitus and hypertension (Bays et al., 2007).

A school-based study among adolescents in Lagos showed a high prevalence of hypertension among obese adolescents (Oduwole et al., 2012). Hypertension and pre-hypertension prevalence increased steadily with rising BMI in both sexes, with none of the underweight children having a hypertensive range blood pressure. Several other studies have revealed a positive association between blood pressure and BMI (Cao et al., 2012; Senbanjo & Oshikoya, 2012; Dulskiene et al., 2014;).

Obirikorang et al. (2015) in their study on obesity and cardio-metabolic risk factors in a rural and urban population in Ashanti region in Ghana, revealed that obesity and overweight were critical risk factors for cardiometabolic and chronic conditions such as dyslipidaemia and hypertension. Their study showed a positive correlation between blood pressure, serum lipids, and anthropometric variables.

It has also been demonstrated that there is a 20% hypertension prevalence in the Americas with normal BMI but greater than 50% in those with obesity (Nguyen et al., 2008).

Among Syrian adolescents, it was revealed that increasing values of BMI significantly increases blood pressure and other biochemical markers. Fasting blood glucose, DBP and SBP were higher in the obese group as compared to those that had normal BMI. The blood pressures in the overweight group were also higher than that in the normal group but were lower than the pressures in the obese group (Al-Bachir & Bakir, 2017).

Among different populations worldwide, children and adolescents have been reported to have hypertension (Ejike et al., 2010). It is also believed that such hypertension in adolescence persists into adulthood. This phenomenon is worrying particularly in the developing world where disorders of nutrition among adolescence such as obesity have been documented (Ejike et al., 2009).

Understanding the relationship between hypertension and obesity is critical in evaluating and controlling the health burden and impact of the global epidemic of obesity which has huge implications on adolescent hypertension (Ogboye, 2012).

CHAPTER THREE

3.0 METHODS

3.1 Study Area

The study was conducted in the Asante Akim North district, located in the Ashanti region of Ghana. The district has a land size measuring about 1,126 square kilometres. It is bordered by Sekyere Kumawu to the north, to the south by Asante Akim South, to the west by Sekyere East and to the east by Kwahu East. Located in the east of Ashanti region, it lies between longitudes 0^0 15' and 1^0 20' West and latitudes 6^0 30' and 7^0 30' North. From the population census of 2010, Asante Akim North has a population of 68,186. Agogo, a town located approximately eighty (80) kilometres east of Kumasi is the capital of the district. The population of Agogo is 36,797. The main economic activity is farming. Asante Akim North district has several schools. These include Tertiary schools, Senior and Junior High Schools. There are three (3) Senior High Schools namely, Owerriman, Collins and Agogo State Senior High School, all public schools with boarding facilities. According to the administrative data collected from these schools, Collins Senior High School has a student population of 2779 (1348 females and 1431 males). Agogo State Senior High School has 2845 students, comprising of 1303 females and 1542 males, while Owerriman Senior High School has 1205 students with 540 females and 665 males.

3.2 Study design

This was a school-based quantitative cross-sectional study conducted among adolescents in Senior High Schools in Asante Akim North district, Ashanti region, in March 2018.

3.3 Variables

3.3.1 Independent variables

Age, Sex, Level of education (Year), Residential status in school, Place of Residence when not in school, Height, Weight, Body Mass Index (BMI).

3.3.2 Dependent variables

Systolic and Diastolic blood pressure.

3.4 Study population

The population comprised of female and male students from Senior High Schools in the Asante Akim North district aged 13 to 19 years.

3.4.1 Inclusion criteria

Male and female adolescent students, aged 13 years to 19 years, who gave their consent were included.

3.4.2 Exclusion criteria

The following were excluded from the study;

1. All non-adolescent students.
2. Any student who declined to participate in the study.
3. Any student who was seriously ill and could not take part in the study.

3.5 Sampling

3.5.1 Sample size

The required sample size was calculated with the Cochran's formula (Cochran, 1977): below:

Sample size, $N = \text{deff}\ \dfrac{z^2pq}{d^2}$

deff is the design effect (the ratio between the variance of the cluster design to the variance that would be obtained from a simple random sampling).

z is the confidence limits

p is the prevalence of obesity-related hypertension among adolescents. From previous studies, p = 15% (Oduwole et al., 2012)

q is given by 1-p

d is the acceptable deviation from the true value

For this study

z= 1.96 for CI at 95%

p= 15% =0.15

q=1-0.15= 0.85

d= 5%= 0.05

Sample size, $N = \frac{2 \times 1.962\ (0.15) \times}{0.05^2}(0.85)$

N= 392

A 10% non-response rate was factored into the sample size: 392 x 10%= 39.2

This gave a total sample size of approximately 432, Four hundred and thirty-two.

3.5.2 Sampling method

A multi-stage sampling technique was used. There are 3 Senior High Schools in the district, all public. For each school, a proportionate sampling was done based on the total student population and the minimum calculated sample size. Within each school, the students were stratified by year in school. A master list for each year group was obtained and numbered. A random number generator was used to select proportionate numbers from each year group. Any student who refused to participate was replaced by the next student on the list.

3.6 Data collection tools

Only participants who consented after a detailed explanation of the study protocol were included in the study. Interviews using self-administered questionnaires were conducted to obtain demographic and clinical data on students. To ensure that the questionnaires were answered independently, the students were supervised.

Body weight was measured with an electronic Seca scale (Model 704 7021098). Height was measured with a wall-mounted stadiometer to the nearest 0.1 cm. The weight and height were measured twice by two different pairs of Research Assistants and the average value used. The students were weighed bare-footed and in light clothing with their pockets emptied and before each weighing, the digital weighing scale was checked to make sure the reading was at zero kg. BMI was calculated as weight divided by height squared. Based on the value of the BMI for age, sex, and height, subjects were classified, using the WHO growth reference chart (WHO, 2007), as obese, overweight, normal or underweight. Obesity and overweight were defined as ≥ 95th and 85th to < 95th percentiles respectively. BMI for age ≥ 5th and <85th percentile was considered normal while BMI for age <5th percentile was considered underweight.

Systolic and diastolic blood pressure (DBP) was measured with participants sitting using a well calibrated electronic sphygmomanometer (Omron HEM-907- E, Omron Healthcare

Co. Ltd, Kyoto, Japan). These were measured twice by two different pairs of research assistants at least 10 minutes apart, and the average value used.

3.7 Quality control

A standardized procedure was used in the process of data collection to ensure uniform and high-quality data. The Research Assistants were trained effectively on the study protocol and I personally supervised and monitored the process of data collection and entry to ensure that there was no deviation from the standard protocols.

The electronic scale was calibrated daily by placing it on a flat floor, resetting the scale to zero kg and testing with standard calibration weights to ensure accuracy and precision of measurements.

