RISK FACTORS OF OBESITY AMONG WOMEN OF REPRODUCTIVE AGE IN VIHIGA COUNTY, KENYA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN APPLIED HUMAN NUTRITION

DEPARTMENT OF FOOD SCIENCE, NUTRITION AND TECHNOLOGY

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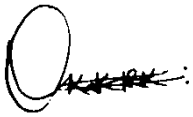
DECLARATION

I Khatsalwa Sonia Khavere declare that this dissertation is my original work and has not been submitted for the award of a degree in any other university

Signature:  Date: …November 6, 2023…….

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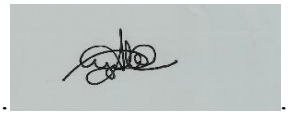
Signature: ……  …… Date: …November 4, 2023…….

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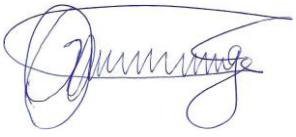
Signature:  Date: October 15, 2023

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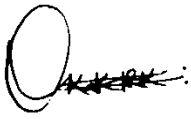
Signature: 

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DEDICATION

To

My Grandmother: Catherine Khavere,

Lovely Parents: Louis Khatsalwa and Elizabeth Koki Munyao,

and

Brother:NevilleKhatsalwa

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I thank God Almighty for His grace and strength that has carried me through my Masters programme. I would have never made it this far without Him.

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OPERATIONAL DEFINITIONS

WOMEN OF REPRODUCTIVE AGE

A woman of reproductive age is any woman aged between 15-49 years.

RISK FACTOR

Exposure of an individual to knowledge or attitude, which increases their probability of developing a health outcome such as a disease.

ATTITUDE

Cognitive beliefs/perceptions that influence the behavior of an individual.

KNOWLEDGE

Proper understanding of a topic, including the ability to remember terminologies.

PRACTICE

Behavior/ behavior change in an individual in response to knowledge or awareness.

READY TO EAT MEALS/ READY TO EAT FOOD

Ready to eat meals/ food (to eat in, to take away or to be delivered), a plant or an animal-derived food that has to be frozen, cooked, and processed beforeit can be directly consumed and requires a very minimal time of preparation involving boiling or reheating beforeconsumption. These exclude beverages and processed packaged products; crisps or biscuits.

CHRONONUTRITION

Chrononutrition is the study of the interaction between meal timing, metabolism and the circadian rhythm. It explores whether aligning the timing of the consumption of food and circadian rhythm influences metabolism and if interventions surrounding these three factors would be of benefit to the prevention and management of chronic lifestyle diseases.

HIERARCHY OF EFFECT MODEL (HOEM)

The hierarchy of effect model theory describes the progression of individual from knowledge or awareness to practicing a positive behavior. It postulates that the stages of progression are hierarchical with the top representing those with knowledge being higher regarding numbers than those practicing the behavior.

ACRONYMS AND ABBREVIATIONS

BMI- Body Mass Index

CDC - Centre for Disease Control and Prevention

FANTA- Food and Technical Assistance

FAO - Food and Agriculture Organization

HOEM -Hierarchy of Effects Model

KAP - Knowledge, Attitude and Practice

KDHS- Kenya Demographic Health Survey

LMICs- Low and Middle-Income Countries

MOH- Ministry of Health

NCDs – Non-Communicable Diseases

NIH - National Institute of Health

RTE - Ready to eat

SO- Specific Objective

USAID - United States Agency for International Development

WC- Waist Circumference

WHO - World Health Organization

WHR- Waist Hip Ratio

ABSTRACT

As the prevalence of obesity is increasing globally, the burden of malnutrition is shifting in the developing countries. In low and middle income countries, women are the most widely affected population by the obesity burden. A similar trend is witnessed in Kenya, as 43.4% of women are overweight or obese. Obesity among women, particularly of reproductive age, has been associated with significant morbidity and mortality that may be passed on to their offspring. Since the commencement of the Kenya Demographic Health Surveys, limited studies have been done, despite the increasing reported prevalence of obesity among women of reproductive age, to determine the associated risk factors of obesity among this target group in the rural population, including Vihiga County. This study aimed to determine the risk factors of obesity among women of reproductive age in Vihiga County. A cross-sectional survey used a semi structured questionnaire to collect data on the sociodemographic profile, nutrition status, factors influencing obesity including knowledge, attitude and practices, nutritional practices, food security and lifestyle habits. Multi-stage sampling was used to select two sub-counties and four wards from the sub-counties. Segmentation method and simple random sampling were used to identify women to include in the study. A total of 106 women of reproductive age were included. Data was analyzed using descriptive and inferential statistics. The prevalence of obesity among women of reproductive age in the County was 13.2% by body mass index while the average waist circumference was 80.76cm. Theprevalence of obesity had almost doubled, from 7% to 13.2%, since 2014, while the average waist circumference, 80.76 cm, was higher than the national average of 79.1 cm. The number of women at increased risk of metabolic diseases regarding waist-hip ratio was, 25%; this figure is less than the recorded 2015 national statistics of 36%. Age, marital status and education level were identified as non-modifiable risk factors among this target group. Age significantly predicted BMI (OR=1.44; 95% CI, 1.24-1.68), waist circumference (WC) (OR=3.02; 95% CI, 2.11-4.34), and waist-hip ratio (OR=1.004; 95% CI, 1.001-1.007),$p<0.001$; older women were at a higher risk of high BMI, WC and WHR. Marital status significantly predicted BMI (OR=0.00; 95% CI, 0.00-0.16), WC(OR=5.40; 95% CI, 1.06-8.57) and WHR (OR=1.33; 95% CI, 1.07-1.65), $p<0.05$. Single women were 5.40 times more likely to have central obesity than the married women while separated women were 1.33 more times likely to have a higher waist hip ratio. Education level significantly predicted WC,(OR=0.003; 95% CI, 0.001-0.7), $p<0.05$. Women with primary education were less likely to

have central obesity compared to women with no formal education. The number of children born to a woman, time of consumption of the last meal of the day and the frequency of consumption of flesh meats were modifiable risk factors to the BMI of the women. Increase in the number of children increased the likelihood of a high BMI by 2.13 times (95% CI, 1.16-3.93), $p<0.05$, while late eating and frequently consuming flesh meats increased the women's risk to obesity regarding BMI by 3.50 (95% CI, 1.19-10.32) and 3.32 (95% CI,1.04-10.58) times, respectively, $p<0.05$. Modifiable risk factors to central obesity included, the number of children born to a woman (OR=7.51; 95% CI, 1.69-33.88), frequently consuming flesh meat (OR=20.45, 95% CI, 1.20-348.62) and frequently consuming white tubers or roots (OR=0.05, 95% CI, 0.01-0.72) and frequently consuming organ meats (OR=0.01, 95% CI, 0.009-0.12), $p<0.05$. The latter two were protective against central obesity. Contrastingly, frequently consuming sugar increased the risk of metabolic disorders regarding waist hip ratio by 1.015 times (95% CI, 1.000-1.028), $p<0.05$.According to this study, the obesity prevalence in Vihiga County among women of reproductive age has increased and was attributed to risk factors such as age, marital status, education level, the number of children, time of consumption of the last meal of the day and frequently consuming white tubers or roots, flesh meats, sugar, and organ meats. Since majority of the modifiable risk factors were dietary, it is imperative for the county government to implement setting specific interventions including nutrition education targeting dietary and lifestyle habits. Also, raising awareness on the influence of age, marital status and parity on obesity will be necessary, the county government can include, in addition to educating the women on proper nutrition during pregnancy, physical activity interventions to help manage the extra weight gained during pregnancy among the women. Lastly, increase accessibility and awareness on the importance of basic education.

CHAPTER ONE
INTRODUCTION

1.1 Background

Obesity rates in the world have tripled since 1975; 1.9 billion adults are either overweight or obese (World Health Organization, 2021b). A similar trend is witnessed in low and middle-income countries; the number of overweight and obese individuals is steadily increasing (Mkuu et al., 2021). Between 1980 and 2013, the prevalence of obesity increased from 857 million to 2.1 trillion (Ng et al., 2014). Women in low and middle-income countries represent the most widely affected population by obesity compared to men (Chowdhury et al., 2016; Mkuu et al., 2018; World Health Organization, 2021b). In Kenya, 43.4% of women were either overweight or obese compared to a 34% prevalence among men (Mkuu et al., 2018); a prevalence higher than that of its neighbouring countries, including Uganda (37.21%) and Tanzania (28%) (Ahmed et al., 2020;Yaya & Ghose, 2019).

Obesity among women of reproductive age (WRA) is correlated with various non-modifiable risk factors, including socio demographic status, level of education, marital status, age, area of residence (Hashan et al., 2020; Yaya et al., 2018), and partially modifiable risk factors including contraceptive use and parity (Mkuu et al., 2018).Women in the higher wealth index quartile are reported to have a higher probability of being obese than women in the lowest (Bishwajit, 2017; Hasan et al., 2020). The link between education level and obesity in literature is conflicting; some studies have reported a direct relationship between the two variables while others suggest an inverse relationship(Hashan, Rabbi, et al., 2020; Mkuu et al., 2018; Yaya et al., 2018). Married women have a higher likelihood of being obese (Mangemba & San Sebastian, 2020; Mukora-Mutseyekwa et al., 2019), while parity substantially negatively affected the body mass index (BMI) of women (Yaya et al., 2018).

