SOCIODEMOGRAPHIC AND SOCIOECONOMIC DETERMINANTS OF OBESITY IN KENYA

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DECLARATION

This research study is my original work and has not been presented for any award of degree in any other University.

Signature…… Date……...

Samwel Maina Gatimu

Reg. No. X53/88824/2016

This research study has been submitted for examination with my approval as the university supervisor.

Signature…… Date……...

Dr Moses Muriithi

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND ACRONYMS

BMI	Body Mass Index
CI	Confidence Interval
DHS	Demographic Health Survey
KDHS	Kenya Demographic Health Survey
KEMRI	Kenya Medical Research Institute
KNBS	Kenya National Bureau of Statistics
LMICs	Low- and Middle-Income Countries
MoH	Ministry of Health
NCDs	Non-Communicable Diseases
OR	Odds Ratio
SD	Standard Deviation
SSA	Sub-Saharan Africa
UK	United Kingdom
US	United States
VIF	Variance Inflation Factor
WHO	World Health Organization

ABSTRACT

Obesity is a global pandemic and a significant public health problem that is associated with premature morbidity and mortality. About 13% of the global population is obese while about 10% of the Kenyan population are obese. However, obesity studies in Kenya have shown a wide variation in the prevalence of obesity of between 9.1% and 58% and have been conducted in specific localities and population groups such as women or slum dwellers. Besides, nationwide studies on obesity have failed to assess the association of known risk factors such as physical activity and consumption of fruits and vegetables on obesity. Hence, this study was conducted to establish the overall and sex-specific prevalence of obesity and assess the sociodemographic and socioeconomic determinants of obesity among adults aged 18–70 years in Kenya. The study used data from the 2015 Kenya STEPwise survey on non-communicable diseases and injuries collected using the WHO STEPwise approach (demographic, anthropometric, and biochemical measurements). Missing observations and multicollinear variables (variance inflation factor of >5) were not included in the analysis. Residual plots and probability and quintile plots were used to assess heteroscedasticity and normality of continuous variables, respectively. Participant characteristics and prevalence of obesity were described using descriptive statistics. Multivariable logistic regression and Probit regression were used to assess the sociodemographic and socioeconomic determinants of obesity. All statistical analyses were performed using STATA 14.0 and adjusted for cluster sampling using sample weights, with the significance level set at p = 0.05. Out of the 4,183 participants, 2,452 (58.6%) were women and 1,731 (41.4%) men. The mean age was 37.6 (SD: 13.4) years. About two-thirds were married, 61.8% lived in rural areas, 60.7% were employed and 55.8% had primary school education. A quarter of the participants are either physically inactive or currently use alcohol, 13% smoke and 85.5% do not consume the recommended five servings of fruits and vegetables. The overall prevalence of obesity was 10.97% (95% CI: 9.06%–13.22%). The prevalence was higher among women (n = 434, 16.53%; 95% CI: 14.15%–19.22%) than men (n = 102, 5.57%; 95% CI: 3.56%–8.61%). The poorest (19.3%), physically inactive (16.3%), female (15.5%), urban residents (15%) and secondary educated (14.5%) had the highest prevalence of obesity. The determinants of obesity in Kenya include age, sex, residence, wealth status, smoking, and physical activity. The study found that female had five-fold (OR: 4.80, 95% CI: 3.25–7.08) higher odds of obesity compared to males. Also, the odds of obesity were 63% (OR: 0.63, 95% CI: 0.24– 0.58) and 86% (OR: 0.86, 95% CI: 0.07– 0.28) lower among richer and richest individual compared to the poorest individuals. Smoking reduced the odds of obesity by 75% (OR: 0.25, 95% CI: 0.11–0.58) compared to non-smoking while physically inactive participants had 1.9 times higher odds of obesity (OR: 1.90, 95% CI: 1.32–2.74) compared the physically active. Our study provides evidence of determinants with obesity adding to the body of knowledge and that are relevant to policymakers especially as they revise the national strategy on NCDs. One of the key policy recommendations is for promotion of physical activities and development of policy actions that promote physical activities such as the promotion of sports, creation of recreational spaces, foot and bicycle paths and playgrounds in schools countrywide and promotional campaigns to promote physical activities.

CHAPTER ONE: INTRODUCTION

1.1 Chapter introduction

Chapter one introduces the study by outlining the background information on obesity including the global, regional, sub-regional and national burden of obesity, drivers and transition stages of obesity, economic burden, and global and Kenya's policy response to obesity. The chapter also highlights the statement of the problem, research questions and aims and the significance of the study.

1.2 Background Information

Obesity is one of the main risk factors for non-communicable diseases (NCDs) (World Health Organisation, 2020). It also contributes to approximately 8% of the global deaths and 997,371 disability-adjusted life years (Gil-Rojas et al., 2019). It is also associated with an increased risk of 22 cancer in the United Kingdom (Bhaskaran et al., 2014) and cardiovascular deaths (Ng et al., 2014). According to the World Health Organization (WHO), the prevalence of obesity more than tripled between 1975 and 2016. The WHO estimated that 13% of the global population or 650 million people are obese; 124 millions of who are children and adolescents (World Health Organisation, 2020). Other estimates show that obesity prevalence ranges between 28.8% and 38.0% worldwide (Ng et al., 2014). Obesity burden is highest in low resource countries where more than half of the obese population live (Ng et al., 2014). As shown in figure 1.1, obesity prevalence varies by countries, regions, gender, and age. Obesity prevalence is lowest in Burundi, Ethiopia, Tanzania, and Togo while it is highest in Tonga and Kuwait (Ng et al., 2014).

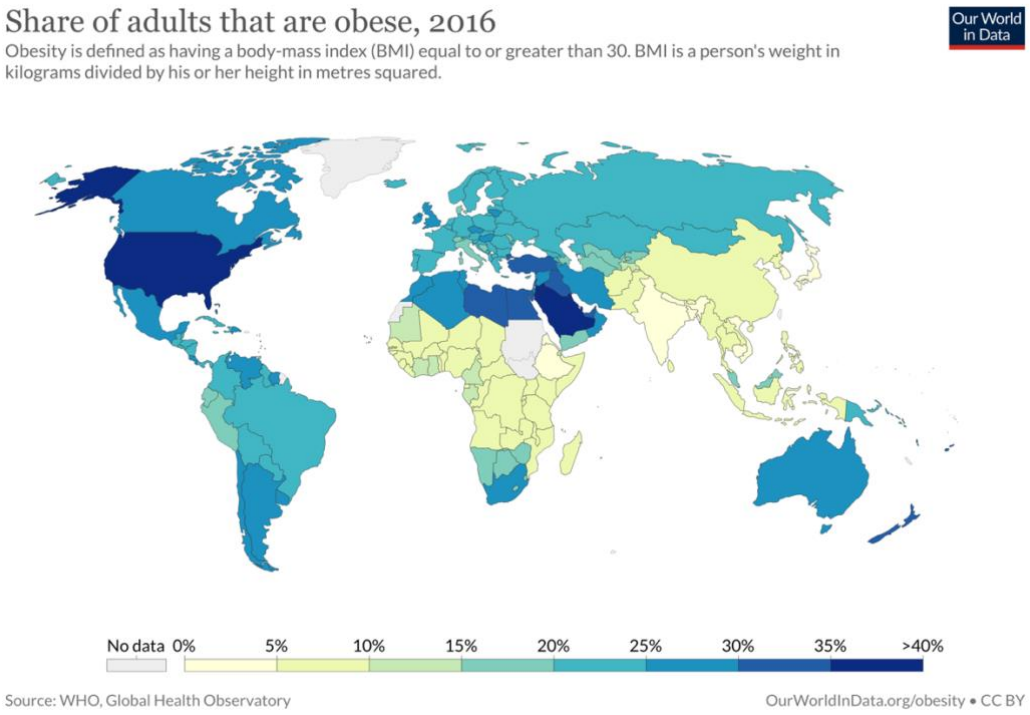

Figure 1.1. Share of adults that are obese

In Africa, 6.7% of the population is estimated to be obese (World Obesity Federation, 2020). North African region has the highest prevalence of obesity with sub-Saharan Africa (SSA) having the lowest prevalence (Ng et al., 2014). About 1.3%–47.8% of North African are obese (Toselli et al., 2014). Madagascar has the lower prevalence of obesity at 1.1% while Swaziland and South Africa have the highest at 23% (Neupane et al., 2016) and 27.2% (Sartorius et al., 2015) respectively. However, a study of four SSA countries found the prevalence of obesity at 34%, with the prevalence being 10% to 14% in Uganda, 31% in Nigeria, 40% in Tanzania and 54% in South Africa (Ajayi et al., 2016).

In East Africa, Kenya has the highest rate of obesity with Rwanda and Tanzania having the lowest rate (Neupane et al., 2016). Obesity prevalence is estimated at 2.3% in Burundi, 2.4% in Rwanda, 4.6% in Uganda and 6.2% in Tanzania (Neupane et al., 2016).