The height, weight, systolic and diastolic blood pressures for each student were taken twice by two different pairs of Research Assistants and the mean values used to minimize intra-observer and inter-observer biases**.** The students were supervised and told to answer the questionnaires independently. Questionnaires were checked for completeness before they were accepted. Questionnaires were numbered during data entry to ensure that the questionnaires were not doubly entered**.** I closely monitored data entry clerks making sure data was entered twice by two different data entry clerks.

3.8 Data processing and analysis

3.8.1 Statistical methods

Data entry, cleaning, and analysis were done using Microsoft Excel 2010 and STATA 15. Blood pressure readings were classified according to the recommendations of the National High Blood Pressure Education Program Working Group on High Blood Pressure in

Children and Adolescents (2004). Hypertensives or pre-hypertensives were further categorized as having elevated blood pressure.

BMI was calculated as weight in kg divided by the height in metres squared. Participants were classified as obese, overweight, normal or underweight based on their BMI (WHO, 2007).

Data analysis was done using descriptive statistics. Continuous variables were expressed as means and standard deviation and categorical variables expressed as frequencies and percentages. The differences in the blood pressure values and anthropometric indices across various categories were compared using the independent-samples t-test, while proportions were compared using the Chi-squared ($\chi 2$) test. Pearson's correlation test was used to investigate the linear relationship between continuous variables (SBP, DBP, BMI, and age). A univariate linear regression analysis was done to determine the relationship between blood pressure (SBP and DBP) and BMI. A multiple linear regression analysis was then done controlling for selected predictor variables likely to have confounding effects. Logistic regression analyses were carried out on BMI, sex, and age using SBP and DBP as dependent variables. A p-value of less than 0.05 was considered statistically significant.

3.9 Ethical consideration

Ethical clearance was obtained from the Ethical Review Committee of the Ghana Health Service and permission was obtained from the Ghana Education Service and the School authorities before starting the study. A written informed consent was obtained from both parents or guardians and the study participants. Students above 18 years of age gave their consent before they were recruited into the study. Parent or guardian consent together with the assent of the student was sought for those younger than 18 years of age. Participant confidentiality and anonymity were assured. No student was forced or coerced to take part in the study. Participation was voluntary and there was no penalty for refusal to participate. The procedure employed in the study caused no physical or emotional harm. Participants were provided with health education and told their BMI status and blood pressure readings. Physician referral was recommended to those with abnormal findings. The data obtained was analyzed solely for the objective of the study and utmost discretion was exercised in the handling of the personal information provided. The questionnaires were secured in a locked cupboard. Data from the study was password-protected and stored on an external storage device.

3.10 Pretest or pilot study

Pre-testing of the questionnaires was carried out among 20 adolescents in Konongo Odumase Senior High School. This school is in the Asante Akim Central Municipal and shares similar characteristics with the schools in the study. This process enabled me to clarify the adequacy of the questions, reaction of the respondents to the research questions, estimate the approximate time for each measurement and help make the necessary corrections or adjustments to the questionnaire for the actual study. Pretesting also served as practice for the data collectors.

3.11 Limitations of the study

1. BMI was used to define overweight and obesity rather than waist circumference and waist to hip ratio, which are better predictors of adiposity. Also, the BMI categorization used were designed for developed countries and may not necessarily be applicable to our population.
2. The study did not assess risk factors for obesity or overweight and hypertension such as smoking, physical activity, diet and family history. It is recommended that future studies should assess the impact of such risk factors on BMI and blood pressure levels.
3. The definition of hypertension may not be exactly applicable to Ghanaian adolescents.
4. The findings from the study may not pertain entirely to adolescents in the district as a significant proportion of the study participants reside in other parts of the country and are only in Asante Akim district temporarily.

3.12 Assumptions

We assumed that there was no recall bias and all the information provided by the participants were accurate.

CHAPTER FOUR

4.0 RESULTS

4.1 Characteristics of study participants

4.1.1 Socio-demographic characteristics of study participants

A total of 429 students aged 14 to 19 years completed the study. The response rate was 99.3%, with 170 (39.6%) and 259 (60.4%) being male and female, respectively. Two hundred and three (203) students (47.3%) were in their first year, whereas 140 (32.6%) and 86 (20.1%) students were in their second and third year. Three hundred and seventy-four (87.2%) were boarders compared to fifty-five (12.8%) who were day students. Majority of the students, 239 (56.4%) lived in urban areas while 185 (43.6%) lived in rural areas.

Table 4.1 shows the socio-demographic characteristics of the participants. The majority were females. A large proportion of the participants were in the first year of school. Also, the modal age was 17 years.

Table 4.1: Socio-demographic characteristics of study participants

Variable	Frequency	Percentage (%)
Sex		
Male	170	39.6
Female	259	60.4
Age		
14	11	2.6
15	64	14.9
16	97	22.6
17	123	28.7
18	91	21.2
19	43	10.0
Educational level		
SHS1	203	47.3
SHS2	140	32.6
SHS3	86	20.1
Residential Area		
Rural	185	43.6
Urban	239	56.4
Residential status in school		
Day	374	87.2
Boarding	55	12.8

4.1.2 Physical characteristics of study participants

The mean age of participants was 16.8±1.29 years. Females had a mean age of 16.6±1.23 years while that of males was 17.1±1.30 years ($p < 0.01$). The modal age was 17 years. The mean age of those with BMI ≥ 85th percentile was 16.8±1.21 years compared to those with lower BMI who had a mean age of 16.8±1.29 years. ($p = 0.79$).

The mean weight of the study participants was 57.7±9.16 kg. The mean weight of the females and males did not differ statistically ($p = 0.81$).

Mean height of participants was 164.1±7.27cm. The male participants were significantly taller than their female counterparts, (169.2± 6.59 cm vs.160.8±5.54 cm) ($p < 0.001$).

BMI of participants ranged from 14.65 to 39.33 kg/m^2 and average BMI was 21.4±3.28 kg/m^2. Females and males had mean BMI of 22.3±3.57 kg/m^2 and 20.1 ±2.25 kg/m^2 respectively. Thus the females had a significantly higher BMI than the males ($p < 0.001$).

Average systolic blood pressure of participants was 112.3±12.49 mmHg. The mean systolic pressure of the males (115.5 ±13.48 mmHg) was significantly higher than that of females (110.2 ±11.32 mmHg) ($p < 0.001$). The mean diastolic blood pressure was 72.5±10.06 mmHg. The mean diastolic blood pressure of the females was 72.1±9.76 mmHg while that of males was 73.1±10.51 mmHg. This was not statistically different ($p = 0.34$).

Table 4.2 shows the distribution of background, anthropometric and blood pressure measurements according to sex. There were statistically significant differences in the mean age, height, BMI, and SBP of males and females.