Obesity is complex and multifactorial and is linked to other risk factors that are modifiable in nature. Research has identified diet and physical activity as the most common modifiable risk factors of obesity among women. However, emerging literature has identified other factors such as food security, level of nutritional knowledge, attitude and practices, sleep patterns,

consumption of ready-to-eat meals and time of day of meal consumption (chrononutrition) that may contribute to the obesity burden.

Food insecurity among women is linked to higher BMI and increased waist circumference (Odunitan-Wayas et al., 2021)while higher levels of nutritional knowledge have been found to enhance belief, self-efficacy and attitude towards positive behaviour. Sleeping less than 7 hours a night and eating out of home are positively associated with weight gain, obesity and metabolic diseases (Lytle, 2009; Watson et al., 2015). Furthermore, chrononutrition, an emerging topic area regarding obesity, described as the interaction between meal timing, metabolism and the circadian rhythm, has been suggested as a factor contributing to the increasing obesity burden. Adults who eat their last meal past 8pm were associated with increased feelings of hunger as compared to those who ate at 6:30pm or before, a possible cause of increased weight andobesity (Ruddick-Collins et al., 2022; Vujović et al., 2022).

Obesity is a leading determinant of chronic diseases such as diabetes, heart disease, and cancer, which account for 71% of global deaths (Benjamin et al., 2018; World Health Organization, 2021a). Women of reproductive age are a vulnerable population to malnutrition. Obesity among this target group, in addition to the aforementioned negative outcomes, substantially increases the risk of poor maternal outcomes, including postpartum haemorrhage, gestational diabetes, pre-eclampsia and caesarean sections (Alkema et al., 2016; Mkuu et al., 2018).In addition, among pregnant women, overweight and obesity increase the risk of delivering low birth weight infants, neonatal death and malformations (Kulie et al., 2011), consequently contributing to the vicious cycle of malnutrition in future generations. This study highlights the risk factors of obesity among WRA, intending to contribute to informed decision-making and the prevention and management of obesity.

1.2 Statement of the Problem

The prevalence of obesity among WRA in Kenya continues to rise; approximately 38.7% (one in three) of women are overweight or obese(KNBS & ICF, 2023). Vihiga County is not exempt; the county recorded the second highest prevalence, 33.2% (KNBS & ICF, 2023)of overweight and obesity in Western Kenya. The reported prevalence is an increase from 26.4% reported in 2014

in the last national health survey. Despite the increasing prevalence of overweight and obesity among women of reproductive age, there is insufficient data at the county level on the primary determinants of obesity, including food consumption patterns and physical activity measurements of women of reproductive age. In addition, inadequate data exists on other emerging determinants of obesity, such as food security, knowledge, attitudes, and practices of women of reproductive age.

1.3 Justification

The County government of Vihiga aims at minimizing predisposition to health risk factors, including obesity and halting and reversing the increasing burden of non-communicable diseases by 2027 regarding its County integrated development plans (2023-2027) and the Kenya Health Policy (2014-2030)(County Government of Vihiga, 2023; MOH, 2014).Despite these two health sector objectives being included in the 2018-2022 and 2023-2027 County Integrated Development plans, the factors leading to the increased prevalence of obesity among different population groups including WRA is still unclear. This study aimed at filling this gap.

Findings from this study are expected to benefit the county government's Ministry of Health by providing baseline data on the burden of obesity and its determinants among WRA that will inform the prioritization, planning, and implementation of evidence-based and cost-effective interventions and policies. Ultimately, there will be improved health of the women in the County and their offspring. Consequently, reducing obesity and NCD-related morbidity and mortality, loss in productivity, and increased healthcare costs (Demmler et al., 2017)among the target group, the County and national health systems. Furthermore, the study will benefit future researchers in highlighting new areas of further research that could significantly improve the health of women of reproductive age.

1.4 Aim of the Study

This study aimed at contributing to the reduction of the prevalence of obesity among women of reproductive age in Vihiga County, Kenya.

1.5 Purpose of the Study

To highlight the risk factors of obesity among women of reproductive age in Vihiga County, Kenya to inform the development and implementation of evidence based interventions and strategies to prevent and manage the rising obesity prevalence among the target group.

1.6 Overall Objective

To determine the risk factors of obesity among women of reproductive age in Vihiga County, Kenya.

1.7 Specific Objectives

1. To determine the sociodemographic status of women of reproductive age in Vihiga County.
2. To determine the nutrition status of women of reproductive age in Vihiga County.
3. To assess factors of obesity, food security, nutritional knowledge, attitudes and practices of women of reproductive age in Vihiga County.
4. To determine the risk factors of obesity among women of reproductive age in the County.

1.8 Research Questions

1 What is the sociodemographic status of women of reproductive age in Vihiga County?

2 What is the nutrition status of obesity among women of reproductive age in Vihiga County?

3 Are factors of obesity, sociodemographic status, food security, nutrition knowledge, attitude and practices associated with the nutrition status of women of reproductive age in Vihiga County?

4 What are the risk factors of obesity among women of reproductive age in Vihiga County?

CHAPTER TWO
LITERATURE REVIEW

2.1 Background

The prevalence of obesity in the world between 1980-2014 has nearly doubled (WHO, 2014a). In 2016, out of 1.9 billion adults who were above normal weight, those who were obese had risen to 650 million (WHO, 2016). Women, in most of the WHO areas, had a higher likelihood of being obese than the men (WHO, 2014a). Local studies in Kenya have reported a higher number of overweight or obese women than men; one study said that 43.4% and 34% of women and men, respectively, were either overweight or obese(Christensen et al., 2008; Oti et al., 2013; Steyn et al., 2011)

Annually, approximately 2.8 million adults die due to overweight and obesity, which are ranked number five among the leading risk for deaths globally(WHO, 2016). Obesity, through lifestyle changes, particularly diet, can be prevented and is a key determinant linked to increased morbidity and mortality related to non-communicable diseases (NCDs)(Nishida et al., 2017). It continues to be regarded as a life-course condition whose origins are established during pregnancy and with an intergenerational cycle, coinciding with the secular trend (Nishida et al., 2017).

2.2 Overweight and Obesity among Women

It is estimated that one in three women are either overweight or obese in Kenya(KNBS & ICF, 2023; Mkuu et al., 2018).This rising prevalence is linked to physical inactivity, an increase in access and high consumption of diets that are rich in calories, and urbanization(Chowdhury et al., 2016; Ziraba et al., 2009).In Sub-Saharan African women, overweight and obesity may worsen maternal and child health problems and have been linked to adverse maternal and child health consequences (Alkema et al., 2016; Pawloski et al., 2012)**,** which include gestational diabetes, preeclampsia, and postpartum hemorrhage(Kulie et al., 2011). In pregnant mothers, overweight and obesity increase the risk of delivering low birth weight infants, neonatal death and malformations(Kulie et al., 2011). The likelihood of being breastfed for the recommended period amid offspring of mothers who are overweight or obese declines as compared to offspring

of mothers who are not; also, these children are at high risk of becoming overweight or obese and may suffer from chronic diseases in adulthood(Boney et al., 2005).

2.3 Risk Factors of Obesity among Women

Significant risk factors for being overweight or obese among women include high education level, wealth, living in an urban area and hormonal contraception use. A positive association was seen with marriage, alcohol use, high socio-economic status and lower educational level; overweight and obesity were lower, 24.4% and 10.8%, respectively, among women with no education as compared to 34.1% and 17.9% among those with some level of education(Chowdhury et al., 2015; Mehboob et al., 2016). According to Koirala, Bajracharya and Koirala (2019), other risk factors that were noted included age and dietary patterns, such as frequency of consumption of fruits and dairy products, whereby women who consumed fruits and dairy once a week had an increased probability of obesity compared to those who consumed the food groups more than three times a week

2.4 Non-Communicable Diseases (NCDs)

Globally, morbidity and mortality related to NCDs are the leading causes of death compared to all other causes combined(MoH-Kenya, 2015). The estimated number of deaths per year as a result of NCDs is estimated to accrue to 52 million by 2030 (Mathers & Loncar, 2006; WHO, 2015). Mortality rates in the world as of 2014 were 56 million deaths per year; NCDs account for 38 million, and of these, 28 million occurred in developing countries(WHO, 2014a, 2014b).

Rapid urbanization characterized by lifestyle changes has resulted in overweight and obesity, which are key determinants of NCDs such as diabetes, certain types of cancer, hypertension, stroke and coronary heart disease(Kiarie, 2019; MoH-Kenya, 2015; WHO, 2014a)

According to WHO (2014), attaining the six targets on obesity, tobacco, alcohol use, salt, blood glucose, and blood pressure by 2025 simultaneously will decrease premature deaths, 19% in women from these four key NCDs to amounts that are nearer to the 25 x 25 goal. At the policy level, controlling the rising burden of NCDs has been prioritized in the Kenya Health Policy 2014-2030, which is the general sector direction in health(Kiarie, 2019).