1.2.1 Burden of obesity in Kenya

In Kenya, there has been a rise in the prevalence of obesity over the year. It is associated with 259,600 cases of diabetes, 1.76 million cases of hypertension and 123,700 cases of ischaemic heart diseases (World Obesity Federation, 2020). According to the 2014 Kenya Demographic Health Survey (KDHS), 10.1% of women of reproductive age are obese. The trends of obesity in Kenya indicate that the proportion of obese women increased from 7% in 2008/9 to 10.1% in 2014 (KDHS, 2009; KDHS, 2014). Other studies have shown that 7.5% and 9.1% of the Kenyan population was obese in 2008 (Neupane et al., 2016) and 2014 (Mkuu et al., 2018) respectively.

The prevalence doubled between 1993 and 2014 from 6.4% to 15% (Amugsi et al., 2017). However, the prevalence varies by regions. In Kisumu East, it was estimated that 58.8% of healthcare worker were obese (Ondicho et al., 2016) while in Nairobi, 36.3% and 26.1% of university staff and female slum residents were found to be obese (Okube and Omandi, 2019; Ayah et al., 2013). In Nakuru, Mathenge et al. (2010) estimated that 20% of the population was obese. Nairobi and Central regions have the highest prevalence of obesity in Kenya while North Eastern has the lowest obesity prevalence. The prevalence of obesity is 18.8% in North Eastern, 24.5% in Western, 26.7% in Nyanza, 28.7% in Rift Valley, 30.3% in Eastern, 32.4% in Coast, 47% in Central and 47.8% in Nairobi (Mkuu et al., 2018). In the former Trans mara, Nairobi and Kitui districts, the prevalence of obesity was estimated at 6.6% and 25.9% among men and women (Christensen et al., 2008). About 7.1% of men and 26.1% of women living in Kibera slums in Kenya are obese (Ayah et al., 2013).

1.2.2 Drivers of obesity

Energy imbalance is the main drivers of obesity (Hill et al., 2012). Consumption of more energy than the body requirement results in weight gain due to the surplus energy (Hill et al., 2012). Globally, the average daily caloric intake per person per day increased from 2200 kilocalories in 1960 to 2800 kilocalories in 2013 (Hannah Ritchie and Roser, 2017). The increase in energy consumption is correlated with obesity (Hannah Ritchie and Roser, 2017; Griera et al., 2007). Besides, most countries are undergoing a nutrition transition, with increased consumption of processed food, high salt and sugar, trans fats and less vegetable consumption (Ford et al., 2017; James, 2008). Traditional healthy foods high in nutrients and fibres are being replaced with highly processed non-nutritious meals (Ford et al., 2017). The changing nutrition has been worsened by increased globalisation, urbanisation and economic development (Ford et al., 2017). These changes have also resulted in a decline in physical activity (Katzmarzyk and Mason, 2009).

Physical inactivity is another main driver of obesity (Ford et al., 2017; James, 2008). More than a quarter of the global population is physically inactive, which contributes to the energy surplus (Guthold et al., 2018). Most jobs are now automated and transportation is motorised reducing opportunities for physical activity at work or during travel (Ford et al., 2017; Hallal et al., 2012; James, 2008). Other drivers of obesity include environmental contaminants, enteric infections, nutrition supplementation and early life undernutrition (Ford et al., 2017; Onyango and Onyango, 2018; James, 2008).

1.2.3 Obesity transition

Jaacks et al. (2019) posit that countries transition between different obesity transition stages over the years. They identified four stages of transition of the obesity epidemic. In stage 1, countries have a prevalence of obesity of more than 5% but less than 20% and affect mostly

people of high socioeconomic status. Stage 2 involves a significant rise in obesity prevalence across all age groups and a narrowing socioeconomic and gender differences in obesity distribution. At this stage, the obesity prevalence ranges from 25% to 40% and is where most middle-income countries are. In stage 3, the prevalence of obesity is increased among children but the differences in obesity prevalence among men and women and between socioeconomic groups are significantly reduced. The last stage 4 is assumed to be a declining phase of obesity with reversal of patterns seen in stages 1 to 3. It involves a significant investment in prevention and management of obesity (Jaacks et al., 2019). These stages are dynamic and countries could transition from one to stage to another depending with the country-specific modifiers of obesity (Jaacks et al., 2019).

1.2.4 Economic burden of obesity

Obesity increases the risk of cardiovascular diseases and other NCDs. It contributes to one of the highest health expenditure with approximately $7.1 billion in costs used in managing it in 2006 (Janssen, 2013). It cost the United Kingdom National Health Service an estimated 5.1 billion pounds yearly with a societal cost of at least 27 billion pounds annually (Scarborough et al., 2011; Dobbs et al., 2014). The United Kingdom estimates that 300 million pounds would be saved annually if the prevalence of obesity were reduced by 1% (UK and Forum, 2016).

In the United States, obesity accounts for 10 per cent of the total medical costs, estimated at $86 billion annually (Finkelstein et al., 2009). It cost approximately $3508 in medical costs per obese adults in 2010, which is a 14.3% increase from $3070 in 2005 (Biener et al., 2017). Withrow and Alter (2011) in their systematic analysis of the economic burden of obesity found that obese patients have 30% greater costs of medical costs compared to normal-weight peers. They also found that obesity accounts for 0.7% and 2.8% of healthcare expenditure (Withrow and Alter, 2011). In Brazil, the healthcare cost of managing obesity was estimated at $1.1

billion per year (Bahia et al., 2012) while in Germany, the societal cost of obesity was estimated to be 12.2 million Euros (Lehnert et al., 2015).

Obesity is estimated to impact 0.5% to 1.6% of the global gross domestic product (OECD, 2019) while the healthcare expenditure associated to obesity is expected to rise to 8.4% in the Organisation for Economic Co-operation and Development (OECD) countries ranging from 5% in France to 14% in the United States (OECD, 2019). In Africa, $7.4 billion (8.8%) of the total healthcare expenditure is attributed to obesity while $4.8 billion (3.4%) of the total healthcare expenditure is attributed to obesity in South East Asian region (World Obesity Federation, 2020).

1.2.5 Global and Kenya's Response to Obesity

In 2011, the "*WHO Global Strategy on Diet, Physical Activity and Health*" was adopted by the World Health Assembly. The strategy sought to improve the diet and physical activity patterns at the local, regional and global level. The strategy formed the basis for the Sustainable Development Goals 3 target 3.4 that seeks to "*reduce by one-third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being*" (United Nations, 2015). To further support the efforts towards reducing the burden of NCDs focussed on increasing the physical activity globally, the WHO developed the "*Global action plan on physical activity 2018–2030*".

Kenya which is a member of the World Health Assembly has adopted and committed to global strategies to address obesity and NCDs. Kenya has also developed various strategies such as "Kenya National Strategy for the Prevention and Control of NCDs 2015–2020", "Kenya National Nutrition Action Plan 2012–2017", "Kenya National Physical Activity Action Plan" and "Kenya National School Health Strategy 2010–2015". These strategies seek to prevent the

risk factors of NCDs including obesity. Specifically, the strategies details actions to prevent diet, physical activity, smoking, alcohol use and high blood pressure targeting children, adolescents, and adults.

1.3 Statement of the problem

Obesity is a global pandemic and a significant public health problem that is associated with the rise in NCDs. Obesity has been a major problem mainly in the Western world but has seen increasing prevalence in low- and middle-income countries (LMICs) including Kenya. With over one billion adults estimated to be obese worldwide by 2030, more than two-thirds of them are expected to be in LMICs. In Kenya, KDHS shows that 7.5% of women 15–49 years are obese. However, there are wide variations in obesity throughout the country. The obesity prevalence has been estimated at 20% in Nakuru (Mathenge et al., 2010), 36.3% among women in Kibera (Ayah et al., 2013), 36.3% among university staff in Nairobi (Okube and Omandi, 2019) and 58.8% among healthcare worker in Kisumu East (Ondicho et al., 2016). These variations are majorly due to studies with smaller sample size making them not generalisable the whole country resulting in challenges in the development of appropriate interventions and policies. Moreover, the main source of national data on obesity has been the demographic health surveys, which have majorly focused on women of reproductive age, which collects a limited number of risk factors of NCDs. Therefore, there exist a paucity of national studies with a population of both sexes estimating the burden of obesity and its determinants. Evidence from existing studies shows that gender, socioeconomic status, wealth, and education are negatively associated with obesity.

Moreover, obesity is caused by a disturbed energy balance resulting from consumption of more calories than energy expenditure for physical activities, maintenance and diet-induced thermogenesis hence surplus calories that are converted to fat. An understanding of the burden

of obesity and its social determinants is key in addressing the increasing burden. This helps identify areas of focus and contribute to identifying the appropriate interventions for the prevention of obesity in the country. Also, due to the rapidly changing socio-cultural, socioeconomic and health policy landscape in Kenya, there is a need for up-to-date evidence on determinants of obesity. Importantly, Kenya is scheduled for revision of its National Policy on NCDs and the findings of this study are key in informing the revision.

1.4 Research questions

1. What is the overall and sex-specific pattern of prevalence of obesity in Kenya?
2. What are the socioeconomic determinants of obesity in Kenya?
3. What are the policy implications socioeconomic determinants of obesity in Kenya?

1.5 Research objectives

1.5.1 Broad objective

The broad objective of the study was to assess sociodemographic and socioeconomic determinants of obesity in Kenya.

1.5.2 Specific objectives

i) To provide the overall and sex-specific pattern of prevalence of obesity in Kenya.

ii) To assess the sociodemographic and socioeconomic determinants of obesity in Kenya.

iii) To draw policy recommendations on obesity in Kenya based on aims (i) and (ii).