Table 4.2: Physical characteristics of study participants by sex

Variable	Female (n=259) Mean ±SD	Male (n = 170) Mean ±SD	Total (n=429) Mean ±SD	p- value
Age (years)	16.6±1.23	17.1±1.30	16.8±1.29	0.0001
Height(cm)	160.8±5.54	169.2± 6.59	164.1±7.27	0.0001
Weight (kg)	57.6±9.73	57.8±8.24	57.7±9.16	0.8130
BMI(kg/m^2)	22.3±3.57	20.1 ±2.25	21.4±3.28	0.000
SBP(mmHg)	110.2 ±11.32	115.5 ±13.48	112.3±12.49	0.000
DBP(mmHg)	72.1±9.76	73.1±10.51	72.5±10.06	0.3379

BMI: Body mass index; DBP: diastolic blood pressure; SBP: systolic blood pressure; SD: standard deviation

4.2 Prevalence of obesity among study participants

Eleven of the participants were obese giving a prevalence of obesity of 2.6% (95% CI 1.3%, 4.5%). The prevalence of overweight, normal weight and underweight were 10.5%, 80.7%, and 6.3% respectively. Overweight or obese individuals constituted 13.1% (95% CI 10.0%, 16.6%) of the respondents.

Table 4.3 shows the distribution of overweight or obesity by sex. The BMI was categorized as obese, overweight, normal and underweight according to guidelines given by the WHO BMI for age growth reference chart. All the obese participants were females. The prevalence of obesity among females was 4.3% and 0% among males ($\chi 2= 41.64$, $p < 0.001$).

Table 4.3: Distribution of BMI categories by sex of participants

	Underweight No (%)	Normal No (%)	Overweight No (%)	Obese No (%)	Statistic
Female	4(1.5)	206(79.5)	38(14.7)	11(4.3)	df = 3 $\chi2$= 41.664 p=0.000
Male	23(13.5)	140(82.4)	7(4.1)	0(0.00)	
Total	27(6.3)	346(80.7)	45(10.5)	11(2.6)	

Table 4.4 shows the distribution of BMI status by background characteristics. Compared to those in SHS1 and SH3, the majority of the overweight and obese participants were in SHS2. The difference was statistically significant (p=0.003). Most of the obese respondents reside in urban areas. Conversely, the majority of overweight individuals reside in rural areas. These differences were however not statistically significant (p=0.333).

Table 4.4: Distribution of BMI status by background characteristics

	Underweight No. (%)	Normal No. (%)	Overweight No. (%)	Obese No. (%)	p-value
Age (years)					
14	0(0.0)	8(72.7)	2(18.2)	1(9.1)	
15	5(7.8)	55(85.9)	4(6.3)	0(0.0)	
16	6(6.2)	76(78.4)	10(10.3)	5(5.2)	0.690
17	8(6.5)	97(78.9)	15(12.2)	3(2.4)	
18	6(6.6)	72(79.1)	11(12.1)	2(2.2)	
19	2(4.7)	38(88.4)	3(7.0)	0(0.0)	
Education level					
SHS1	117(8.4)	166(81.8)	16(7.9)	4(2.0)	0.003
SHS2	2(1.4)	108(77.1)	24(17.1)	6(4.3)	
SHS3	8(9.3)	72(83.7)	5(5.8)	1(1.2)	
Residential area					
Rural	10(5.4)	148(80.0)	24(13.0)	3(1.6)	0.333
Urban	17(7.1)	193(80.8)	21(8.8)	8(3.4)	
Residential status					
Day	24(6.4)	301(80.5)	38(10.2)	11(2.9)	0.572
Boarding	3(5.5)	45(81.8)	7(12.7)	0(0.0)	

4.3 Prevalence of hypertension among study participants

Fifty-five (12.8% CI 9.8%, 16.4%) out of the 429 participants (27 (10.4%) females and 28 (16.5%) males) were hypertensive according to the defined criteria. There was no statistically significant difference in the prevalence of hypertension among both sexes ($\chi2$=3.46, p=0.18).

Thirty-nine participants (9.1%) had diastolic hypertension (8.5% in females versus10.0% in males). Thirty-one participants (7.2%) had systolic hypertension (4.6% in females versus 11.2% in males). The difference in prevalence of systolic hypertension in the different sexes was significant ($\chi2$=6.55, p= 0.010). There was, however, no significant sex difference in the prevalence of diastolic hypertension (p=0.596).

Thirty-two participants (7.5%) (19(7.3%) females and 13(7.6%) males) had pre-hypertension according to the defined criteria while three hundred and forty-two (79.7%) had normal blood pressure. The overall prevalence of pre-hypertension and hypertension (elevated blood pressure) among the respondents was 20.3%.

Table 4.5 shows the distribution of hypertension status by background and anthropometric characteristics. The highest prevalence of hypertension occurred among those aged 17 years (18.7%). Also, the prevalence of hypertension was highest amongst overweight participants (20.0%). The prevalence of hypertension was 10.5% and 15.1% among urban dwellers and rural dwellers respectively. This difference was statistically significant. ($\chi2$= 6.35, p = 0.04).

Table 4.5: Distribution of blood pressure status by background and anthropometric characteristics

Variable	Normal (n=342) No. (%)	PHTN (n= 32) No. (%)	HTN (n= 55) No. (%)	p- value
Sex				
Male	129(75.9)	13(7.7)	28(16.5)	0.177
Female	213(82.2)	19(7.3)	27(10.4)	
Age (years)				
14	8(72.7)	1(9.1)	2(18.2)	
15	53(82.8)	5(7.8)	6(9.4)	
16	75(77.3)	9(9.3)	13(13.4)	0.547
17	91(74.0)	9(7.3)	23(18.7)	
18	78(85.7)	6(6.6)	7(7.7)	
19	37(86.1)	2(4.7)	4(9.3)	
Education level				
SHS1	163(80.3)	15(7.4)	25(12.3)	0.993
SHS2	112(80.0)	10(7.1)	18(12.9)	
SHS3	67(77.9)	7(8.1)	12(14.0)	
Residential area				
Rural	149(80.5)	8(4.3)	28(15.1)	0.042
Urban	190(79.5)	24(10.0)	25(10.5)	
Residential status				
Day	298(79.7)	28(7.5)	48(12.8)	0.998
Boarding	44(80.0)	4(7.3)	7(12.7)	
BMI status				
Underweight	19(70.4)	3(11.1)	5(18.5)	
Normal	281(81.2)	25(7.2)	40(11.6)	0.385
Overweight	34(75.6)	2(4.4)	9(20.0)	
Obese	8(72.7)	2(18.2)	1(9.1)	

PHTN: Pre-hypertension; HTN: Hypertension

4.4 Relationship between BMI and blood pressure

Table 4.6 shows the Pearson correlation analysis between SBP and DBP and other continuous variables including BMI. Height, weight, and BMI showed a statistically significant positive correlation with SBP and DBP. Though age correlated positively with DBP, this was not statistically significant.