2.5 Food Security and Obesity

The scholarship of food security provides a platform to understand the existence of obesity in the presence of inadequate access, availability, stability and utilization of food (Hunter-Adams et al., 2019). The World Food Summit defined food security as "A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2009). Thus representing food security into four classes of availability, access, utilization and stability (FAO, 2012). Food insecurity has been linked as a determinant of obesity and obesity-related comorbidities (Myers et al., 2020). The pathway relating to food insecurity and obesity has been explored. Evidence suggests three main mechanisms: the nutrition pathway, psychological and "insurance" hypothesis (Myers et al., 2020; Te Vazquez et al., 2021).

The nutrition pathway mechanism posits that due to food insecurity, particularly affordability, individuals end up consuming cheaper foods per calorie basis, such as those high in saturated fats, sugar, sodium and highly processed foods (Weigel & Armijos, 2019). Consequently, constant consumption of poor-quality diets increases the risk of obesity (Myers et al., 2020; Townsend et al., 2001; Wu et al., 2019). The psychological pathways theorize that food insecurity causes psychological adaptations such as anxiety and depression that can result in increased production of stress hormones (Arenas et al., 2019; Silverman et al., 2015);increased exposure to high levels of stress hormones has been associated with higher BMI(Banerjee et al., 2020), waist circumference and increased risk of obesity (Cowen, 2002; Pervanidou & Chrousos, 2011). Contrastingly, the "insurance" hypothesis states that exposure to food insecurity over long periods can cause a constant perception of food insecurity despite seasons of food security, thus causing increased consumption of food as an "insurance" for seasons of food insecurity (Myers et al., 2020).

In Sub-Saharan Africa, women have been shown to have a higher probability of being food insecure than the men(Lukwa et al., 2022). In addition, food-secure women are at a decreased risk of obesity and significantly greater waist circumference compared to food-insecure women (Odunitan-Wayas et al., 2021; Poulsen et al., 2019); possible explanation for this is the "insurance" hypothesis whereby consumption of food in seasons (Myers et al., 2020) while

constant seasons of ‘food security’ among food secure women allows them to voluntarily, without anxiety, restrict food intake to prevent weight gain (Townsend et al., 2001).

2.6 Lifestyle and Obesity

2.6.1 Sleep

Healthy sleep needs adequate duration, absence of sleep disturbances and disorders, good quality, suitable timing and consistency (Watson et al., 2015). Individual sleep needs differ and depend on medical, environmental, genetic, and behavioural factors(Watson et al., 2015) . The association between cardio-metabolic health, weight status and sleep issues can be described by a bidirectional pathway (Sa et al., 2020). A U-shaped dose-response is seen, where the base of the curve represents an ideal sleep-health ratio present in 7–8 hour sleepers(Ardern & Kanagasabai, 2019). The probable pathways that can explain the consequences of sleep arrears on obesity are multifaceted, which include changes in activation of hedonic paths, eating behaviour such as skipping meals, irregular mealtimes and snacking and increased ghrelin to leptin ratio(Ding et al., 2018). Women report more significant sleep disturbances, while among the black race, sleeping for short and long periods was substantially associated with obesity (Sa et al., 2020).

Restricting sleep was linked to increased saturated fatty acid and total fat intake(Roberts et al., 2011), consumption of carbohydrate-rich night-time snacks and total energy. Partial sleep deprivation resulted in a 385 kcal rise in energy intake(Dashti et al., 2015), for adult females, this is a 19% increase in the recommended caloric intake(Ding et al., 2018). Moreover, decreasing sleep by an hour resulted in a 0.35 kg/m2 increase in BMI in adults (Ding et al., 2018). A greater probability of obesity was predicted among individuals who had short sleep duration (≤6 hours/night)(Wen & Lee, 2016)while long sleepers (≥10 h) reported increased intake of sugary drinks and depression symptoms. Caloric intake past 8:00 PM, otherwise defined as late-time eating, significantly projected a rise in BMI; this implies that eating late at night can cause obesity(Baron et al., 2009).

2.6.2 Ready to Eat Food

Ready to eat food (RTE) food is defined as “a plant or an animal-derived food that has to be frozen, cooked, and processed before it can be directly consumed and requires a very minimal

time of preparation involving boiling or reheating before consumption"(Howard et al., 2012). Frequent and excessive RTE food consumption leads to obesity since it is high in calories, fats, and salts(Duffey et al., 2009).Individuals who consume food prepared away from home have less knowledge of the content of energy in the food(Hillier-Brown et al., 2017).

According to Hillier-Brown et al. (2017), consuming readymade meals daily in high amounts yielded a significant relationship with abdominal obesity that was measured by waist circumference. This relationship was independent of other potential confounders, such as lifestyle and dietary factors. To guarantee control over nutritional constituents and general quality of food, preparing and cooking meals at home was implied(Hillier-Brown et al., 2017).

2.7 Knowledge, Attitude and Practice Methodology

Knowledge, Attitude and Practices (KAP) survey is a method that collects quantitative data using already defined questions and standard questionnaires and can provide qualitative information. KAP surveys disclose misconceptions that may represent barriers to activities that are to be applied and potential obstacles to change in behavior (USAID, 2011). KAP is very valuable in determining the wide-scale dissemination of community knowledge and assessing the effectiveness of education and media campaigns concerning changes in knowledge. A limitation of these studies is that they need to pay more attention to other types of knowledge, such as that of the health system (Hausmann-Muela & Ribera, 2003). Furthermore, it does not allow reports on actual practices as questions on practice are usually hypothetical, nor does it try to consider fundamental contextual factors, and attitudes are also not easy to attain from such a survey (Launiala, 2009). They are cheap, easy, and rapid and can be used to obtain a faster understanding of data on the main knowledge data(Hausmann-Muela & Ribera, 2003).Combining qualitative and quantitative methods may resolve the deficiencies of either technique; the quantitative method can collect data at scale, while the qualitative approach may help recognize potential respondent bias and incorrect framing of questions(Id et al., 2018).

2.8 Nutrition Assessment Methods for Adults

2.8.1. Body Mass Index

Body Mass Index (BMI) is described as weight (kg)/height (m2); it is a valuable metric in categorizing overweight and obesity in adults (Nishida et al., 2017). It is an indirect

measurement of fat in the body and can be used to obtain an easy metric of body size that is independent of age and sex; however, it is not a diagnostic tool(Jensen et al., 2012; Nishida et al., 2017). BMI has been used for population assessment of overweight and obesity as it is inexpensive and relatively easy to use as it requires only weight and height (CDC, 2015). It provides a standard system of coding the reporting body weight for height. It is a critical variable in determining the consequences of excess fat accumulation regarding metabolism and mortality (Nuttall, 2015). According to the National Institute of Health (1998), the cap points for BMI in adults are BMI <18.5 = underweight, BMI 18.5–24.9 = desirable, BMI 25.0–29.9 = overweight and BMI ≥30 = obese.

Despite the relative easiness and inexpensiveness of using BMI, it does have its limitations; it cannot capture body fat location information, nor does it differentiate between body lean and fat mass (Nuttall, 2015), and may not agree to the same grade of fatness in varied populations, due to different body proportions (Nishida et al., 2017). It may misdiagnose individuals as at high risk of developing metabolic and some disease outcomes. For example, BMI overestimates body fat in very muscular individuals while underestimates those who have lost muscle mass (NIH, 1998).

2.8.2 Waist Circumference and Waist Hip Ratio

The 1997 WHO Expert Consultation on Obesity emphasized the need for other indicators to accompany BMI when identifying individuals at greater risk of morbidity due to obesity-related factors such as the accretion of abdominal fat (visceral fat) (WHO, 2000a). This is after realising the relevance of abdominal fat that may significantly differ from body mass index (BMI) and total body fat. The deposition of abdominal fat is best related to triacylglycerols accumulation in the liver and skeletal muscle (Nuttall, 2015).More precisely, both visceral fat accumulation (Nguyen-Duy et al., 2003; Wajchenberg et al., 2002) and an expanded width are linked to the occurrence of hypertension, resistance to insulin, diabetes, and coronary heart disease(Kissebah et al., 1989; Pouliot et al., 1994; Wildman et al., 2008),

Alternative measures, such as waist–height ratio, waist circumference and waist–hip ratio, that reveal abdominal adiposity have been implied as grander to BMI in identifying overweight and

obesity despite BMI traditionally being the chosen indicator for measurements of body composition and size(WHO, 2008). A relationship between BMI and increased odds of diseases has been found in women. However, a more substantial independent risk factor, waist–hip ratio, was identified compared to BMI (Lapidus et al., 1984). In addition, waist circumference could replace waist- hip ratio and BMI as the sole determinant of all-cause mortality (WHO, 2008).

The association level varies regardless of the link between waist circumference, waist-hip ratio and BMI, indicating that these measures cannot be used interchangeably as different measures can be obtained. Despite the presence of an association between BMI and abdominal adiposity, where possible, BMI should be obtained. Still, consideration should be made to the usefulness of the dual use of two indicators (WHO, 2008).