1.6 Study justification

Understanding the determinants of obesity is important in addressing it. Earlier studies on obesity have shown that almost a quarter of Kenyan women are obese. However, most of the earlier studies have small samples or based on specific geographical areas. Available national

studies, majorly the KDHS are focus on the female population limiting their generalisation to the entire Kenyan population. This study used nationally representative data, that is generalisable and allowed for assessment of overall and sex-specific prevalence and determinants. The study findings provide evidence on the determinants of obesity adding to the body of knowledge and relevant to policymakers especially as they revise the national strategy on NCDs.

CHAPTER TWO: LITERATURE REVIEW

2.1 Chapter introduction

This chapter discusses the theoretical and empirical literature on obesity and its determinants. The literature reviewed was obtained after a literature search conducted in PubMed and Google Scholar. The key search terms were “obesity,” “determinants,” “associated factors” and “risk factors.” An overview of the literature is provided at the end of the chapter.

2.2 Theoretical literature review

The study used the social-ecological theory to health which focusses on multilevel and multifactorial factors that are related to health (Dahlgren and Whitehead, 1991; Whitehead and Dahlgren, 2006). Based on the model, the individual and their characteristics are at the centre with the increasing influence of social and community factors and structural factors. Social and community factors include social capital while structural factors include housing, unemployment, education, food production, living and working conditions and healthcare services. The model addresses broader health issues and community approaches with a goal of policies, education and health promotion (Dahlgren and Whitehead, 1991; Whitehead and Dahlgren, 2006).

Based on the model highlighted in figure 2.1, the multifactorial factors can also be classified as distal, intermediate, and proximate. The distal factors include increased urbanisation and globalisation. Fox, Feng and Asal (2019) noted that globalisation is one of the key drivers of obesity. They highlighted that globalisation together with national processes such as increased urbanisation, women empowerment and economic development could explain the growing burden of obesity (Fox et al., 2019). As a result of globalisation and urbanisation, there is a declining level of physical activity, consumption of highly processed food, importation of non-

nutritious or junk food, less cooking and increased time spent working and in the sedentary state (Fox et al., 2019). The intermediate factors include socioeconomic factors such as occupation and wealth, transportation, culture, governance, media, public health, social capital and land use (Quick et al., 2017). The proximate factors have a direct effect on the individual and include dietary intake, genetics, age, household wealth, gender, physical activity, smoking and alcohol use (Quick et al., 2017). Obesity is associated with wealth and prestige in some African cultures (Edith, 2019). An ecological study found that the affordability of carbonated and non-carbonate sweet-sweetened beverages was a key driver for overweight and obesity (Ferretti and Mariani, 2019).

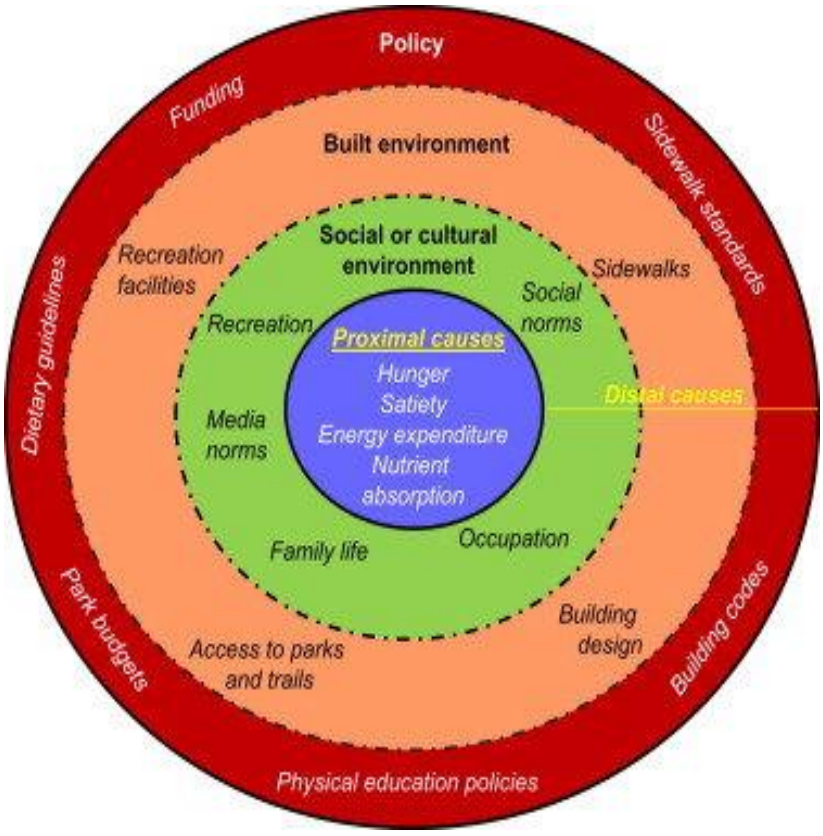

Figure 2.1. Social-ecological model of obesity

Adapted from Sansbury and Hill (2014)

2.3 Empirical literature review

Studies on obesity have found that more women than men are obese. In SSA and China, women are thrice and twice likely to be obese compared to men (Ajayi et al., 2016; Yu et al., 2019). Ondicho et al. (2016) found that 9% and 34.3% of male and female health providers were obese. Najafi et al. (2020) and Abubakari et al. (2008) showed that the odds of being obese is increased 2.8 and 3.2 times respectively among women compared to men (Najafi et al., 2020; Abubakari et al., 2008). Asiki et al. (2018) also found that women were six times more obese than men in Nairobi while Christensen et al. (2008) found a similarly high prevalence among women (25.9%) than men (6.6%) in Nakuru.

Age has a positive effect on obesity (Yu et al., 2019; Ondicho et al., 2016). Evidence also shows that age squared is associated with an increase in obesity (Yu et al., 2019; Ondicho et al., 2016). Ajayi et al. (2016) found that adults aged 35–44 years and ≥45 years had a three- and a five-fold increase in obesity risk. In Kenya and South Africa, older adults had increased odds of obesity (Sartorius et al., 2015). Also, in Zimbabwe, women aged 30–44 years and ≥45 years were associated with 3- to 6-fold higher odds of obesity compared to those aged 15–29 years (Mangemba and San Sebastian, 2020). In Hawassa Ethiopia, adults aged 45–54 years and 55–64 years were associated with three-fold higher odds of obesity compared to adults 18–24 years (Darebo et al., 2019).

In Iran and China, studies have shown that married, separated, divorced, and widowed individuals had increased odds of obesity compared to single individuals (Yu et al., 2019; Najafi et al., 2020). Najafi et al. (2020) found that married, separated, divorced, and widowed individuals have twice to thrice the odds of obesity compared to single individuals. In Kenya, Mkuu et al. (2018) found that being married increased the obesity odds 1.7 times compared to not being married while Ajayi et al. (2016) found that married and separated/divorced/widowed

adults had 1.7 and 2 times increased odds of obesity compared single adults in four SSA countries. Similarly, married women had 54% higher odds of obesity compared to unmarried women in Zimbabwe (Mangemba and San Sebastian, 2020).

High education affects obesity positively (Neupane et al., 2016). According to Neupane et al. (2016), with educated individuals have high obesity risk compared to uneducated individuals. This is confirmed by Yu et al. (2019) who also found that secondary educated individuals were likely to be obese. Steyn et al. (2011) also found that secondary/tertiary-educated individuals in Kenya had 50% increase in odds of obesity while Ajayi et al. (2016) found that these individuals had six times increase in odds of obesity.

Urban residence increases obesity risk (Ettarh et al., 2013; Mangemba and San Sebastian, 2020). According to Neupane et al. (2016), urban residents had 2.5 times increased odds of obesity compared to rural residents. Also, more women in urban informal settings in Kenya than men are obese (Ettarh et al., 2013). Mkuu et al. (2018) found that compared to urban women, rural women had 17% reduced obesity odds. In Zimbabwe, Mangemba and San Sebastian (2020) found that women living in a rural area had a 3% reduced odds of obesity. Chowdhury et al. (2018) found that the odds of obesity increased by 12% to 94% among urban and rural women compared to normal weighted women in Bangladesh.

Wealth affects obesity both positive for richer and richest quintiles and negative for poorest and poorer quintiles. In China, Yu et al. (2019) found rich individuals had reduced obesity risk. However, Neupane et al. (2016) in 32 SSA countries using the demographic health survey data, the poor were less likely to be obese than the rich. Similarly, according to Ajayi et al. (2016) in a regression study of four SSA countries, obesity was more among the wealthy than the poorest individuals. In Kenya, compared to the poorest women, richer and richest women had increased obesity odds (Mkuu et al., 2018). Mangemba and San Sebastian (2020) found

increased odd of obesity among women in Zimbabwe with improved wealth status, with the richest having 7-fold higher odds of obesity compared to the poorest.

Unemployment is negatively associated with obesity. According to Steyn et al. (2011), employed, seasonal or casual workers in Kenya had increased risk of obesity which was similar to South Africa (Sartorius et al., 2015). Moreover, Mkuu et al. (2018) found that unemployed women had increased obesity risk compared to employed women in Kenya. Among women in Burkina Faso, unemployment was found to be protective against obesity and reduced the odds of obesity by 10% (Diendéré et al., 2019). In Bangladesh, being employed was found to be associated with a 48% reduced risk of obesity among urban women (Chowdhury et al., 2018).