Table 4.6: Correlation between SBP and DBP and age, height, weight and BMI

	SBP (mmHg)		DBP (mmHg)	
Variable	R	p-value	r	p-value
Age (years)	0.1611	0.0008	0.0610	0.2075
BMI	0.1207	0.0124	0.1355	0.0049
Weight (kg)	0.2610	0.0000	0.2055	0.0000
Height (cm)	0.2577	0.0000	0.1319	0.0062

DBP: Diastolic blood pressure; r: Pearson correlation coefficient; SBP: Systolic blood pressure

In a simple linear regression analysis, BMI alone explained 1.5% of the variance in SBP and 1.8% of the variance in DBP. Each unit increment in BMI increased SBP and DBP by 0.46 and 0.42 mmHg, respectively. Table 4.7 shows a multiple regression analysis for the relationship between blood pressure (SBP and DBP) and BMI while controlling for age and sex. The variables in the analysis account for 8.4% of the variance in SBP and 2.1% of the variance in DBP.

Table 4.7: Linear regression analysis of BMI and blood pressure

	SBP			DBP		
	Regression coefficient	95% CI	p-value	Regression coefficient	95% CI	p-value
BMI(kg/m^2)	0.73	0.36-1.10	0.000	0.50	0.19-0.81	0.002
Adjusted R^2		0.08			0.02	

**Adjusted for Age and Sex*

When the effects of BMI on blood pressure were studied in a multiple logistic regression equation model (Table 4.8), BMI was significantly associated with elevated SBP (OR 3.39, 95% CI: 1.3–9.1, $p < 0.05$).

Table 4.8: Logistic regression of BMI status as a risk factor for hypertension

	Elevated SBP AOR (95% CI)	p-value	Elevated DBP AOR (95% CI)	p-value
BMI				
<85th percentile	1	0.015	1	0.258
≥85th percentile	3.39 (1.3-9.1)		1.69 (0.7- 4.2)	

AOR: Adjusted odds ratio **Adjusted for Age and Sex*

CHAPTER FIVE

5.0 DISCUSSION

5.1 Prevalence of obesity

There are challenges in comparing data on the prevalence of obesity and overweight obtained from various studies. These challenges arise due to the utilization of different diagnostic criteria in estimating such prevalence (Goon et al., 2010).

The overall prevalence of obesity was 2.56% (95% CI 1.29%, 4.54%). This is consistent with findings by Musa et al. (2012) who reported a prevalence of 1.86% among children and adolescents in Benue State, Nigeria. The prevalence of overweight in this study is also comparable to that revealed by Musa and co. In this study, none of the males was found to be obese. This contrasts sharply with the study by Musa et al. (2012) which reported a higher prevalence of obesity among males (2.1%) as compared to the females (1.6%). The prevalence of obesity in this study (2.56%) was significantly higher than the 0.8% rate reported by Kumah et al. (2015) among students in Kumasi aged 10 to 20 years. This represents a three (3) fold increase in obesity prevalence over a period of 8 years and may be related to urbanization, changing lifestyle and dietary patterns among others. It is also higher than the prevalence rate of 1% reported among adolescents in Wa municipality by Kullah (2015). The lower prevalence reported in their study may be due to the lower socio-economic status of participants in that study.

The prevalence of obesity in this study is, however, lower than the 10.9% prevalence rate reported by Mohammed & Vuvor (2012) and Oduwole et al. (2012). Both studies were carried out in urban areas where socio-economic status are very high.

Additionally, this study showed a higher prevalence of overweight among females than males (14.67% versus 4.12%) and a significantly higher mean BMI of 22.28 kg/m^2 in females compared to 20.14 kg/m^2 in males. This pattern was also demonstrated by Musa et al. (2012). They reported a prevalence of overweight of 10% in females and 9.3% in males.

The combined prevalence of obesity and overweight was 13.05% (95% CI 10.01%, 16.61%) which is comparable to the rates reported by Kumah et al. (2015). They reported a prevalence of 13.0% overweight and obesity among students in the Kumasi metropolis. The rate is also comparable to a rate of 11.5% prevalence of overweight and obesity reported by Musa et al. (2012). The similarities may be due to similarities in the socio-economic status, lifestyle patterns and the rural environments in both study areas.

The overweight and obesity prevalence rate revealed by this study (13.05%) is significantly higher than that reported among Nigerian children by Goon et al. (2010). They reported a prevalence rate of 2.1% among 9 to 12-year-old children. Emmanuel et al. (2017) in their study also found a lower rate of 6.7% among the respondents. The lower rates reported by Goon and co in their study could be due to the younger age group employed in the study.

The overweight and obesity prevalence rate from this study was however significantly lower than rates reported among South African children with rates from 17.2–22.8%. (Armstrong et al., 2006).

There are challenges in comparing data on the prevalence of obesity and overweight obtained from various studies. These challenges arise due to the utilization of different diagnostic criteria in estimating such prevalence (Goon et al., 2010).

The variations in prevalence rates in the different studies may be largely attributed to different methodologies and diagnostic criteria used in these studies and may also be due to regional or geographic variations.

5.2 Prevalence of hypertension

The prevalence of hypertension in this study was 12.8% (95% CI 9.8%, 16.4%). This is very high, and more than double the prevalence reported in a systematic review and meta-analysis by Noubiap et al. (2017). They reported a prevalence of hypertension (SBP or DBP ≥95th percentile) of 5.5% (95% CI 4.2%, 6.9%) among children and adolescents in Africa. The lower rates in their study may be due to the inclusion of much younger children, from 1 year to 19 years of age compared to 13-19 years in this study. The rate is also higher than the 9.1% prevalence rate reported by Sekyere (2017) in her study among adolescents in selected senior high schools also in the Ashanti region. In two studies in Nigeria, a lower prevalence (3.7%) among adolescents was reported by Bugaje et al., (2005) in Zaria state whereas a rate similar to that obtained in this study (10.1%) was reported among in-school adolescents by Emmanuel et al. (2017) in Ekiti state. Ejike et al., (2010) also reported a prevalence of hypertension of 10.1% among school-going adolescents in urban and suburban populations in Nigeria. A similar rate (10.7%) was also reported by Uwaezuoke et al. (2016) in their study among adolescents in secondary schools in Enugu, Nigeria. A study in Quebec, Canada also reported a prevalence of 12-23% among adolescents (Paradis et al., 2004)**.** The rate in their study is comparable to the rate revealed by this current study and suggest that the prevalence rate of hypertension in developing countries may be fast approaching those in the developed countries.

The prevalence of hypertension was higher in rural dwellers than urban dwellers. This has also been reported in Poland (Krzywinska-Wiewiorowska et al., 2017). The pattern of increased prevalence of hypertension among rural dwellers may be attributed to lower socioeconomic conditions in such areas. (Leng et al., 2015).

The varying prevalence rates reported in the different studies may be due to factors such as differences in methodology, different criteria for defining hypertension, use of different types and brands of sphygmomanometers and differences in the socio-economic status of various study sites.

Individuals with pre-hypertension are at increased risk of becoming hypertensive. Therefore such individuals require lifestyle and behavioural changes to prevent them from becoming hypertensive (NHBPEP, 2004). The prevalence of pre-hypertension in this study (7.6%) is low compared to that reported by Noubiap et al. (2017), who reported rates of 12.7% among children and adolescents in Africa. It is also lower than the rates reported by Ejike et al. (2010) who reported a prevalence of pre-hypertension of 15.10% to 37.20% in a study in Nigeria.