2.9 Hierarchy of Effects Model (HOEM)

The HOEM was developed by William McGuire in 1984(McGuire, 1984) and has been recommended for use in public health, particularly for cross sectional surveys, (Russell-Bennett et al., 2016) to explain the effects of marketing campaigns and strategies to individual's behavior change. The model hypothesizes that there are three stage variables that are linked in the pathway of behavior change upon individual receiving knowledge. These stages are the distal variables such as awareness and knowledge, intermediate variables such as attitude and self-regard and the outcome variables such as consumption of a healthy diet and engaging in the recommended amount of physical activity. The model explains that the distal variables are interlinked with outcome variables; however, movement of an individual from the distal to the outcome variables is not linear and is influenced by the intermediate variables. It also posits that the number of individuals in the distal variable stage is often higher than those who are practicing the right behavior or in the outcome variable stage.

It is argued that increase in knowledge and awareness may increase self-efficacy and influence positive attitudes and elevated intention to change regarding a behavior that result in behavior change. The model has been criticized due to the difficulty to measure concepts such as health promotion; however, it has been used successfully in various studies as a conceptual framework in understanding the relationship between advertising of junk food and weight (Kelly et al., 2015), as well as exploring other associations in health related studies. According to Kite et al., (2018), the hierarchy of effects model is robust for assessment of various behavioral outcomes.

Therefore HOEM was used to evaluate whether knowledge and awareness of factors of obesity as influenced by the women's attitude or social norms equates to positive behavior as assessed by adequate dietary intake, physical activity among others.

2.10 Summary

Obesity prevalence among women is on an increasing trend in the world and Kenya. Furthermore, obesity is a key determinant of NCDs and whose epidemiology is multifactorial. Inadequate information exists on primary determinants of obesity, including food consumption patterns and physical activity at the County Level, including Vihiga County. In addition, evidence is limited on emerging risk factors of obesity such as food security, knowledge, attitude and practices such as sleep and consumption of ready to eat meals; despite sufficient documented literature evidence that implicates other dietary and non-dietary habits that may be contributing to the obesity burden among women in Kenya.

CHAPTER THREE
SOCIODEMOGRAPHIC RISK FACTORS OF OBESITY AMONG WOMEN OF REPRODUCTIVE AGE IN VIHIGA COUNTY, KENYA

3.1 Abstract

Introduction: The prevalence of obesity among women of reproductive age (WRA) in low and middle-income countries is increasing. In Kenya, a third of women between the ages of 15 and 49 are overweight or obese; however, context-specific studies on the prevalence and risk factors of obesity are scarce, particularly in Vihiga County. Thus, this study sought to assess the sociodemographic correlates of obesity in the area.

Methodology: A cross-sectional study design was utilized, and a survey methodology was employed to collect sociodemographic data. The weight and height of respondents were measured using an electronic scale and a stadiometer, respectively, while a non-stretch tape was used to measure waist and hip circumferences. Descriptive and inferential statistics, percentages/ frequencies, chi-square/fishers test, Kruskal-Wallis test and regression analysis were conducted in SPSS version 25.

Results: The prevalence of obesity among women of reproductive age in the County was 13.2% by body mass index while the average waist circumference was 80.76cms. Theprevalence of obesity had almost doubled, from 7% to 13.2%, since 2014, while the average waist circumference, 80.76 cms, was higher than the national average of 79.1 cms. The number of women at increased risk of metabolic diseases regarding waist-hip ratio was, 25%; this figure is less than the recorded 2015 national statistics of 36%. Age, marital status and education level were identified as non-modifiable risk factors among this target group. Age significantly predicted BMI (OR=1.44; 95% CI, 1.24-1.68), waist circumference (WC) (OR=3.02; 95% CI, 2.11-4.34), and waist-hip ratio (OR=1.004; 95% CI, 1.001-1.007),$p<0.001$; older women were at a higher risk of high BMI and WC. Marital status significantly predicted BMI (OR=0.00; 95% CI, 0.00-0.16), WC(OR=5.40; 95% CI, 1.06-8.57) and WHR (OR=1.33; 95% CI, 1.07-1.65), $p<0.05$. Single women were 5.40 times more likely to have central obesity than the married women while separated women were 1.33 more times likely to have a higher waist hip ratio. Education level significantly predicted WC,(OR=0.003; 95% CI, 0.001-0.7), $p<0.05$. Women with primary education were less likely to have central obesity compared to women with no formal education.

Conclusion and Recommendations: The prevalence of obesity among women of reproductive age in the county has almost doubled. Age, marital status and education were sociodemographic determinants of obesity in the target group. Future research should identify modifiable risk factors of obesity to facilitate the development and implementation of sustainable interventions for the prevention and management of obesity.

Key words: obesity, women of reproductive age, sociodemographic,correlates, risk factors.

3.2 Introduction

Globally, the prevalence of obesity, since 1980, has increased by two fold, the number of overweight or obese adults is about 1.9 billion (World Health Organization, 2021b). A similar trend is being witnessed in low and middle income countries (LMICs), the number of obese individuals is steadily increasing (R. Mkuu et al., 2021). Obesity is a leading modifiable determinant of chronic diseases including heart disease, cancer and type 2 diabetes which contribute to 71% of deaths worldwide (Benjamin et al., 2018; World Health Organization, 2021a). Women in LMICs represent the most widely affected population by obesity compared to the men (Chowdhury et al., 2016; Mkuu et al., 2018; World Health Organization, 2021b). In Kenya, 43.4% of women were either overweight or obese compared to 34% prevalence among men (Mkuu et al., 2018). In addition to chronic diseases, obesity, among this target group, substantially increases the risk of detrimental maternal outcomes including postpartum hemorrhage, gestational diabetes, pre-eclampsia and caesarean sections (Alkema et al., 2016).

Obesity among women of reproductive age has been affiliated with various non-modifiable determinants including sociodemographic status, level of education, marital status, age, area of residence, parity (Hashan et al., 2020; Yaya et al., 2018), and contraceptive use (Mkuu et al., 2018). Women in the higher wealth index quartile had increased risk of being obese compared to women in the lowest wealth index quartile (Bishwajit, 2017; Hasan et al., 2020). The relationship between wealth index and obesity among WRA was linked to the increased availability of foods of high energy and junk foods among this group (Biswas et al., 2020; Sarma et al., 2016; Tanwi et al., 2019). However, the association between education level and obesity among WRA is conflicting.

Evidence exists suggesting an inverse relationship between education level and obesity where the prevalence of obesity was highest among women with lower education level i.e. those with only primary school education (Hashan et al., 2020). Contrastingly, some studies suggest a direct relationship, whereby, women with secondary education and/ or more were at increased risk of being obese (Mkuu et al., 2018; Yaya et al., 2018) compared to those with primary education or no education. Moreover, younger women of reproductive age, 15-24 years, had a lower risk of being obese as likened to older women between 35-49 years (Hashan et al., 2020; Yaya et al., 2018). Married women or those living with a partner, also had an increased risk than single,

widowed and separated women (Mangemba & San Sebastian, 2020; Mukora-Mutseyekwa et al., 2019). Parity substantially negatively affected the body mass index (BMI) of women (Yaya et al., 2018); BMI was found to increase with each successive increase in parity (Hashan et al., 2020).

Despite evidence of high prevalence of obesity and its related adverse health outcomes among WRA there is scarcity of studies (Mkuu et al., 2018), context specific studies i.e. county level data, particularly in Vihiga County, assessing the sociodemographic factors influencing the obesity burden among this target group. Strengthening the collection and analysis of sex diversified data for improved clinical nutrition and the prevention and management of diet related NCDs is among the key outcomes of the Vihiga County Nutrition Action Plan (2023-2027) (County Government of Vihiga, 2023). In addition, minimizing the predisposition to health risk factors, such as obesity and halting and reversing the increasing burden of non-communicable diseases (Vihiga County, 2021). Therefore, this study paper seeks to assess the sociodemographic correlates of obesity among this target group.

3.3 Materials and Methodology

3.3.1 Study design

This study was a cross-sectional design among women of reproductive age in Vihiga County, Kenya. Descriptive and analytical features of the cross sectional design was used to assess the nutrition status of the study sample and to determine the sociodemographic risk factors of obesity among WRA in Vihiga County, respectively.

3.3.2 Research context and study setting

Obesity is a risk factor to health. It is estimated that 25% of Kenyans are overweight or obese, with the greatest number among women in their mid to late 40s (MOH, 2014). Kenya's population totals about 47.56 million people; of these, 590,013 people reside in Vihiga County (KNBS, 2019). The ratio of men to women is 1:1 with, the female population being slightly higher, at 306,323 , while that of men stands at 283,678 (KNBS, 2019). The Vihiga County Vision has five investment focus areas that are in line with the eight health policy orientations in the Kenya Health Policy 2014-2030. Policy objectives on minimizing exposure to health risk factors including obesity and halting and reversing the rising burden of NCDs are among the six outputs of these eight health policy orientations.

This study followed the William McGuire's Hierarchy of Effect theory, 1980. The hierarchy of effect model (HOEM) states that a causal relationship exists between immediate variables such as awareness and knowledge and outcomes such as behavior change. However, this is through an order of measures such as social norms, attitudes and intentions, and series of effects can differ. HOEM also states that the fraction of a population that involves itself in a desired behavior is small as the likelihood of achieving each outcome reduces as one progresses through the hierarchy (Kite et al., 2018).