Obesity has a positive relationship with physical activity. In South Africa, physical activity decreases obesity risk by 9% and 24% among women and men, respectively (Sartorius et al., 2015). In China, regular physical activity reduced the odds of obesity (Yu et al., 2019) while physical inactivity increased the odds of obesity 2.4 times in Ethiopia (Bogale and Zewale, 2019). In Kenya, Ondicho et al. (2016) and Okube and Omandi (2019) found reduced obesity odds among individuals who performed vigorous physical activity. In India, a sedentary lifestyle was found to be associated with a high prevalence of obesity (Panchal et al., 2019) while in North Western Ethiopia, mild-moderate physical activity reduced by 40% the odds of obesity (Mekonnen et al., 2018).

The effect of smoking and alcohol on obesity is still unclear despite both being known risk factors of obesity but evidence shows that they affect obesity negatively. In a study in Uganda, Nigeria, Tanzania and South Africa, smoking was found to be protective of smokers having 11% reduced odds of obesity (Ajayi et al., 2016). In Iran, smokers had a 7% increased odds of obesity compared to non-smokers Iran (Najafi et al., 2020). However, Okube and Omandi (2019) found that alcohol use increased the odds of obesity among university staff. Similarly,

Bogale and Zewale (2019) and Darebo et al. (2019) found that alcohol users had 2 times increased odds of obesity compared to non-alcohol users. In Burkina Faso, Diendéré et al. (2019) found that alcohol reduced the odds of overweight and obesity by 13% though the association was non-significant. Mkuu et al. (2018) showed found a relationship between alcohol use and overweight/obesity among women in Kenya but did not assess the magnitude of the association.

The WHO encourages individuals to eat at least five servings of vegetables and fruits weekly. Eating of fruits and vegetable is protective against obesity. Okube and Omandi (2019) found that daily fruits/vegetable servings also reduced the odds of obesity. In Hawassa and North Western Ethiopia, vegetables and fruits consumption was found to be protective against obesity and reduced the odds of obesity by 24% and 49% respectively (Mekonnen et al., 2018; Darebo et al., 2019).

2.4 Overview of the literature

Obesity affects about one-tenth of the global population; half of who are from LMICs. Studies have shown significant differences in obesity prevalence globally and regionally. About 2.3% and 7.5% of East Africans are obese, with Kenya having the highest obesity prevalence. Evidence showed that age, urban residence, female sex, marital status, occupation, education, physical inactivity, smoking, alcohol use and wealth are positively associated with obesity (Yu et al., 2019; Ondicho et al., 2016; Najafi et al., 2020; Mangemba and San Sebastian, 2020). It also shows that wealth status, physical activity, alcohol, smoking and fruits and vegetable are negatively associated with obesity (Mekonnen et al., 2018; Darebo et al., 2019; Ajayi et al., 2016; Sartorius et al., 2015). Studies on the determinants of obesity have mainly used logistic regression in their analysis and have only focussed on both overweight and obesity and in most cases used a combined overweight and obesity variable. Besides, most studies especially in

Africa have focussed on the women and used data from the demographic health surveys (Mangemba and San Sebastian, 2020; Mkuu et al., 2018; Chowdhury et al., 2018) leaving out men as well as women aged 50 years and above. However, there is a paucity of obesity studies using Probit regression or other analytical methods that are mainly focused on obesity especially in Kenya hence the need for this study.

CHAPTER THREE: METHODOLOGY

3.1 Chapter introduction

This chapter discusses how the study was conducted. It provides the study's conceptual framework and describes the data source, econometric models and estimation issues. It also identifies, defines and operationalises the study variables.

3.2 Conceptual Framework

The study used the social determinants of obesity model to highlights the various pathways and association between the factors and obesity. Age and sex are critical factors that are independently associated with obesity. Wealth, residence, education employment, and wealth form the socioeconomic or structural determinants that directly affect obesity as well as contribute to the health behaviours, which are classified as intermediate social determinants of obesity.

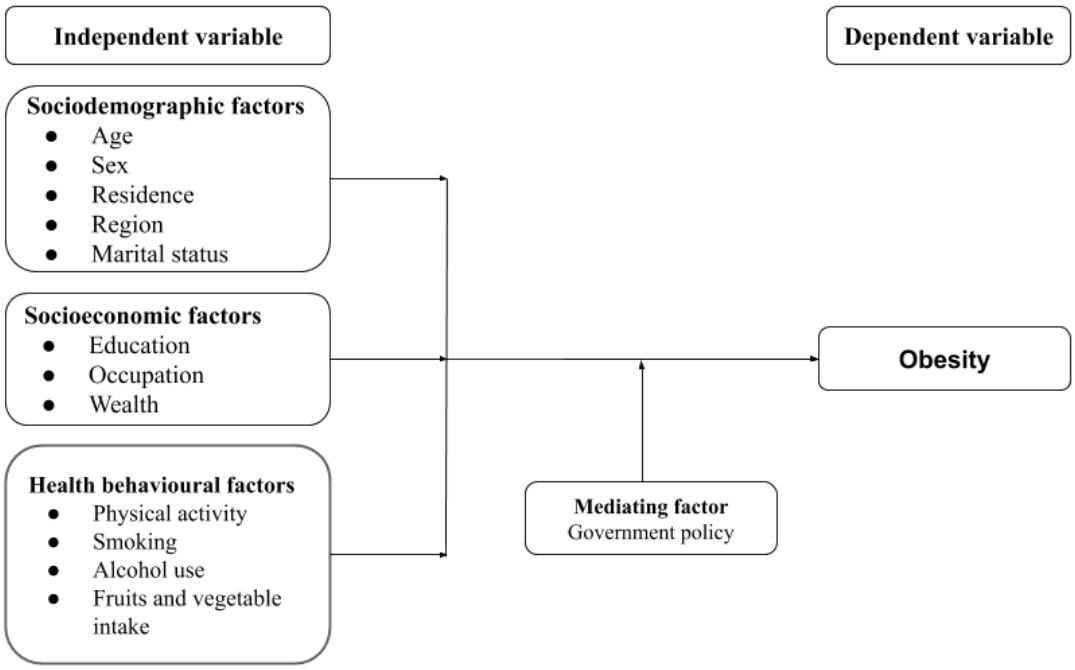

Figure 3.1: Obesity conceptual framework

Source: Author

3.3 Model specifications

3.3.1 Probit Model

A binary Probit regression model was used to estimate the obesity determinants in Kenya. Obesity, the outcome variable was binary (1 = obese and 0 = non-obese). The Probit model assumes the outcome and independent variables have a linear relationship and have an inverse standard normal distribution of the probability as follows (Wooldridge, 2010):

$$y_i^* = \alpha + \beta x_i + \varepsilon \quad (1)$$

Where:

y_i^* = the unobserved dependent variable [obesity]

x_i = vector of independent variables (see table 1)

β = estimated parameters vector

ε = error

The observed outcome variable (y) is linked to the unobserved outcome variable (y_i^*) variable as follows:

$$y_i = \begin{cases} 1 \; if \; y_i^* > \tau \\ 0 \; if \; y_i^* \leq \tau \end{cases} \quad (2)$$

Where, τ is the threshold, while obesity is y = 1 and non-obese is y = 0. The cumulative distribution function of the Probit model can then be expressed as:

$$prob(y_i) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{x_i\beta} e \frac{-(x_i - x_i\beta)^2}{2} dx = \Phi x_i \beta \quad (3)$$

Equation 4 shows the probability of obesity:

$$\Pr(y_i = 1) = \Phi(x_i\beta') \quad (4)$$

Where; $\Phi(x_i\beta')$ is the cumulative distribution function; used to calculate the maximum likelihood function (L) as follow:

$$\mathrm{L} = \prod_{y=0} \Phi(-x_i\beta') \prod_{y=1} [1 - \Phi(-x_i\beta')] \quad (5)$$

The marginal effects at the mean of the Probit model ($\frac{\partial y}{\partial x}$) were calculated as follows:

$$y = \Phi(\beta_0 + \beta_1 x_1 + \beta_1 x_1 + \beta_1 x_1 + \cdots + \beta_n x_n) \text{ so} \quad (6)$$

$$\frac{\partial y}{\partial x} = \beta_i \phi(\beta_0 + \beta_1 x_1 + \beta_1 x_1 + \beta_1 x_1 + \cdots + \beta_n x_n) \quad (7)$$

The Probit model was interpreted based on the coefficients or marginal effects. Positive coefficients showed that an increase in the independent variable increases the predicted probability while negative coefficients showed a decrease in the predicted probability for every increase in the independent variable.

3.3.2 Estimable Model

The descriptive characteristics of the respondents and the magnitude of obesity were analysed using frequency tables and percentages in absolute numbers and weighted proportions. The statistical analyses were performed using Stata 14.0 with the significance level being set at 0.05 and adjusted for survey weights.