Individuals with pre-hypertension have a tendency to become hypertensive. The high prevalence of pre-hypertension from this study indicates that a significant proportion of adolescents who are otherwise classified as non-hypertensives are actually at heightened risk of developing overt hypertension.

It is thus evident from this study that the prevalence of hypertension among adolescents in developing countries is approaching the rates in developed countries. Increasing prevalence of obesity and overweight, often associated with improvement of socio-economic status and other lifestyle changes are implicated in the upsurge in the prevalence of elevated blood pressure (Ejike et al., 2008). This is worrying and will overburden the current health system in Ghana if the trend continues. There is, therefore, the need for urgent public health interventions to curb the situation.

5.3 Relationship between Blood pressure and BMI

We found a positive but weak correlation between BMI and systolic/diastolic blood pressure. The findings are similar to those reported by Emmanuel et al. (2017) who also demonstrated a weak positive correlation between BMI and systolic and diastolic pressure in their study among in-school adolescents in Ekiti State of Nigeria. Similarly, Ejike (2010) also showed a significant positive correlation between SBP and DBP with BMI. The study also showed that obesity was a good predictor of SBP. Several other studies in Africa have shown linkages between BMI and blood pressure in adolescents (Forouzanfar et al., 2016; Emmanuel et al., 2017). These studies support the fact that as BMI of adolescents increase, blood pressure also tends to increase. Therefore, decreasing body mass index would result in a concomitant lowering of blood pressure.

As BMI increases, there is an increased retention of salt, less physical activity and eventual occurrence of increased blood pressure and other CVD risks (Mohan et al., 2004; Ejike et al., 2008).

It was however noted that 45 (78.1%) out of the 55 study participants diagnosed with hypertension had normal weight. This contrasts with the findings by Noubiap et al. (2017) who demonstrated that among overweight and obese children, the prevalence of hypertension was higher than among those with normal BMI. This may be due to the fact that several other risk factors contributed to hypertension in this study. Also, though used in assessing general obesity, BMI is a poor measure of actual body fat (Karelis et al., 2004). Therefore in the determination of the risk of hypertension and CVD among adolescents, BMI may be a poor predictor (Ejike, 2010).

CHAPTER SIX

6. 0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The study reported obesity and hypertension prevalence among adolescents in Senior High Schools in Asante Akim North district. It has shown that the prevalence of adolescent obesity and hypertension was high. Adolescent hypertension, obesity and overweight in Ghana are fast becoming a major public health issue. Also, the prevalence of overweight and pre-hypertension was 10.49% and 7.46% respectively. These groups of adolescents are at high risk of becoming overtly obese and/or hypertensive and thus must be targeted to prevent this transition.

It is, therefore, necessary that further studies be carried out to evaluate the burden of obesity, hypertension and other cardiometabolic risk factors such as dysglycaemia and dyslipidemia among adolescents. It is also important that preventive strategies and efforts be put in place to curb adolescent obesity and hypertension.

6.2 RECOMMENDATIONS

The study revealed that among SHS students, obesity and hypertension have become issues of public health significance that require urgent preventive policies. To reduce the burden of adolescent hypertension and obesity, population-based primary prevention interventions should be implemented to address modifiable risk factors. Early detection of hypertension and obesity and the institution of appropriate interventions will reduce the burden from these conditions. To forestall this, all relevant stakeholders must get involved. Extensive public health education campaigns should be embarked on by both governmental and non-governmental organizations.

In our health facilities, routine measurement of BP of adolescents whenever they visit the hospital should be instituted.

Parents and guardians should ensure that their wards are eating healthy diets and having adequate exercises. They should also restrict the number of hours their wards spend watching television. Adolescents should also be encouraged to adopt a healthy lifestyle and habits.

In schools, health education should be included in the curriculum. Students need to be educated and counselled on risk factors for hypertension and obesity. There is also the need for the provision of recreational facilities and promotion of sporting activities in the schools. It is also essential to implement entry medical screening for all those to be enrolled in the senior secondary schools and those found to have risk factors should be monitored closely. Also critical is the provision of healthy diets in the school canteens and dining halls.

Finally, additional further studies must be carried out to estimate the burden of hypertension, obesity and other cardiovascular risk factors among adolescents.

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APPENDIX

APPENDIX 1: CONSENT FORM FOR STUDY PARTICIPANTS

Project Title: The prevalence of Obesity and elevated blood pressure among senior high school students in Asante Akim North district, Ghana.

Institution of affiliation: School of Public Health, University of Ghana, Legon.

Background of interviewer:

My name is……………..…………………………from………………………… (I am a student who is here) or (I am helping a student) to collect data purely for academic work for a degree in Masters in Public Health.

Procedure: Information required from you for this study includes background and clinical characteristics. Data collection is through the administration of a structured questionnaire, measurement of weight, height and blood pressure.

Risks and benefits: There are no risks if you take part in this study. There are also no incentives but the information you provide will help you improve on your health and that of your loved ones. If you are found to be obese or hypertensive, you will be referred to see a physician at Agogo Presbyterian Hospital for treatment and follow-up.

Right to refuse: Your consent to participate in this study is voluntary and you can withdraw from this study at any time.

Anonymity and Confidentiality: You are assured of strict anonymity and confidentiality on any information you give.

If you have any further information or questions about the study, you may contact the principal investigator, Inusah Abdul- Jalil, on phone number: 020 2536 176 or email: docjalil@yahoo.com

Your rights as a Participant: If you have any questions about your rights as a research participant you can contact the Ghana Health Service ERC Office on Monday to Friday between the hours of 9 am – 4 pm through 0507041223 (Miss Hannah Frimpong).

I have read the information above, or it has been read to me. I consent voluntarily to be a participant in this study.

Name of Participant:…………………………………………………

Signature or Thumbprint of Participant: ………………………………………………..

Date: …………………………………………………..

(To be completed if Student is less than 18 years of age)

Name of Parent/ Guardian:……………………………………………………………

Signature or Thumbprint of Parent/Guardian:………………………………………………

Date …………………………………………………..

Thank you for agreeing to participate

Name of witness:…………………………………………………..

Signature of witness:……………………………………………………

Date:…………………………………………………

I confirm that the individual has not been coerced into giving consent, and the consent has been

given freely and voluntarily.

Name of Researcher or Principal investigator:……………………………………………..

Signature of Researcher:……………………………………………..

Date:………………………………………………

APPENDIX 2: CONSENT FORM FOR PARENT OR GUARDIAN

Project Title: Obesity and hypertension among adolescents in Senior High Schools in Asante Akim North district, Ghana.

Institution of Affiliation: School of Public Health, University of Ghana, Legon.

Procedure: Information required from your child for this study includes background characteristics. Data collection is through the administration of a structured questionnaire, and measurement of your child's blood pressure, weight and height.

Risks and benefits: There are minimum or no risks if your child takes part in this study. There are also no incentives but the information your child provides will help you improve on the health of your child and loved ones.