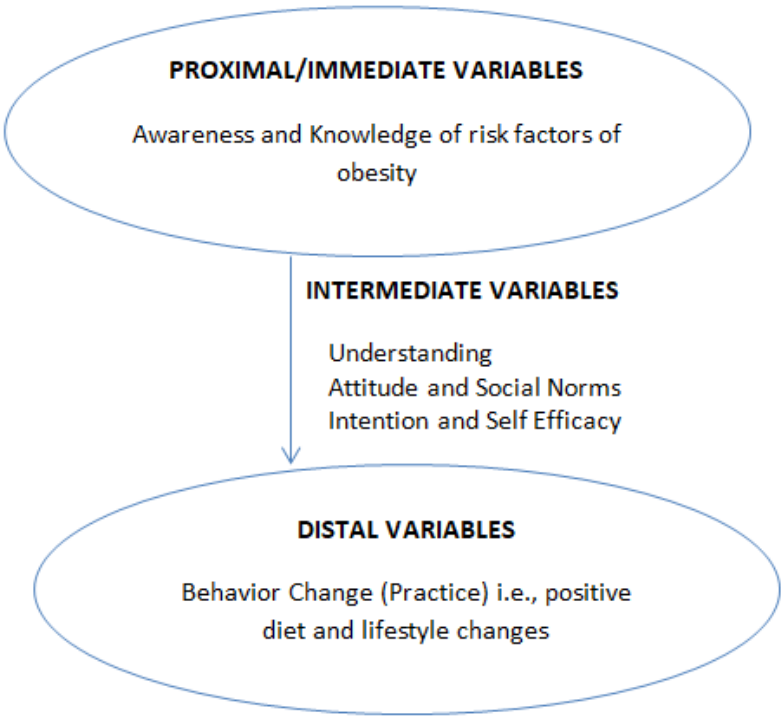

Figure 3 1 Modified Hierarchy Effect Model

a) Study setting

Vihiga County is among the 47 Counties in the Republic of Kenya; it is divided into five sub counties; Hamisi, Emuhaya, Luanda, Sabatia and Vihiga which are divided into twenty five electoral wards. It covers a total area of 531.0 Km^2 and has an altitude range of between 1300-1800 meters above sea level and lies between latitudes 0° and 0°15'North and longitudes 34°30' and 35°0'East. The county's population density is among the highest in the country at 1,033 persons per square kilometer while the national average is 66 persons per square kilometer; its demography highlights a youthful population whereby 46% of individuals are below 15 years. It borders Nandi County to the East, Kakamega County to the North, Siaya County to the West and Kisumu County to the South. The county experiences high equatorial climate with an average annual rainfall of 1900mm and temperatures ranging between 14ºC - 32ºC, and a mean of 23ºC. It consists of rolling hills and valleys; majority of its streams drain into Lake Victoria, soils are mainly sedimentary in nature. The main socioeconomic activities in the county include crop farming of tea, coffee, bananas, maize and beans. Fish, poultry, dairy and pig farming are also practiced. Regarding healthcare and access to health the county has a government facility, theVihiga County Referral Hospital and a faith based facility, Kaimosi Mission Hospital. In

order to achieve its healthcare vision of having a worldwide competitive, healthy and productive county, the county, between 2023 -2027 sets to prioritize health programmes such as public healthcare and services that ensures the population adopts healthy living habits as a means of disease prevention.

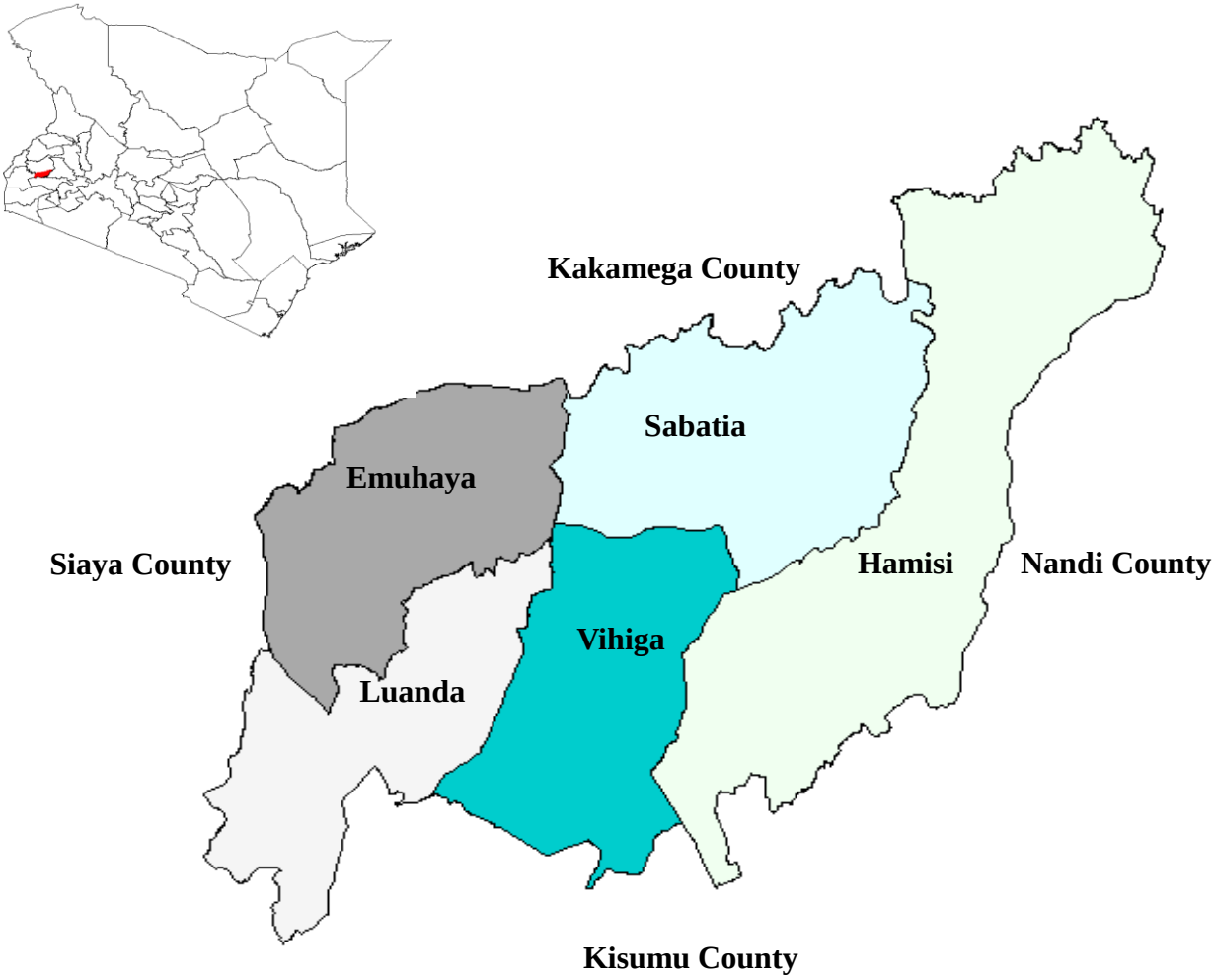

Figure 3 2: The map of Vihiga County in Kenya and the administrative regions (Sub-counties) within her.

The map was generated using the ggplot2 package of the R programming language (R Core Team, 2022) using the globalUniversal Transverse Mercator(UTM) grid (MapTools, 2023).

3.3.3 Study population

The study population comprised of WRA in Vihiga County. Women of the reproductive age (15-49 years) who reside in Vihiga County and gave written consent to the study were included as participants. The exclusion criteria included non-ambulatory women, as anthropometric measurements procedures required participants to stand on a scale and during height measurement. In addition, women below the age of 15 years or above 49 years and self-reported pregnant women.

3.3.4 Sampling Design

Probability and Non-probability sampling methods were used in this study.

3.3.4.1 Sample Size Determination

The minimum sample size was determined using Fisher, 1991.

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

$$100 = \frac{1.96^2 \times 0.07 \times 0.93}{0.05^2} = 100$$

Where n is the sample size, Z is the table value for standard normal deviation consistent with 95% significance level (1.96), p is the prevalence of obese women (15-49yrs) in Vihiga County (0.07) (KDHS, 2014), q is (1-p) and d is (0.05) sampling error; margin error of 5%.

An attrition rate of 5% to account for non-participation or participants who may fail to finish the interview was added.

$$\text{Total Sample Size} = 100 + \left(\frac{5}{100} \times 100\right) = 105$$

3.3.4.2 Sampling Procedure

A multi-stage sampling criterion was applied in order to account for population heterogeneity in the study area. In Vihiga County, Hamisi and Sabatia Sub-Counties were purposively selected as the two neighboring administrative regions. The two sub-counties are inhabited by different subtribes, Maragoli dominate Sabatia sub-county whereas the Tiriki dominate Hamisi Sub-County. From each sub-county, two wards were randomly selected through generated random numbers in Microsoft Excel. Lastly, segmentation and simple random sampling method

wereused to locate women of reproductive age whereby the community health worker (CHW) led the team to a random section within the ward, whether a household or market, any woman of reproductive age within the radius would be randomly recruited. If the sample was not reached from the initial start the CHW would lead the team to another area where the same process would be repeated until the sample size was reached. The total sample size was divided equally within the four wards, in each ward 27 women were recruited, to meet the minimum sample size estimated using the Fisher's formula. Figure 3 illustrates the sampling schema.