The model was as follow:

$$y = \beta + \beta_1(age) + \beta_1(age^2) + \beta_1(Sex) + \beta_1(religion) + \beta_1(marital\ status)\ (education) + \beta_1(residence) + \beta_1(occupation) + \beta_1(physical\ activity) + \beta_1(fruit\ and\ vegetable) + \beta_1(smoking) + \beta_1(alcohol) + \varepsilon$$

3.4 Definition, measurement, and signs of variables

The main outcome of the study was obesity. The body weight and heights of the respondents were measured using an electronic measuring scales and a height/length board, respectively. The body mass index (BMI) was calculated based on weights divided by height squared. Based on the WHO classification, a "BMI <29.9 kg/m^2" was normal and "BMI ≥30.0 kg/m^2" was obesity (Villar et al., 2014). The socioeconomic position and living standards of the respondents was determined based on their wealth index. The wealth index was generated through principal component analysis using household assets data collected in the household survey. The household data collected included household characteristics (the type of house, floors, windows), ownership of durable goods (car, motorbikes, refrigerators, television) and tap water, sanitation, and electricity (Rutstein, 2015). The principal component analysis produced a factor score for each household which was categorised into five dichotomous quintiles (1 – poorest and 5 – richest) used in the analysis in the study (Howe et al., 2012). The wealth index was adjusted for the area (either rural or urban) to account for the differences in residence. Table 1 summarises the operational definitions and measurements of the variables. The independent variables of the study included sociodemographic, socioeconomic, and behavioural factors.

Table 3.1. Summary table on definition, measurement, and signs of variables

Variables	Definitions	Measurements	Expected sign
Dependent			
Obesity	"Body mass index (BMI) of ≥30 kg/m²"	Dummy variable: Yes, if "BMI ≥30 kg/ m²" No if "BMI <30 kg/ m²"	
Independent			
Age in years	In years	Continuous variable	Negative (–)
Sex	Whether male or female	0 if Male 1 if Female	Negative (–)
Marital status	Whether married or not married	0 if married 1 if not married	Negative (–)
Education	Levels of education	'1 if no formal, 0 if otherwise' '1 if primary, 0 if otherwise' '1 if secondary, 0 if otherwise' '1 if tertiary, 0 if otherwise'	Negative (–) Negative (–) Positive (+) Positive (+)
Residence	Area of residence in terms of urban and rural	0 if Rural 1 if Urban	Positive (+)
Occupation	Employment status	Dummy variable: 0 if unemployed, 1 if employed	Negative (–)
Physical activity	Whether someone is physically active or sedentary	0 if not active 1 if active	Negative (–)
Smoking	Current use of tobacco	Dummy variable: '0 if No, 1 if Yes'	Negative (–)
Alcohol use	Current use of alcohol	Dummy variable: '0 if No, 1 if Yes'	Negative (–)
Fruits and vegetable intake	Consumption of ≥5 servings of fruits and vegetable	Dummy variable: 0 if ≥5 servings [enough], 1 if <5 servings [not enough]	Negative (–)
Wealth index, quintiles	A measure of living standard based on the aggregate of household assets using principal component analysis	'1 if poorest, 0 if otherwise' '1 if poorer, 0 if otherwise' '1 if middle, 0 if otherwise' '1 if richer, 0 if otherwise' '1 if richest, 0 if otherwise'	Negative (–) Negative (–) Negative (–) Positive (+) Positive (+)

3.5 Estimation issues

The study analysed only cases with complete observation and without missing observations. Missing observations were dropped from the analysis. Variance inflation factors (VIF) was used to assess for multicollinearity and find the most robust variables for our model, which inflates the variance in parameter estimates. Variables were considered collinear if they have a VIF greater than 5 (Vatcheva et al., 2016). Cross tabulations between the predictor and exposure variables were performed to check for empty and small cells which may cause unstable model (Wooldridge, 2010).

Observations with large variance than others, heteroscedasticity, was detected using residual plots and Breusch-Pagan test. Residuals were assessed for normality using skewness/kurtosis tests for normality and using density plots (histogram, probability plot, Q-Q plot. Sample weights were applied in the regression models to adjust for the cluster sampling of the survey data used in the study. The Stata command *svy* was used to account for the sampling weights.

3.6 Data source

The study used data obtained from the Kenya STEPwise survey for non-communicable diseases risk factors 2015 survey. The survey used a 3-stage cluster randomised approach where 200 clusters of rural and urban houses were identified followed by a selection of 30 household from each of the clusters and a randomly selected individual from each of the households.

The household survey conducted nationwide among adults 18–69 years used the WHO STEPwise approach. The first step involved demographic and behavioural information data collection, the second step involved taking anthropometric measurements while the last steps involved biochemical measurements of blood glucose and lipids. Ninety-five per cent or 4500

respondents of the 4754 respondents who consented were interviewed in step 1. Anthropometrics measurements were taken for 99% of them and 93% underwent the biochemical measurements (KNBS et al., 2015).

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Chapter introduction

Chapter four presents and interpret the study findings. First, the chapter describes data, the study participants, and the prevalence of obesity. Second, the estimation issues and econometric findings are presented and interpreted. Lastly, the study findings are discussed.

4.2 Descriptive statistics

Out of the 4500 participants, 4,183 were included in the analysis and 317 (7%) with missing observations were dropped. Table 4.1 summarises the details of the study variables. All variables have 4183 observations except for alcohol use, which had seven missing observations. The mean age was 37.6 (SD: 13.4) years with a range of between 18 and 70 years.

Table 4.1. Summary statistics

Variables	Observations	Mean	Std. Dev.	Min	Max
Obesity	4183	0.128	0.334	0	1
Residence	4183	1.486	0.500	1	2
Sex	4183	1.586	0.493	1	2
Age	4183	37.6	13.4	18	70
Marital status	4182	1.676	0.468	1	2
Education	4183	1.704	1.042	0	2
Occupation	4183	1.780	0.742	0	1
Wealth	4183	2.991	1.416	1	5
Smoking	4183	1.119	0.324	0	1
Alcohol	4176	0.210	0.407	0	1
Vegetable intake	4183	0.869	0.337	0	1
Physical activity	4183	1.380	0.681	0	1

4.3 Sample characteristics

Table 4.2 highlights the overall and sex-specific characteristics of the participants. Out of the 4,183 participants, 2,452 (58.6%) were women and 1,731 (41.4%) men. About two-thirds were married, 61.8% lived in rural areas, 60.7% were employed and 55.8% had primary school education (Table 4.2). A quarter of the participants are either physically inactive or currently use alcohol, 13% smoke and 85.5% do not consume the recommended five servings of fruits and vegetables (Table 4.2).

Table 4.2. Sample characteristics

Categories	Characteristics	Gender n (%)		Total
	(N = 4183)	Male n = 1731	Female n = 2452	
Sociodemographic variables	**Age, years**			
	Age (mean (SD))	37.8 (13.1)	37.4 (13.5)	37.6 (13.4)
	Marital status			
	Single	544 (19.0)	809 (16.2)	1353 (35.1)
	Married	1187 (31.8)	1642 (33.1)	2829 (64.9)
	Residence			
	Rural	823 (29.4)	1326 (32.3)	2149 (61.8)
	Urban	908 (21.3)	1126 (16.9)	2034 (38.2)
Socioeconomic variables	**Education**			
	No formal	158 (3.4)	524 (8.8)	682 (12.2)
	Primary	959 (27.4)	1391 (28.34)	2350 (55.8)
	Secondary+	614 (19.9)	537 (12.1)	1151 (32.0)
	Occupation			
	Unemployed	414 (12.9)	1299 (26.4)	1713 (39.3)
	Employed	1317 (37.9)	1153 (22.8)	2470 (60.7)
	Wealth			
	1 – Poorest	407 (13.8)	439 (9.9)	846 (23.8)
	2	381 (11.4)	459 (9.1)	840 (20.5)
	3	331 (8.7)	506 (10.5)	837 (19.2)
	4	329 (9.5)	497 (9.5)	826 (19.0)
	5 – Richest	283 (7.4)	551 (10.2)	834 (17.6)
Health behaviours	**Smoking**			
	No	1340 (39.7)	2346 (47.3)	3686 (87.0)
	Yes	391 (11.0)	106 (2.0)	497 (13.0)

Alcohol use			
No	1044 (22.9)	2255 (44.5)	3299 (74.5)
Yes	683 (20.8)	194 (4.7)	877 (25.5)
Vegetable intake			
Enough	237 (6.2)	311 (5.3)	548 (11.5)
Not enough	1494 (44.6)	2141 (44.0)	3635 (88.5)
Physical activity			
Active	1383 (39.6)	1688 (35.5)	3071 (75.1)
Inactive	348 (13.1)	764 (13.8)	1112 (24.9)

4.4 Prevalence of obesity

Table 4.3 outlines the prevalence of obesity according to participants characteristics. A total of 536 participants had BMI ≥30kg/m^2 hence were classified as obese. The overall prevalence of obesity was 10.97% (95% CI: 9.06%–13.22%). The prevalence was higher among women (n = 434, 16.53%; 95% CI: 14.15%–19.22%) than men (n = 102, 5.57%; 95% CI: 3.56%–8.61%) (Table 4.3).

Prevalence of obesity was also high among urban residents (15%), the married (12.7%), employed (12.5%) and with a secondary and above level of education (14.5%). Across the wealth quintiles, the poorest had the highest prevalence at 19.3% (15.0%–24.5%). Participants who consumed less than recommended servings of vegetable and fruits had a higher prevalence than those who consumed the recommended servings (11% vs 10.7%) (Table 4.3). Based on all participants characteristics, the poorest (19.3%), physically inactive (16.3%), female (15.5%), urban residents (15%) and secondary educated (14.5%) had the highest prevalence of obesity (Table 4.3).