Rights to refuse: You have the right to refuse your child to participate in this study.

Anonymity and confidentiality: You are assured of strict anonymity and confidentiality on any information that is collected.

If you have any further information or questions about the study, you may contact the principal investigator, Inusah Abdul- Jalil, on phone number: 020 2536 176 or email: docjalil@yahoo.com

Your rights as a Parent or Guardian: This research has been reviewed and approved by the Ethical Review Committee of the Ghana Health Service. If you have any questions about your rights as a parent or guardian you can contact the Ghana Health Service ERC Office on Monday to Friday between the hours of 9 am – 4 pm through 0507041223 (Miss Hannah Frimpong).

I have read the information above, or it has been read to me. I consent voluntarily for my child to be a participant in this study.

Name of Parent or Guardian:…………………………………………………….

Signature or Thumbprint of Participant: …………………………………..

Date: ………………………………………………..

Thank you for agreeing for your child to participate

Name of Researcher or Principal Investigator…………………………….

Signature of Researcher: ……………………………………………….

Date:……………………………………………………………………….

APPENDIX 3: QUESTIONNAIRE FOR OBESITY AND HYPERTENSION AMONG ADOLESCENTS IN SENIOR HIGH SCHOOLS IN ASANTE AKIM NORTH DISTRICT.

Greetings, my name is……………………………………………... I am a member of a team from the University of Ghana conducting a research on obesity and elevated blood pressure among senior high school students in Asante Akim North district. If you agree to take part in this study, I will give you a questionnaire to fill and then measure your height, weight and blood pressure. The questions and measurements will take about 25 to 30 minutes.

Your responses to all questions will be confidential and will not be shared with anyone other than members of our study team. No answer is wrong.

Your participation in the study is voluntary and you are free to end the interview or measurement process at any time. However, I will be happy if you participate in the study to contribute to existing knowledge on obesity in adolescents.

Questionnaire number:……………………………………………………………….…...

Name of interviewer: …………………………………………………………..….…...

Date: …………………………………………………………..….…...

SECTION A: SOCIODEMOGRAPHIC CHARACTERISTICS

1 Date of birth ………………………………………

2 Age (at last birthday) …………………………………….

3 Sex FEMALE …………0 MALE …………1

4 Level of Education SHS 1 …………1 SHS 2 …………2 SHS 3 …………3

5 Ethnicity Akan………… 1

Ga..………….. 2

Ewe....……….. 3

Other……………. 4

6 Residential area (where do you stay when not in school?)

Agogo……… 1

Konongo..…...2

Kumasi…….. 3

Other.. . . . . . 4 Please specify ………………………

7. Place of residence Rural……..0 Rural.. …….………. 1

8. Residential status in school Day . . . . . . .0 Boarding…. 1

SECTION B: ANTHROPOMETRIC MEASUREMENTS

	FIRST READING	SECOND READING	AVERAGE
HEIGHT (m)			
WEIGHT (kg)			
SYSTOLIC BP (mmHg)			
DIASTOLIC BP (mmHg)			

BMI (kg/m^2) …………………………………………………

BMI STATUS Obese ……………..... 3

Overweight…..…..….. 2

Normal... …….........…1

Underweight… ………0

BLOOD PRESSURE STATUS

SYSTOLIC BLOOD PRESSURE Hypertensive……………. 2

Pre-hypertensive……… 1

Normotensive………….. 0

DIASTOLIC BLOOD PRESSURE Hypertensive………..…… 2

Pre-hypertensive…………. 1

Normotensive……………. 0

Thank you

APPENDIX 4: WHO BMI REFERENCE DATA FOR BOYS

		Percentiles (BMI in kg/m²)										
Year	Month	1st	3rd	5th	15th	25th	50th	75th	85th	95th	97th	99th
14: 0	168	15.1	15.6	16.0	16.9	17.6	19.0	20.8	21.9	24.2	25.3	27.8
14: 1	169	15.1	15.7	16.0	17.0	17.7	19.1	20.8	22.0	24.3	25.4	27.9
14: 2	170	15.1	15.7	16.1	17.0	17.7	19.1	20.9	22.0	24.4	25.5	28.0
14: 3	171	15.2	15.8	16.1	17.1	17.8	19.2	21.0	22.1	24.5	25.6	28.1
14: 4	172	15.2	15.8	16.2	17.2	17.8	19.3	21.1	22.2	24.6	25.7	28.2
14: 5	173	15.3	15.9	16.2	17.2	17.9	19.3	21.1	22.3	24.7	25.8	28.3
14: 6	174	15.3	15.9	16.3	17.3	17.9	19.4	21.2	22.4	24.7	25.8	28.3
14: 7	175	15.3	16.0	16.3	17.3	18.0	19.5	21.3	22.4	24.8	25.9	28.4
14: 8	176	15.4	16.0	16.4	17.4	18.1	19.5	21.3	22.5	24.9	26.0	28.5
14: 9	177	15.4	16.1	16.4	17.4	18.1	19.6	21.4	22.6	25.0	26.1	28.6
14:10	178	15.5	16.1	16.5	17.5	18.2	19.6	21.5	22.7	25.1	26.2	28.7
14:11	179	15.5	16.1	16.5	17.5	18.2	19.7	21.6	22.7	25.1	26.3	28.8
15: 0	180	15.6	16.2	16.5	17.6	18.3	19.8	21.6	22.8	25.2	26.4	28.9
15: 1	181	15.6	16.2	16.6	17.6	18.3	19.8	21.7	22.9	25.3	26.4	28.9
15: 2	182	15.6	16.3	16.6	17.7	18.4	19.9	21.8	23.0	25.4	26.5	29.0
15: 3	183	15.7	16.3	16.7	17.7	18.4	20.0	21.8	23.0	25.5	26.6	29.1
15: 4	184	15.7	16.4	16.7	17.8	18.5	20.0	21.9	23.1	25.5	26.7	29.2
15: 5	185	15.8	16.4	16.8	17.8	18.5	20.1	22.0	23.2	25.6	26.7	29.3
15: 6	186	15.8	16.4	16.8	17.9	18.6	20.1	22.0	23.2	25.7	26.8	29.3
15: 7	187	15.8	16.5	16.9	17.9	18.7	20.2	22.1	23.3	25.8	26.9	29.4
15: 8	188	15.9	16.5	16.9	18.0	18.7	20.3	22.2	23.4	25.8	27.0	29.5
15: 9	189	15.9	16.6	17.0	18.0	18.8	20.3	22.2	23.5	25.9	27.0	29.5
15:10	190	15.9	16.6	17.0	18.1	18.8	20.4	22.3	23.5	26.0	27.1	29.6
15:11	191	16.0	16.7	17.0	18.1	18.9	20.4	22.4	23.6	26.1	27.2	29.7
16: 0	192	16.0	16.7	17.1	18.2	18.9	20.5	22.4	23.7	26.1	27.3	29.7
16: 1	193	16.1	16.7	17.1	18.2	19.0	20.6	22.5	23.7	26.2	27.3	29.8
16: 2	194	16.1	16.8	17.2	18.3	19.0	20.6	22.6	23.8	26.3	27.4	29.9
Year	Month	1st	3rd	5th	15th	25th	50th	75th	85th	95th	97th	99th