Sampling Schema

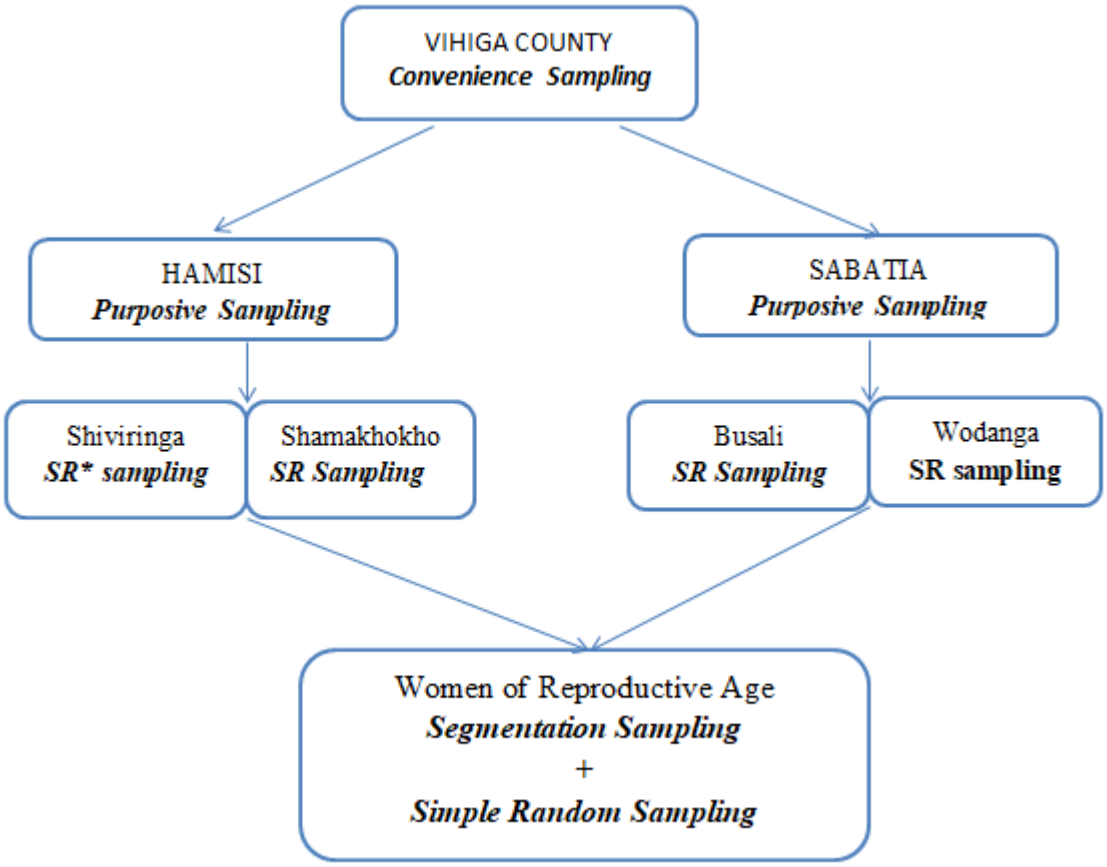

Figure 3 3: Sampling Schema for inclusion of participants into the study.

***SR* Sampling**- Simple Random Sampling*

3.3.5Data collection methods

3.3.5.1 Sociodemographic status of women of reproductive age in Vihiga County

A semi-structured interview questionnaire was used for data collection on sociodemographic characteristics of women of reproductive age see (Appendix 2). Variables included: age, education level, marital status, income and wealth index. The latter was assessed using the World Food Programme (2017), household wealth index questionnaire.

3.3.5.2 Nutrition status of women of reproductive age in Vihiga County

The nutrition status of participants was assessed regarding their body mass index, waist circumference, and waist-hip ratio.

a. Body Mass Index Measurement Procedure

Weight: An electronic SECA813 bathroom scale was used to take the weight of the participants. First, the scale was standardized to zero, participants were asked to remove any items of substantial weight e.g. phones, watches, and bags before measuring their weight. Participants were barefoot and lightly dressed while taking measurements; they were requested to look forward and remain as immobile as possible; this ensured that weight was equally distributed. Weight was measured twice and recorded to one decimal place. In case of a significant difference of >0.5 kg between the two measurements a third measurement was taken, thereafter, an average weight was computed and used to calculate BMI.

Height: Participants were requested to remove any footwear or headgear and stand with feet together. A Stadiometer, Kangkang 2 meters stadiometer tape, was placed on the wall and was used to measure height. Participants would stand parallel to the Stadiometer with their heels touching the wall, their eyes straight and at the same level as ears; they were requested to breathe in and stand tall. A board was placed on top of their head and measurement was read and recorded in Centimeters.

b. Waist Circumference and Hip Circumference Measurement Procedure

Waist Circumference was measured according to WHO STEPS protocol: the measurement was made done in the middle of the lowest margin of the rearmost visible rib and the upper part of the pelvic crest (WHO, 2008b). Hip Circumference measurements were taken at the broadest part of the buttocks. Measurements were taken using a non-stretch tape; participants had both arms at their sides with their feet close together and were asked to take deep natural breaths before the measurement was taken at minimal expiration. The tension of the tape was not constricting but snug on the participant's body and was parallel to the ground. Measurements were recorded in centimeters to one decimal place.

3.3.6Recruitment and training of enumerators

3.3.6.1 Recruitment

Recruitment of enumerators was done in Hamisi and Sabatia Sub Counties before the commencement of the study following an advertisement of the position via posters and interviews in the designated wards. Three enumerators and four community health volunteers, who served as guides, were recruited.

Training of enumerators was done within three days. Topics covered included introduction to the research study, sampling procedure, inclusion and exclusion criteria, data collection methods, use of research tools and ethics in research. This was done by the principal investigator to ensure data quality is good and that ethics in research are followed. Formal methods e.g., lectures and informal methods e.g., discussions and demonstrations, were utilized during the training.

Pre-testing of the research tool was done in both sub-counties among 10 women of reproductive age to improve research tools. Pre-testing sharpened interviewers interviewing and practical skills. Data collected was excluded in the data analysis. Follow up discussions were held to determine challenges faced and recommendations were made and implemented for example the SI units of height and time measurements (whether in meters/ centimeters or hours/ minutes) to be used to ensure consistency among enumerators and data collected.

3.3.6.2 Definitive data collection

Ethics in Research and During Fieldwork

An informed consent form was issued to participants. Evidence suggests that low levels of literacy levels may limit the independent understanding of the informed consent because understanding of the informed consent is influenced by literacy levels and language (Alaei et al., 2013). Thus, the consent forms were translated to Swahili, the national language. Furthermore, written consent forms and questionnaires were translated from English to Swahili in adherence with the ethical principle of justice to ensure fairness among respondents who are not fluent in the English language. For anonymity, participant's personal information was not used; codes and numbers were used instead of names. Sources of information used in this study were cited appropriately to prevent plagiarism.

3.3.7 Data Quality Control

Data quality control was ensured in two stages: before the study, during and after the study.

3.3.7.1 Pre-study

The principal researcher ensured that only qualified enumerators are selected, properly and adequately trained. Pre-testing of research tools was done to identify and address deficiencies and challenges faced during data collection.

3.3.7.2 Data collection

The use of segmentation method during sampling reduced selection bias as respondents had an equal probability of being selected.

3.3.7.3Data management (entry and cleaning)

Data was entered from the ONA platform into the Statistical Packages for Social Sciences (SPSS) Version 25, (IBM Corporation, New Orchard, and Armonk, New York, USA) and cleaned. Cleaning was done by exploring the data to identify outliers, of which 4/110 respondents' information were excluded from analysis. Descriptive statistics were used to determine the distribution of data via skewness and kurtosis and consequently, appropriate data analysis method.

3.3.8 Data Analysis

Data was analyzed using both descriptive and inferential statistics. Descriptive statistics was used to summarize sociodemographic information and the nutrition status of respondents. Inferential statistics: Cross tabulation including chi-square and non-parametric tests, Kruskal-Wallis, were used to identify associations between sociodemographic characteristics of respondents' and their BMI, waist circumference and waist hip ratio. In some cases one assumption of chi-square, expected value of cells being 5 or greater in at least 80% of the cells, was violated, therefore fishers exact test was used. Regression was used to control confounding variables when identifying the sociodemographic correlates of the nutrition status of respondents. Independent variables tested included age, marital status, education level, gross monthly income and household wealth index; while the dependent variables tested were BMI, Waist Circumference, and Waist Hip Ratio.A p-value of <0.05 was considered significant for all these tests.