Table 4.3. Prevalence of obesity according to sociodemographic, socioeconomic, and behavioural characteristics

Categories	Characteristics	Prevalence of Obesity (N=4183)			p-value (Chi-square test)
		No N=3647	Yes N=536	Yes 95% CI	
Sociodemographic variables	**Residence**				
	Rural	1931 (91.5)	218 (8.5)	[6.9, 10.5]	0.002*
	Urban	1716 (85.0)	318 (15.0)	[11.2, 19.7]	
	Age, years (mean (SD))	37.2 (13.5)	41.8 (12.3)		<0.001**
	Gender				
	Male	1629 (94.4)	102 (5.6)	[3.5, 8.6]	<0.001**
	Female	2018 (83.5)	434 (16.5)	[14.2, 19.2]	
	Marital status				
	Single	1208 (92.3)	145 (7.7)	[5.5, 10.7]	0.001**
	Married	2439 (87.3)	390 (12.7)	[10.6, 15.2]	
Socioeconomic variables	**Education**				
	No formal	624 (93.6)	58 (6.5)	[4.1, 10.0]	
	Primary	2070 (90.1)	280 (9.9)	[8.1, 12.1]	0.002*
	Secondary+	953 (85.5)	198 (14.5)	[10.9, 19.1]	
	Occupation				
	Unemployed	1542 (91.5)	171 (8.5)	[6.9, 10.5]	0.013*
	Employed	2105 (87.4)	365 (12.5)	[9.8, 15.9]	
	Wealth				
	1 – Poorest	647 (80.7)	199 (19.3)	[15.0, 24.5]	<0.001**
	2	704 (88.0)	136 (12.0)	[8.8, 16.0]	
	3	737 (88.8)	100 (11.2)	[8.2, 15.1]	
	4	757 (93.0)	69 (7.0)	[4.9, 10.1]	
	5 – Richest	802 (97.4)	32 (2.6)	[1.6, 4.1]	
Health behaviours	**Smoking**				
	No	3166 (87.7)	520 (12.3)	[10.2, 14.8]	<0.001**
	Yes	481 (98.2)	16 (1.8)	[0.9, 3.6]	
	Alcohol use				
	No	2831 (88.1)	468 (12.0)	[10.2, 14.0]	0.151
	Yes	809 (91.8)	68 (8.2)	[4.6, 14.2]	
	Vegetable intake				
	Enough	473 (89.3)	75 (10.7)	[7.7, 14.5]	0.867
	Not enough	3174 (89.0)	461 (11.0)	[8.9, 13.5]	
	Physical activity				
	Active	2734 (90.8)	337 (9.2)	[7.3, 11.6]	<0.001**
	Inactive	913 (83.7)	199 (16.3)	[12.9, 20.4]	

**p<0.001; * p<0.05;

4.5 Estimation issues

To test for multicollinearity, the variance inflation factor (VIF) was used with the cut-off set at VIF>5. Table 4.4 highlights the results of the variance inflation test which showed that there was no multicollinearity. VIF ranged between 1.04 and 3.60 which was below our criteria for multicollinearity. Correlation between the categorical independent variables was also assessed using the Spearman rank correlation test (Table 4.5).

Table 4.4. Variance inflation factors

Variables	VIF	Variables	VIF
Residence	1.19	**Wealth**	
Gender	1.37	Poorer	1.70
Age	1.14	Middle	1.88
Marital status	1.04	Richer	1.96
		Richest	2.63
Education			
Primary	3.15	Smoking	1.30
Secondary and above	3.60	Alcohol	1.29
		Vegetables	1.07
Occupation	1.23	Physical activity	1.11

Table 4.5 presents the results of the Spearman rank correlation test and shows that the variables had a weak correlation and were all thus included. In addition, to assess for heteroscedastic and normality of continuous variables (body mass index, age and age squared), residuals were plotted using histogram and quantile and probability plots and fitted in a regression model. Figure 4.1 shows that body mass index, age and age squared were all normally distributed with no significant outliers.

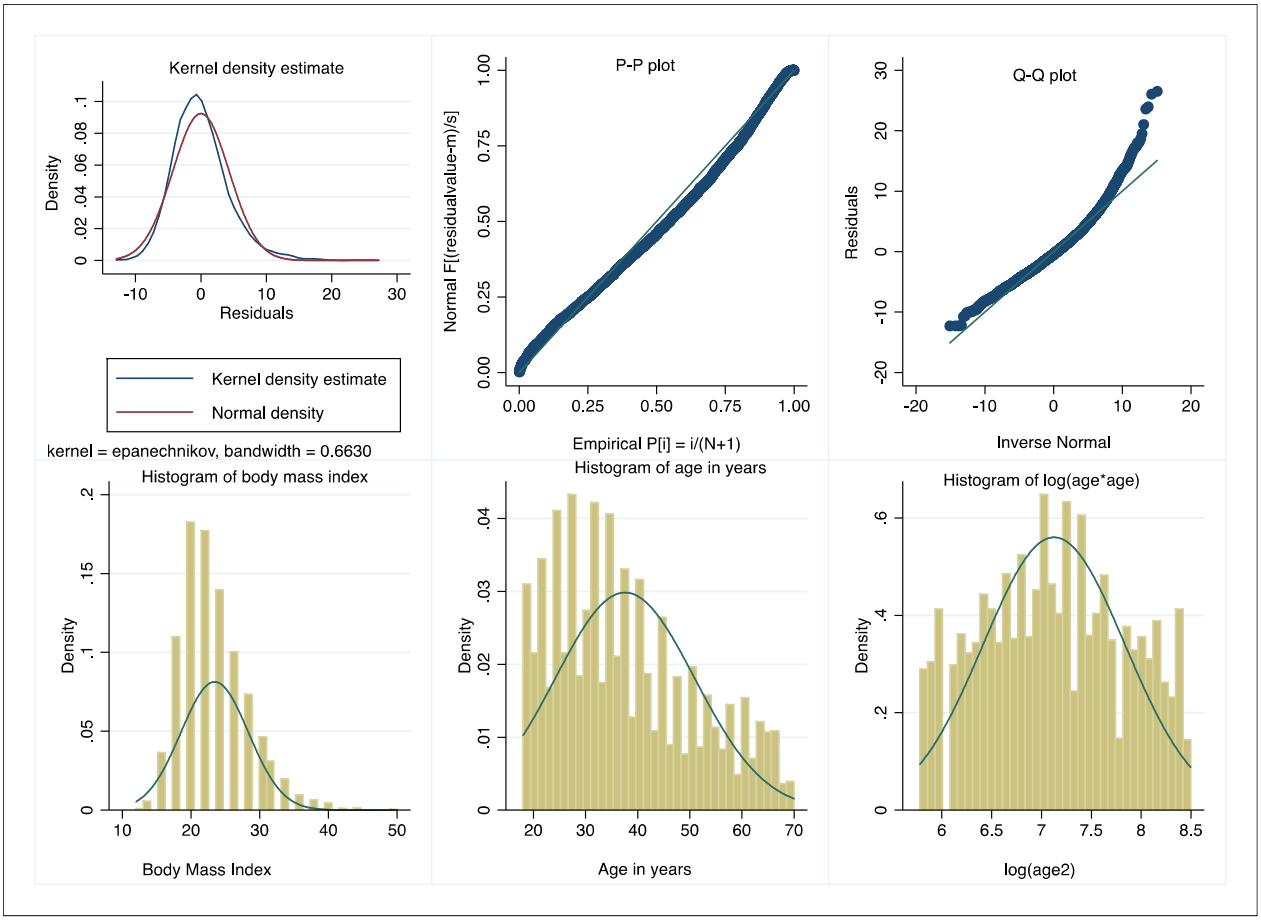

Figure 4.1: Diagnostic tests for continuous variables

Cross-tabulation between the outcome variables and independent variables was performed to assess for empty and small cells which may make the model unstable. Table 4.3 highlights the results of the cross-tabulations and none of the cells was either small or empty hence a stable model was run. The Probit regression (Table 4.7) and multivariable regression models (Table 4.6) were stable and were statistically significant as indicated with a p = <0.0001. A total of 4175 observations were included in both models, which analysed only cases with no missing observations.