16: 3	**195**	16.1	16.8	17.2	18.3	19.1	20.7	22.6	23.9	26.3	27.5	29.9
16: 4	**196**	16.2	16.8	17.2	18.4	19.1	20.7	22.7	23.9	26.4	27.5	30.0
16: 5	**197**	16.2	16.9	17.3	18.4	19.2	20.8	22.7	24.0	26.5	27.6	30.1
16: 6	**198**	16.2	16.9	17.3	18.5	19.2	20.8	22.8	24.0	26.5	27.7	30.1
16: 7	**199**	16.3	17.0	17.4	18.5	19.3	20.9	22.9	24.1	26.6	27.7	30.2
16: 8	**200**	16.3	17.0	17.4	18.5	19.3	20.9	22.9	24.2	26.7	27.8	30.2
16: 9	**201**	16.3	17.0	17.4	18.6	19.3	21.0	23.0	24.2	26.7	27.8	30.3
16:10	**202**	16.4	17.1	17.5	18.6	19.4	21.0	23.0	24.3	26.8	27.9	30.4
16:11	**203**	16.4	17.1	17.5	18.7	19.4	21.1	23.1	24.3	26.8	28.0	30.4
17: 0	**204**	16.4	17.1	17.5	18.7	19.5	21.1	23.1	24.4	26.9	28.0	30.5
17: 1	**205**	16.4	17.2	17.6	18.7	19.5	21.2	23.2	24.5	27.0	28.1	30.5
17: 2	**206**	16.5	17.2	17.6	18.8	19.6	21.2	23.3	24.5	27.0	28.1	30.6
17: 3	**207**	16.5	17.2	17.6	18.8	19.6	21.3	23.3	24.6	27.1	28.2	30.6
17: 4	**208**	16.5	17.3	17.7	18.9	19.7	21.3	23.4	24.6	27.1	28.2	30.7
17: 5	**209**	16.6	17.3	17.7	18.9	19.7	21.4	23.4	24.7	27.2	28.3	30.7
17: 6	**210**	16.6	17.3	17.7	18.9	19.7	21.4	23.5	24.7	27.2	28.4	30.8
17: 7	**211**	16.6	17.4	17.8	19.0	19.8	21.5	23.5	24.8	27.3	28.4	30.8
17: 8	**212**	16.6	17.4	17.8	19.0	19.8	21.5	23.6	24.8	27.3	28.5	30.8
17: 9	**213**	16.7	17.4	17.8	19.1	19.9	21.6	23.6	24.9	27.4	28.5	30.9
17:10	**214**	16.7	17.4	17.9	19.1	19.9	21.6	23.7	24.9	27.4	28.6	30.9
17:11	**215**	16.7	17.5	17.9	19.1	19.9	21.7	23.7	25.0	27.5	28.6	31.0
18: 0	**216**	16.7	17.5	17.9	19.2	20.0	21.7	23.8	25.0	27.5	28.6	31.0
18: 1	**217**	16.8	17.5	18.0	19.2	20.0	21.8	23.8	25.1	27.6	28.7	31.0
18: 2	**218**	16.8	17.5	18.0	19.2	20.1	21.8	23.9	25.1	27.6	28.7	31.1
18: 3	**219**	16.8	17.6	18.0	19.3	20.1	21.8	23.9	25.2	27.7	28.8	31.1
18: 4	**220**	16.8	17.6	18.0	19.3	20.1	21.9	24.0	25.2	27.7	28.8	31.2
18: 5	**221**	16.8	17.6	18.1	19.3	20.2	21.9	24.0	25.3	27.8	28.9	31.2
18: 6	**222**	16.9	17.6	18.1	19.4	20.2	22.0	24.0	25.3	27.8	28.9	31.2
18: 7	**223**	16.9	17.7	18.1	19.4	20.2	22.0	24.1	25.4	27.9	29.0	31.3
18: 8	**224**	16.9	17.7	18.1	19.4	20.3	22.0	24.1	25.4	27.9	29.0	31.3
18: 9	**225**	16.9	17.7	18.2	19.5	20.3	22.1	24.2	25.5	27.9	29.0	31.3
18:10	**226**	16.9	17.7	18.2	19.5	20.3	22.1	24.2	25.5	28.0	29.1	31.3
18:11	**227**	16.9	17.8	18.2	19.5	20.4	22.2	24.3	25.5	28.0	29.1	31.4
19: 0	**228**	17.0	17.8	18.2	19.5	20.4	22.2	24.3	25.6	28.1	29.1	31.4

World Health Organization

APPENDIX 5: WHO BMI REFERENCE DATA FOR GIRLS

		Percentiles (BMI in kg/m^2)										
Year	Month	1st	3rd	5th	15th	25th	50th	75th	85th	95th	97th	99th
14: 0	168	15.0	15.6	16.0	17.2	17.9	19.6	21.6	22.9	25.5	26.7	29.3
14: 1	169	15.0	15.7	16.1	17.2	18.0	19.6	21.6	22.9	25.6	26.8	29.4
14: 2	170	15.0	15.7	16.1	17.3	18.0	19.7	21.7	23.0	25.6	26.8	29.5
14: 3	171	15.1	15.8	16.2	17.3	18.1	19.7	21.8	23.1	25.7	26.9	29.6
14: 4	172	15.1	15.8	16.2	17.4	18.1	19.8	21.8	23.2	25.8	27.0	29.7
14: 5	173	15.1	15.8	16.2	17.4	18.2	19.9	21.9	23.2	25.9	27.1	29.7
14: 6	174	15.2	15.9	16.3	17.4	18.2	19.9	22.0	23.3	25.9	27.1	29.8
14: 7	175	15.2	15.9	16.3	17.5	18.3	20.0	22.0	23.4	26.0	27.2	29.9
14: 8	176	15.2	15.9	16.4	17.5	18.3	20.0	22.1	23.4	26.1	27.3	30.0
14: 9	177	15.3	16.0	16.4	17.6	18.4	20.1	22.2	23.5	26.1	27.4	30.0
14:10	178	15.3	16.0	16.4	17.6	18.4	20.1	22.2	23.5	26.2	27.4	30.1
14:11	179	15.3	16.0	16.5	17.6	18.4	20.2	22.3	23.6	26.3	27.5	30.2
15: 0	180	15.3	16.1	16.5	17.7	18.5	20.2	22.3	23.7	26.3	27.6	30.2
15: 1	181	15.4	16.1	16.5	17.7	18.5	20.3	22.4	23.7	26.4	27.6	30.3
15: 2	182	15.4	16.1	16.6	17.8	18.6	20.3	22.4	23.8	26.5	27.7	30.4
15: 3	183	15.4	16.2	16.6	17.8	18.6	20.4	22.5	23.8	26.5	27.7	30.4
15: 4	184	15.4	16.2	16.6	17.8	18.6	20.4	22.5	23.9	26.6	27.8	30.5
15: 5	185	15.5	16.2	16.6	17.9	18.7	20.4	22.6	23.9	26.6	27.9	30.5
15: 6	186	15.5	16.2	16.7	17.9	18.7	20.5	22.6	24.0	26.7	27.9	30.6
15: 7	187	15.5	16.3	16.7	17.9	18.8	20.5	22.7	24.0	26.7	28.0	30.6
15: 8	188	15.5	16.3	16.7	18.0	18.8	20.6	22.7	24.1	26.8	28.0	30.7
15: 9	189	15.6	16.3	16.8	18.0	18.8	20.6	22.8	24.1	26.8	28.1	30.7
15:10	190	15.6	16.3	16.8	18.0	18.8	20.6	22.8	24.2	26.9	28.1	30.8
15:11	191	15.6	16.4	16.8	18.0	18.9	20.7	22.8	24.2	26.9	28.2	30.8
16: 0	192	15.6	16.4	16.8	18.1	18.9	20.7	22.9	24.2	27.0	28.2	30.9
16: 1	193	15.6	16.4	16.8	18.1	18.9	20.7	22.9	24.3	27.0	28.2	30.9
16: 2	194	15.7	16.4	16.9	18.1	19.0	20.8	23.0	24.3	27.1	28.3	31.0