3.4.1 Sociodemographic Profile

Out of 106 women of reproductive age interviewed, most of them (n=51) were aged between 15-21 years. The mean age of respondents was 24.70 ± 9.366 years and a median age of 22 years (Interquartile range (IQR: 17-33 years). Most of the women, 57.5% were single whereas only 39.6% were married. The women had largely attained the basic education, 39.6% and 36.8% had completed high school and primary school, respectively.

Table 3 1: Sociodemographic profile of the respondents'

Sociodemographic characteristic	N	Percentage
Age		
15-21	51	48.1
22-28	19	17.9
29-35	18	17.0
36-42	14	13.2
43-49	4	3.8
Residency		
Shamakhokho	30	28.3
Shiru	25	23.6
Busali	28	26.4
Wodanga	23	21.7
Marital Status		
Single	61	57.5
Married	42	39.6
Separated	1	0.9
Widowed	2	1.9
Education Level		
Primary	39	36.8
High School	42	39.6
College/Polytechnic	10	9.4
Never Attended School	15	14.2
Gross Household Income		
1000-5000	63	59.4
5001-10000	25	23.6
10001-15000	10	9.4
15001-20000	5	4.7
20001-25000	2	1.9
>25000	1	0.9

The education status of respondents ranged from those who never attended school (14.2%) to those who completed/ attended college or polytechnic (9.4%). The median household income was 5000 Kenyan Shillings (35 USD) among the participants. Income ranged between a minimum of 1000 (7 USD) and a maximum of 30,000 (207 USD) Kenyan Shillings. See table 3.1 above.

3.4.1.1 Household Wealth Index

The wealth index of households regarding principal component analysis classified 74.5% of respondents' in the lower wealth category while 20.8% and 4.7% of the respondents' were categorized in the middle and upper wealth category respectively. The mean respondents' wealth index was $1.89*10^{-6}\pm$ 1.004 with maximum and minimum wealth index of 2.112 and -1.6983, respectively. Shiru ward had comparatively more households with higher wealth index than Busali and Wodanga wards (Figure 3 4).

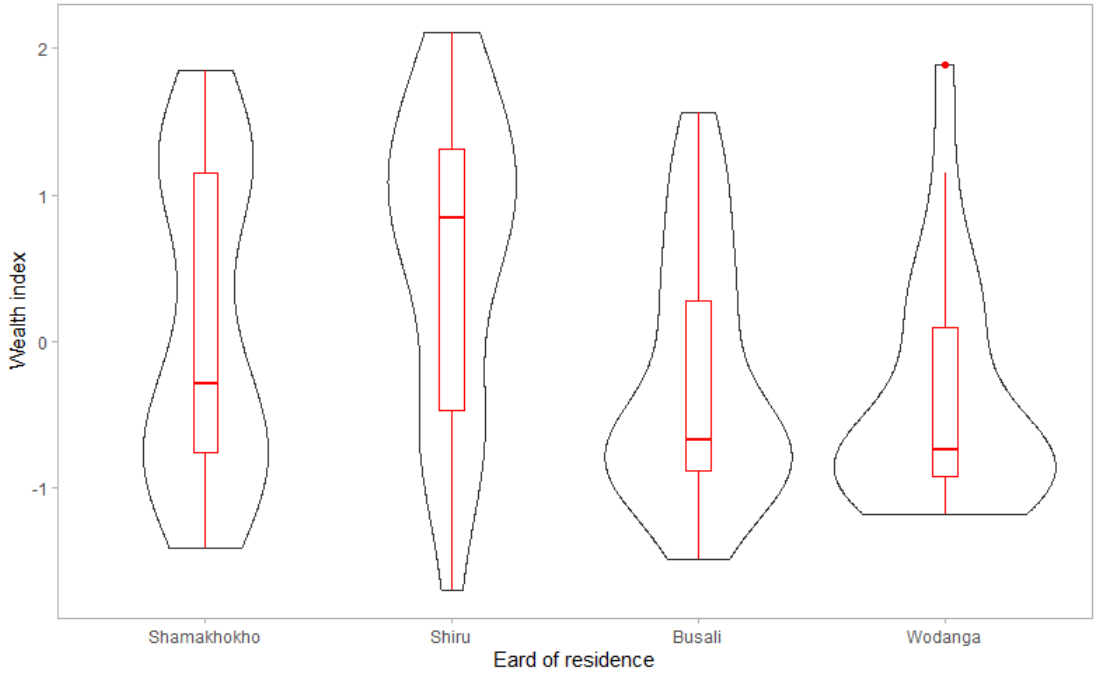

Figure 3 4:Violin and box plots of distribution of Wealth Index among Respondents per Ward

3.4.2 Anthropometric Measurements

a) Body Mass Index

The Body Mass Index of respondents ranged between underweight (14.05 kg/m^2) to Obese (39.38 kg/m^2) with a mean BMI of 24.21 kg/m^2 ± 5.11. Majority of respondents, 58%, fell within the normal BMI category (18.5-24.9 kg/m^2), Figure 5. A third of the women were overweight (21%), obese class (9%) or obese class 2, (4%); only nine respondents were underweight.

b) Waist Circumference

The mean waist circumference of respondents was 80.76 ± 13.57 cm (range 53.3-122.5 cm). The majority of the women 60% were within the normal range (<80 cm) whereas the remaining 40% were classified as either of increased risk (>80-88 cm) or substantially increased risk (>88Cms) regarding obesity related health problems.

c) Waist Hip Ratio

The respondents waist hip ratio had a mean of 0.82 ± 0.088 (range 0.68- 1.22); 25.5% of the women were classified under the increased risk of metabolic complications category defined as a ratio of >0.85. The remaining women, 74.5%, were categorized under normal category defined as a ratio of <0.85.

Table 3 2 provides a summary of the anthropometric measurements of the respondents according to their BMI classification, waist circumference and waist hip ratio. The table indicates that 13.2% were obese, 39.6% had a high waist circumference and 25.5 % had a high waist hip ratio.

Table 3 2: Distribution of the nutrition status of women of reproductive age in Vihiga County

Anthropometric Measurement	Classification	% of Respondents
Body Mass Index (BMI)	Underweight (<18.5)	8.5
	Normal (18.5-24.9)	57.5
	Overweight (25.0-29.9)	20.8
	Obese (30.0-39.9)	13.2
Waist Circumference	Normal (<80 Cms)	60.4
	Increased Risk (>80-87.9Cms)	16.0
	Substantially Increased Risk (>88Cms)	23.6
Waist Hip Ratio	Normal (<0.85)	74.5
	Increased Risk of Metabolic Complications (>0.85)	25.5

3.4.3 Sociodemographic Profile Correlates and Anthropometric Measurement

3.4.3.1 Sociodemographic characteristics and Body Mass Index

A fisher's exact test was used to test the link between BMI and level of education and marital status (Table 3 3). There was no statistically significant association (p= 0.30) between BMI and level of education. A statistically significant association was established between the marital status and BMI (p= 0.023). Less of the single women (6.6%) were obese compared to the married. Kruskal-Wallis test indicated a statistically significant association (p<0.05)between age and the BMI of the women. Women who were obese or overweight (30 years, median value) were older than those that were underweight or of normal BMI (p<0.001).

Table 3 3 indicates that marital status and age were associated with the BMI status of the respondents. Contrastingly, there were no associations between the BMI of the respondents and education level, household income or wealth index.

Table 3 3: Distribution of WRA BMI regarding sociodemographic characteristics (N=106)

Variable		N	Nutrition Status (BMI) Underweight (%)	Normal (%)	Overweight (%)	Obese (%)	P-value
Education Level*							0.30
	Primary	39	7.7	66.7	12.8	12.8	
	Secondary	42	11.9	57.1	23.8	7.1	
	Tertiary	10	10	50	20	20	
	None	15	0	40	33.3	26.7	
Marital Status*							**0.02**
	Single	61	13.1	63.9	16.4	6.6	
	Married	42	2.4	47.6	28.6	21.4	
	Separated	1	0	0	0	100	
	Widowed	2	0	100	0	0	
Age*		106	8.5^{a}	57.5^{b}	20.8^{a}	13.2^{ab}	**<0.001**
Household Income*(KES)		106	8.5	57.5	20.8	13.2	0.12
Wealth Index*		106	8.5	57.5	20.8	13.2	0.06

*Cumulative percentages are across rows for each category

*Median values for age, household income and wealth index were obtained as the distributions violated assumption of normality. Values with differing superscript letters across a row, were statistically different at $p<0.05$.

3.4.3.2 Sociodemographic characteristics and Waist Circumference (WC)

A fisher's exact test was adopted to test associations between waist circumference and level of education or marital status (Table 3 4). Both education level and marital status were significantly associated ($p<0.05$) with the waist circumference of the women. More proportion of women (53.3%) who never attended school had higher waist circumferences than those that attended school ($p=0.006$). Single women rather than the married or separated had less waist circumferences ($p<0.001$). Kruskall Wallis test was applied to test for statistical differences in the ages, household income and wealth index of women of different waist circumference classification. Age and household income of the women significantly ($p<0.05$) differed across the different waist circumference classification. Women with higher waist circumferences earned

more and were older than those with normal waist circumferences (Benjamini-Hochberg, $p<0.05$).