Table 4.5. Spearman rank correlation test

	Region	Residence	Gender	Age	Marital status	Education	Occupation	Income	Smoking	Alcohol	Nutrition
Region	**1.0000**										
Residence	0.0067	**1.0000**									
Gender	0.0120	-0.0644	**1.0000**								
Age	0.0109	-0.0986	-0.0068	**1.0000**							
Marital status	0.0002	-0.0708	-0.0166	0.1187	**1.0000**						
Education	-0.0460	0.2491	-0.1873	-0.2209	-0.0563	**1.0000**					
Occupation	-0.0013	0.2080	-0.3068	0.0149	0.0501	0.3372	**1.0000**				
Income	0.0137	-0.3269	0.0975	0.0741	-0.0353	-0.5662	-0.3358	**1.0000**			
Smoking	-0.0350	-0.0320	-0.2780	0.1332	-0.0224	0.1402	0.0339	0.1540	**1.0000**		
Alcohol	-0.0473	0.0474	-0.3824	0.0352	-0.0391	0.0852	0.1555	-0.0256	0.3377	**1.0000**	
Nutrition	0.0222	0.0147	0.0147	-0.0076	-0.0020	-0.0260	-0.0038	0.0075	0.0068	-0.0037	**1.0000**
Physical Activity	0.0589	0.111	0.1245	0.0111	-0.0068	-0.0229	-0.0373	-0.046	-0.0472	-0.0005	0.0301

4.6 Econometric results

Table 4.6 outlines the results of multivariable logistic regression. The analysis showed that after adjusting for other independent variables, a one-year increase in age increased the odds of obesity by 1.24 times (OR: 1.24, 95% CI: 1.15– 1.34) while advanced age reduced the odds of obesity by less than 1%. The odds of obesity were 1.5 times higher among urban residents compared to the rural residents. Urban residents are known to have increased risk for obesity due to the sedentary life of most of the urban residents, consumption of highly processed foods and involvement in other risky health behaviours such as smoking and alcohol (Mkuu et al., 2018). This study also found that female had five-fold (OR: 4.80, 95% CI: 3.25–7.08) higher odds of obesity compared to males. Studies have found that females have a higher prevalence of obesity and are more likely to be obese. The increased risk of obesity among women in emerging markets have been attributed to occupational changes, sociocultural factors, increased alcohol consumption, and societal preference for obese women (Mkuu et al., 2018; Kanter and Caballero, 2012).

Wealth status is the other determinant of obesity in Kenya. Richest, richer, middle and poorer wealth quintiles reduced the odds of obesity compared to the poorest wealth quintile. The odds of obesity were 36% (OR: 0.36, 95% CI: 0.45– 0.91), 45% (OR: 0.45, 95% CI: 0.35–0.84), 63% (OR: 0.63, 95% CI: 0.24– 0.58) and 86% (OR: 0.86, 95% CI: 0.07– 0.28) lower among poorer, middle, richer, and richest individual compared to the poorest individuals. The association between wealth status and obesity has been shown to vary with some studies highlighting that richest individuals have increased risk (Neupane et al., 2016) while some showing the poorest having increased risk (Ajayi et al., 2016). This finding shows that wealth status is protective against obesity in Kenya since it has a positive association with and lowers the odds of obesity.

This study found smoking to be a protective determinant against obesity. Smoking reduced the odds of obesity by 75% (OR: 0.25, 95% CI: 0.11–0.58) compared to non-smoking. Ajayi et al. (2016) also found that smoking was protective against obesity in Uganda, Nigeria, Tanzania, and South Africa (Ajayi et al., 2016). It is unclear why smoking which is a known risk factor for NCDs is protective against obesity. However, the low proportion of smokers in Kenya (13%) could explain the protective nature of smoking.

The odds of obesity were 1.9 times (OR: 1.90, 95% CI: 1.32–2.74) higher among participants who were physically inactive compared to those who were physically active. WHO has identified physical inactivity as one of the risk factors for NCDs including obesity (World Health Organization, 2013). Earlier studies in Kenya and elsewhere have also found that people with sedentary lifestyles have increased risk of obesity (Ondicho et al., 2016; Okube and Omandi, 2019). Physically inactive individuals use fewer calories than they consume, which is the biological basis of obesity.

Table 4.6. Adjusted odds ratio

Categories	Characteristics	Odds Ratio	Std. Err.	t	P>|t|	(95% Conf. Interval)
Socio-demographic variables	**Age, years**					
	Age	1.242**	0.0483	5.57	<0.001	1.150, 1.340
	Age squared	0.998**	0.0005	-4.28	<0.001	0.997, 0.999
	Residence					
	Rural					
	Urban	1.573*	0.3024	2.35	0.020	1.076, 2.298
	Gender					
	Male					
	Female	4.800**	0.9460	7.96	<0.001	3.254, 7.080
	Marital status					
	Single					
	Married	1.324	0.2713	1.37	0.172	0.884, 1.984
Socio-economic variables	**Education**					
	No formal					
	Primary	1.177	0.3088	0.62	0.535	0.702, 1.975
	Secondary+	1.453	0.3485	1.56	0.121	0.905, 2.332
	Occupation					
	Unemployed					
	Employed	1.336	0.2583	1.50	0.136	0.912, 1.956
	Wealth					
	1 – Poorest					
	2	0.643*	0.1131	-2.51	0.013	0.454, 0.909
	3	0.546*	0.1200	-2.75	0.006	0.354, 0.842
	4	0.370**	0.0854	-4.31	<0.001	0.235, 0.584
	5 – Richest	0.140**	0.0500	-5.51	<0.001	0.069, 0.283
Health behaviours	**Smoking**					
	No					
	Yes	0.253**	0.1066	-3.26	0.001	0.110, 0.581
	Alcohol use					
	No					
	Yes	1.182	0.2997	0.66	0.511	0.717, 1.948
	Nutrition					
	Enough					
	Not enough	0.850	0.1570	-0.88	0.379	0.590, 1.223
	Physical activity					
	Active					
	Inactive	1.899**	0.3518	3.46	0.001	1.318, 2.737
	LR chi2 (26)	529.94				
	Prob > chi2	0.0000				
	Pseudo R2	0.1658				

**p<0.001; * p<0.05

Table 4.7 highlights the results of the average marginal effects of the Probit regression analysis. In this analysis, all the selected variables were included. The analysis showed that age, residence, sex, wealth, smoking, and physical inactivity were associated with obesity. Age had a negative association with obesity, with a one-year increase in age contributing to increasing the probability of obesity by 0.112. However, increasing age, as measured by age squared, has a positive association decreasing the probability of obesity by 0.001 for every one-year increase in squared age. Compared to men, women had a 0.848 increased probability of obesity. Urban residence was negatively associated with obesity and decreased the probability of obesity by 0.256 compared to the rural residence. Wealth also had a positive association with obesity. The richest, richer, middle, and poorer wealth quintiles decreased the probability of obesity by 0.9432, 0.5191, 0.3461 and 0.2529 respectively compared to the poorest wealth quintile. Physical inactivity increases the probability of obesity while smoking decreases the probability of obesity. The probability of obesity is increased by 0.3486 among physically inactive compared with physically active participants. Compared to non-smokers, smokers had 0.6623 decreased probability of obesity.

Table 4.7. Marginal effects

Categories	Characteristics	ME (*df/dx*)	Std. Err.	t	P>|t|	(95% Conf. Interval)
Socio-demographic variables	**Age, years**					
	Age	0.1124**	0.0199	5.66	<0.001	0.0732, 0.1516
	Age squared	-0.0011**	0.0002	-4.34	<0.001	-0.0016, -0.0006
	Residence					
	Rural					
	Urban	0.2556*	0.1049	2.44	0.016	0.0489, 0.4624
	Gender					
	Male					
	Female	0.8484**	0.098	8.66	<0.001	0.6551, 1.0417
	Marital status					
	Single					
	Married	0.1358	0.1092	1.24	0.215	-0.1255, 0.4148
Socio-economic variables	**Education**					
	No formal					
	Primary	0.1446	0.1370	1.06	0.292	0.1255, 0.4148
	Secondary+	0.2485	0.1295	1.92	0.056	-0.0069, 0.5039
	Occupation					
	Unemployed					
	Employed	0.1699	0.1043	1.63	0.105	-0.0358, 0.3757
	Wealth					
	1 – Poorest					
	2	-0.2529*	0.0972	-2.6	0.010	0.4446, -0.0612
	3	-0.3461*	0.1223	-2.83	0.005	-0.5873, -0.1050
	4	-0.5191**	0.1254	-4.14	<0.001	0.7664, -0.2719
	5 – Richest	-0.9432**	0.1685	-5.6	<0.001	-1.2755, -0.6109
Health behaviours	**Smoking**					
	No					
	Yes	-0.6623**	0.1904	-3.48	0.001	-1.0378, -0.2867
	Alcohol use					
	No					
	Yes	0.0530	0.1395	0.38	0.704	-0.2221, 0.3282
	Nutrition					
	Enough					
	Not enough	-0.0715	0.0994	-0.72	0.473	-0.2675, 0.1244
	Physical activity					
	Active					
	Inactive	0.3486**	0.0998	3.49	0.001	0.1518, 0.5454
	LR chi2 (26)	529.94				
	Prob > chi2	0.0000				
	Log-likelihood	-1333.4				
	Pseudo R2	0.1658				

**p<0.001; * p<0.05; ME: Marginal effects (*dy/dx*)

4.7 Discussion of the results

This study found that the prevalence of obesity was 11%, with the prevalence being higher among females (16.5%) than males (5.6%). The prevalence is higher than the average 6.7% prevalence of obesity in Africa (Neupane et al., 2016). It is lower compared to 15% estimated in a nationwide study by Amugsi et al. (2017) and 58.8% among healthcare worker (Ondicho et al., 2016) and 36.3% among university staff in Nairobi (Okube and Omandi, 2019). The prevalence is comparable to the estimated 10%–14% in Uganda (Ajayi et al., 2016). The estimated prevalence of obesity is also comparable to 9.1% in Kenya (Mkuu et al., 2018) and 12.3% in Zimbabwe (Mangemba and San Sebastian, 2020) reported in previous studies using the demographic health surveys.