Year	Month	1st	3rd	5th	15th	25th	50th	75th	85th	95th	97th	99th
16: 3	195	15.7	16.4	16.9	18.1	19.0	20.8	23.0	24.4	27.1	28.3	31.0
16: 4	196	15.7	16.5	16.9	18.2	19.0	20.8	23.0	24.4	27.1	28.4	31.0
16: 5	197	15.7	16.5	16.9	18.2	19.0	20.9	23.1	24.4	27.2	28.4	31.1
16: 6	198	15.7	16.5	16.9	18.2	19.1	20.9	23.1	24.5	27.2	28.4	31.1
16: 7	199	15.7	16.5	17.0	18.2	19.1	20.9	23.1	24.5	27.2	28.5	31.1
16: 8	200	15.7	16.5	17.0	18.3	19.1	20.9	23.1	24.5	27.3	28.5	31.2
16: 9	201	15.7	16.5	17.0	18.3	19.1	21.0	23.2	24.6	27.3	28.5	31.2
16:10	202	15.8	16.6	17.0	18.3	19.2	21.0	23.2	24.6	27.3	28.6	31.2
16:11	203	15.8	16.6	17.0	18.3	19.2	21.0	23.2	24.6	27.4	28.6	31.2
17: 0	204	15.8	16.6	17.0	18.3	19.2	21.0	23.3	24.7	27.4	28.6	31.3
17: 1	205	15.8	16.6	17.0	18.3	19.2	21.1	23.3	24.7	27.4	28.6	31.3
17: 2	206	15.8	16.6	17.1	18.4	19.2	21.1	23.3	24.7	27.4	28.7	31.3
17: 3	207	15.8	16.6	17.1	18.4	19.2	21.1	23.3	24.7	27.5	28.7	31.3
17: 4	208	15.8	16.6	17.1	18.4	19.3	21.1	23.4	24.8	27.5	28.7	31.3
17: 5	209	15.8	16.6	17.1	18.4	19.3	21.1	23.4	24.8	27.5	28.7	31.4
17: 6	210	15.8	16.6	17.1	18.4	19.3	21.2	23.4	24.8	27.5	28.8	31.4
17: 7	211	15.8	16.6	17.1	18.4	19.3	21.2	23.4	24.8	27.6	28.8	31.4
17: 8	212	15.8	16.7	17.1	18.4	19.3	21.2	23.4	24.8	27.6	28.8	31.4
17: 9	213	15.8	16.7	17.1	18.5	19.3	21.2	23.5	24.9	27.6	28.8	31.4
17:10	214	15.8	16.7	17.1	18.5	19.3	21.2	23.5	24.9	27.6	28.8	31.4
17:11	215	15.8	16.7	17.1	18.5	19.4	21.2	23.5	24.9	27.6	28.9	31.4
18: 0	216	15.9	16.7	17.1	18.5	19.4	21.3	23.5	24.9	27.7	28.9	31.5
18: 1	217	15.9	16.7	17.2	18.5	19.4	21.3	23.5	24.9	27.7	28.9	31.5
18: 2	218	15.9	16.7	17.2	18.5	19.4	21.3	23.6	25.0	27.7	28.9	31.5
18: 3	219	15.9	16.7	17.2	18.5	19.4	21.3	23.6	25.0	27.7	28.9	31.5
18: 4	220	15.9	16.7	17.2	18.5	19.4	21.3	23.6	25.0	27.7	28.9	31.5
18: 5	221	15.9	16.7	17.2	18.5	19.4	21.3	23.6	25.0	27.7	28.9	31.5
18: 6	222	15.9	16.7	17.2	18.5	19.4	21.3	23.6	25.0	27.7	29.0	31.5
18: 7	223	15.9	16.7	17.2	18.6	19.5	21.4	23.6	25.0	27.8	29.0	31.5
18: 8	224	15.9	16.7	17.2	18.6	19.5	21.4	23.6	25.1	27.8	29.0	31.5
18: 9	225	15.9	16.7	17.2	18.6	19.5	21.4	23.7	25.1	27.8	29.0	31.5
18:10	226	15.9	16.7	17.2	18.6	19.5	21.4	23.7	25.1	27.8	29.0	31.5
18:11	227	15.9	16.7	17.2	18.6	19.5	21.4	23.7	25.1	27.8	29.0	31.5
19: 0	228	15.9	16.7	17.2	18.6	19.5	21.4	23.7	25.1	27.8	29.0	31.6

World Health Organization

APPENDIX 6: ETHICAL APPROVAL LETTER

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the

MyRef. HS/RDD/ERC/Admin/App/18/020

Research & Development Division

Ghana Health Service
P. O. Box MB 190 Accra
Tel: +233-302-681109
Fax + 233-302-685424
Email: ghserc@gmail.com

17TH March, 2018

Your Ref No.

Inusah Abdul-Jalil
University of
Ghana School
of Public Health
Legon, Accra

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHS-ERC Number	GHS-ERC: 066/12/17
Project Title	Obesity and Hypertension among Adolescents in Senior High Schools in the Asante Akim North District
Approval Date	17 March, 2018
Expiry Date	16th March, 2019
GHS-ERC Decision	Approved

This approval requires the following from the Principal Investigator

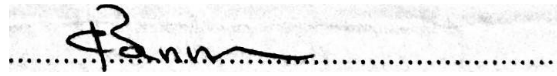
- Submission of yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than i2 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report after completion of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.

Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED



DR. CYNTHIA BANNERMAN
(GHS-ERC CHAIRPERSON)

Cc: Director, Research & Development Division, Ghana Health Service, Accra