Similar to previous studies (Mkuu et al., 2018; Amugsi et al., 2017), women had a higher prevalence of obesity compared to men. Ondicho et al. (2016), Christensen et al. (2008) and Asiki et al. (2018) have also found higher prevalence and likelihood of obesity among women compared to men in Kenya. The study found that women were had three times higher prevalence of obesity and increased likelihood of obesity than men, which is similar to what was found in studies in China and in four SSA countries where women were thrice and twice likely to be obese compared to men (Ajayi et al., 2016; Yu et al., 2019). In a study in urban slums in Kenya, body sizes that could be perceived to be overweight and obese are preferred by more than a third of adults (Ettarh et al., 2013). The high prevalence and risk of obesity among women have also been associated with genetics and hormones (Erem et al., 2004).

Age had a negative association with obesity while advanced age had a positive association with obesity. Older adults have been shown to have increased odds of obesity (Sartorius et al., 2015; Ajayi et al., 2016), which is contrary to our findings that showed a negative association. This finding could be explained by increased sedentary lifestyle among the young population which

was previously associated with older adults (Guthold et al., 2018). Also, older adults tend to experience hormonal and metabolic change increasing their risk of obesity (Erem et al., 2004).

Moreover, similar to previous studies (Neupane et al., 2016; Mkuu et al., 2018), urban residents were found to have high obesity prevalence and increased obesity risk. Neupane et al. (2016) found that urban residents have 2.5 times increased risk of obesity compared to rural residents while Mkuu et al. (2018) found that rural women had 17% reduced obesity risk compared to urban women. Urbanisation is one of the key drivers of obesity. Urban population are known to engage in less physical activities, consume highly processed food, have psychological stress due to work and limited social capital and tend to engage in unhealthy behaviours such as smoking and alcohol use (Ford et al., 2017; Fox et al., 2019). Most urban areas also have high population density, lack of recreational public spaces, insufficient time due to inflexible work environments and social support (Alves et al., 2011).

Wealth status was found to decrease the likelihood of obesity. In China, Yu et al. (2019) found rich individuals had reduced obesity risk. However, Neupane et al. (2016) in 32 SSA countries using the demographic health survey data, the poor were less likely to be obese than the rich. Similarly, according to Ajayi et al. (2016) in a regression study of four SSA countries, obesity was more among the wealthy than the poorest individuals. In Kenya, compared to the poorest women, richer and richest women had increased obesity risk (Mkuu et al., 2018). In most African settings, obesity is associated with wealth and good fortune (Edith, 2019). Moreover, high socioeconomic status has been associated with changes in diet with increased consumption of calorie-dense foods and limited physical activities (Ford et al., 2017).

This study also found that physical inactivity increased the risk of obesity, which is similar to previous studies that have shown that physical inactivity increased the odds of obesity by 2.4 times (Bogale and Zewale, 2019). Studies including in Kenya have shown that engaging in

physical activities reduces the odds of obesity (Sartorius et al., 2015; Yu et al., 2019). In Kenya, individuals who performed vigorous physical activity have been found reduced obesity risk (Ondicho et al., 2016; Okube and Omandi, 2019).

Smoking was found to have a positive association with obesity. Smoking reduced the predicted probability of obesity. This finding is similar to a previous study in Uganda, Nigeria, Tanzania and South Africa where smoking was found to be protective against obesity (Ajayi et al., 2016). However, the finding differs from findings in Iran that found an increased risk of obesity among smokers (Najafi et al., 2020).

CHAPTER FIVE: SUMMARY, CONCLUSION AND POLICY RECOMMENDATIONS

5.1 Chapter introduction

This chapter presents a summary and conclusions of the study. It also highlights the key policy recommendations arising from this study and outlines some of the strengths and limitations of the study. The chapter also provides suggestions for future studies.

5.2 Summary

Obesity is a global pandemic and a significant public health problem that is associated with the rise in NCDs. The prevalence of obesity has more than triple since 1975 and is expected to increase further. In Kenya, about one-tenth of the population is obese with significant regional and sub-population variations ranging from a low of 9.1% to a high of 58.8% (Mathenge et al., 2010; Ayah et al., 2013; Okube and Omandi, 2019; Ondicho et al., 2016). These variations are due to studies with small sample size and conducted in a specific population (e.g., women) and localities. Therefore, there is a paucity of nationwide studies on obesity in Kenya highlighting its burden and determinants and that include both men and women, hence the motivation for this study.

Literature has shown that age, urban residence, female sex, marital status, occupation, education, physical inactivity, smoking, alcohol use and wealth are positively associated with obesity (Yu et al., 2019; Ondicho et al., 2016; Najafi et al., 2020; Mangemba and San Sebastian, 2020). It also shows that wealth status, physical activity, alcohol, smoking and fruits and vegetable are negatively associated with obesity (Mekonnen et al., 2018; Darebo et al., 2019; Ajayi et al., 2016; Sartorius et al., 2015). Hence, this study estimated the prevalence of obesity and establish the sociodemographic and socioeconomic determinants of obesity in Kenya. The

study used nationwide data from the 2015 Kenya STEPwise survey on NCDs and injuries and assessed the determinants of obesity using both the multivariable logistic and Probit regression models.

The study analysed data on 2,452 women and 1,731 men with a mean age was 37.6 (SD: 13.4) years with a range of between 18 and 70 years. A quarter of the study participants are either physically inactive or currently use alcohol, 13% smoked and 85.5% did not consume the recommended five servings of fruits and vegetables.

The analysis showed that eleven per cent of the adult population in Kenya is obese. The prevalence in this study is similar to the previously estimated prevalence in nationwide studies in Kenya. The prevalence is also high among East Africa countries and reflects a need for targeted public health interventions to preventing the growing burden. In line with the pattern of obesity globally and nationally, the study also found that the prevalence of obesity among women (16.5%) was thrice the prevalence of obesity among men (5.6%).

The study also found that the prevalence of obesity was high among individuals living in urban areas, married, employed and with a secondary and above level of education. It was also highest among the poorest individuals, those who consumed less than recommended servings of vegetable and fruits and physically inactive.

Overall, the study found that the key determinants of obesity in Kenya were age, sex, residence, wealth status, smoking, and physical activity. The sociodemographic determinants were age, sex, and residence while the socioeconomic determinant was wealth status and behavioural determinants were smoking and physical inactivity. Age, female sex, urban residence, and physical inactivity increased the odds of obesity by 24% and 90% while wealth status and smoking decreased the risk of obesity in Kenya by 36% and 86%.

5.3 Conclusion

In conclusion, the study found that eleven per cent of the adult population in Kenya is obese. The prevalence in this study is similar to the previously estimated prevalence in nationwide studies in Kenya. The prevalence is also high among East Africa countries and reflects a need for targeted public health interventions to preventing the growing burden. In line with the pattern of obesity globally and nationally, the study also found that the prevalence of obesity among women was thrice that of men. The study also found that age, female sex, and physical inactivity were associated negatively with obesity while old age, wealth status and smoking had a positive association with obesity.

5.4 Policy recommendations

Physical activity is a modifiable determinant and a driver of obesity. This study found physical activity to be positively associated with obesity. Hence there is a need for targeted interventions that seek to increase overall physical activity in the population. These interventions could include the development of policy actions that promote physical activities such as the promotion of sports, creation of recreational spaces, foot and bicycle paths and playgrounds in schools countrywide and promotional campaigns to promote physical activities. As highlighted in the WHO strategy on diet and physical activity, increasing physical activities at individual and population level has an impact on obesity as well as non-communicable diseases in general.

In this study, women also had an increased risk of obesity. Gender-specific interventions are needed to address the high prevalence of obesity among women. The government should increase awareness on the risk of obesity among women and provide safe spaces for women to engage in physical activities and promote positive body image messaging in mass and social media.

Increase in age was found to be associated with increased risk of obesity. This calls for interventions targeted at all age groups with a specific focus on young population. Creating awareness about obesity and prevention measures targeted at young population is key in reducing the growing burden of obesity. The government could promote healthy behaviours such as promoting healthy eating and physical activities in schools and regulating sale and distribution of unhealthy foods through taxes and other regulations.

5.5 Study strength and limitations

The study used a large sample size which allowed for the generalisation of the findings to the adult population in Kenya. The data used were also collected using the standardised WHO stepwise approach making the study findings comparable to other settings using a similar approach. However, the study has some limitations. First, the cross-sectional nature of the data limits causal inference. Second, the study was conducted at the national level and not at the county and sub-county level, which are the current administrative units in Kenya. Third, there is still a debate on whether BMI is the best measure of obesity, especially among the African population. Fourth, some of the study variables are self-reported hence may be over- or underestimated. Lastly, some variables were not available hence were not included in the study.

5.6 Areas for future studies

This study showed the sociodemographic and socioeconomic determinants of obesity in Kenya. However, the study had limitations that provide areas for further studies. This study focussed on the determinants at the national level and not at county level hence future studies should seek to establish the pattern of obesity and determinants at the county and sub-county level for more specific policy interventions. Future studies should also consider multilevel approaches to establish contextual factors associated with obesity in Kenya. Also, future studies should

consider stratification of obesity into three classes (low, moderate, and high) to provide more specific evidence on obesity classes.

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