Table 3 4 shows that education level, marital status, age and household income were significantly associated with the waist circumference (cms) of the WRA in Vihiga County. No association was established between the wealth index of respondents and their waist circumference.

Table 3 4: Association between sociodemographic factors and waist circumference (cm)

			Nutrition Status (Waist Circumference Classification)			
Variable		**N**	**Normal (%)**	**Increased Risk (%)**	**Substantially Increased Risk (%)**	**P-value**
Education Level*						**0.006**
	Primary	39	71.8	7.7	20.5	
	Secondary	42	64.3	19.1	16.7	
	Tertiary	10	30	50	20	
	None	15	40	6.7	53.3	
Marital Status*						**<0.001**
	Single	61	70.5	19.7	9.8	
	Married	42	45.2	11.9	42.9	
	Separated	1	0	0	100	
	Widowed	2	100	0	0	
Age*		106	60.4^{a}	16.0^{a}	23.6^{b}	**<0.001**
Household Income*(KES)		106	60.4^{a}	16.0^{ab}	23.6^{b}	**0.03**
Wealth Index*		106	60.4	16.0	23.6	0.079

*Cumulative percentages are across rows for each category

*Median values were obtained as the distributions violated assumption of normality. Values with differing superscript letters across a row, were statistically different at $p<0.05$.

3.4.3.3 Sociodemographic characteristics and Waist Hip Ratio (WHR)

A fisher's exact test was applied to determine the link between WHR and education level or marital status of the respondents. There was no statistically significant association (p= 0.277) between WHR and the level of education (Table 3 5). A statistically significant association was established between marital status and WHR (p= 0.015). A Cramer's V value of 0.284 suggested moderate associations between the variables. The Mann Whitney U'test was used in assessing differences in age, wealth index and household income between the two groups of classification of the respondents in terms of WHR. Respondents who had WHR>85 were older (33 year, median value) than those with WHR<0.85 (20 years, median value), (p=0.002).Table 3 5 reports the sociodemographic correlates of waist hip ratio of the respondents.

Table 3 5: Association between sociodemographic factors and WHR

		Nutrition Status (Waist Hip Ratio)			
Variable		**N**	**Normal (%)**	**Increased Risk (%)**	**P-value**
Education Level*					0.28
	Primary	39	79.5	20.5	
	Secondary	42	76.2	23.8	
	Tertiary	10	80.0	20.0	
	None	15	53.3	46.7	
Marital Status*					**0.015**
	Single	61	83.6	16.4	
	Married	42	64.3	35.7	
	Separated	1	0	100	
	Widowed	2	50	50	
Age*		106	74.5^{a}	25.5^{b}	**0.002**
Household Income*(KES)		106	74.5	25.5	0.09
Wealth Index*		106	74.5	25.5	0.35

*Cumulative percentages are across rows for each category

*Median values were obtained as the distributions violated assumption of normality. Values with differing superscript letters across a row, were statistically different at p<0.05.

3.4.4 Sociodemographic risk factors of obesity among the respondents

Regression was used to predict the response of BMI to changes in age, marital status, education level, gross income and household wealth index. Age, and marital status statistically significantly predicted BMI status, F (3, 102) $p<0.001$, $R^2= 0.245$ with both variables significantly contributing to the prediction, $p < 0.05$ at 95% confidence interval see table 3.6 below. The fitted model showed that age had odds of 1.44 (beta=0.367) of increasing the BMI of the women in the county.

Regression was used to predict the response of WC to changes in age, marital status, education level, gross income and household wealth index. Age, marital status and education level statistically significantly predicted WC status, F (3, 102) $p < 0.001$, $R^2= 0.361$ with all variables significantly contributing to the prediction, $p < 0.05$ at 95% confidence interval.

Regression was used to predict the response of WHR to changes in age, marital status, education level, gross income and household wealth index. Age and marital status statistically significantly predicted WHR of the respondents, F (1, 104) $p < 0.001$, $R^2= 0.106$ at 95% confidence interval.

Table 3 6 below illustrates the sociodemographic risk factors of obesity regarding BMI, waist circumference and waist hip ratio in tables 3 6 (a), 3 6 (b), 3 6 (c),respectively, with their corresponding p-value and odds ratio, among women of reproductive age in Vihiga County, Kenya

Table 3 6: Sociodemographic risk factors of obesity among women of reproductive age in Vihiga County, Kenya

Table 3 6 (a) shows that divorced women were less likely to have a high BMI compared to married women (p=0.01, OR=0.00, 95% CI= 0.00-0.16). In addition increase in age among the women increased the odds of having a high BMI by 1.44 times (p<0.001, OR=1.44, 95%CI= 1.24-1.68)

Table 3 6 (a) Sociodemographic risk factors of body mass index among women of reproductive age in Vihiga County, Kenya

	Body Mass Index				
			95% CI for OR		
Variable		**OR**	**Lower**	**Upper**	**P-value**
Education Level	N				
Primary	39	0.09	0.01	1.32	0.08
Secondary	42	0.16	0.01	2.68	0.20
Polytechnic	10	0.08	0.00	3.12	0.18
None	15	-	-	-	-
Marital Status					
Single	61	15.24	0.98	237.13	0.052
Separated	1	164.10	0.01	2436797.97	0.30
Divorced	2	0.00	0.00	0.16	**0.01**
Married	42	-	-	-	-
Wealth Index					
Lowest	79	1.25	0.02	101.49	0.92
Middle	22	2.71	0.03	281.33	0.67
Highest	5				-
Household Income	106	1.00	1.00	1.00	0.32
Age	106	1.44	1.24	1.68	**<0.001**

Table 3 6 (b) illustrates that women who had attained primary education had decreased likelihood (p=0.01, OR=0.003, 95% CI=0.001-0.17) of having central obesity as compared to those who had no formal education. Furthermore, the married women were more likely to have central obesity than those divorced (p=0.002, OR=0.006, 95% CI=0.003-0.008), however, single and separated women were more likely to have central obesity compared to those who were married (p=0.05, OR=5.40, 95% CI=1.06-8.57) and (p=0.01, OR=3.61, 95% CI= 2.42- 5.89), respectively. As age increased, the odds of having central obesity increased by three times (p<0.001, OR=3.02, 95% CI= 2.11 to 4.34).

Table 3 6 (b) Sociodemographic risk factors of waist circumference among women of reproductive age in Vihiga County, Kenya

	Waist Circumference				
			95% CI for OR		
Variable		**OR**	**Lower**	**Upper**	**P-value**
Education Level	N				
Primary	39	0.003	0.001	0.17	**0.01**
Secondary	42	0.01	0.003	5.42	0.14
Polytechnic	10	0.003	0.0025	8.04	0.14
None	15	-	-	-	-
Marital Status					
Single	61	5.40	1.06	8.57	**0.05**
Separated	1	3.61	2.42	5.89	**0.01**
Divorced	2	0.006	0.003	0.008	**0.002**
Married	42	-	-	-	-
Wealth Index					
Lowest	79	266.93	0.01	332.57	0.30
Middle	22	745.45	0.01	987.48	0.24
Highest	5				
Household Income	106	1.00	1.00	1.00	0.41
Age	106	3.02	2.11	4.34	**<0.001**

According to table 3 6 (c) separated women were 1.33 times more likely to have a high waist hip ratio than those who were divorced (p=0.008, OR=1.33, 95% CI=1.07 to 1.65). Similarly to BMI and waist circumference, increase in age increased the odds of having a higher waist hip ratio by 1.004 times.

Table 3 6 (c) Sociodemographic risk factors of waist hip ratio among women of reproductive age in Vihiga County, Kenya

		Waist Hip Ratio			
			95% CI for OR		
Variable		**OR**	**Lower**	**Upper**	**P-value**
Education Level	N				
Primary	39	0.98	0.94	1.03	0.43
Secondary	42	0.99	0.95	1.05	0.91
Polytechnic	10	0.95	0.89	1.01	0.11
None	15	-	-	-	-
Marital Status					
Single	61	1.07	0.94	1.22	0.30
Married	42	1.04	0.92	1.16	0.55
Separated	2	1.33	1.07	1.65	**0.008**
Divorced	1	-	-	-	-
Wealth Index					
Lowest	79	1.03	0.95	1.12	0.44
Middle	22	1.00	0.92	1.08	0.92
Highest	5				-
Household Income	106	1.00	1.00	1.00	0.58
Age	106	1.004	1.001	1.007	**<0.001**

3.5Discussion

3.5.1 Sociodemographic Characteristics

This study included 106 women of reproductive age with a mean age of 24.70 ± 9.366 years, indicating a youthful population with the highest number of participants aged between 15-21 years. These results slightly differs from the Vihiga County integrated development plan that recorded under 15 as the highest population with those 20-24 years recording the 5th highest population after those <15 years. This can be explained by the study's inclusion criteria that excluded under 15s.

The percentage of respondents who had never attended school (14%) was almost similar to the county and national levels of 11.7% and 18.6% respectively, while for respondents who attended school, the percentage indicated a decreasing trend as one approached higher levels. This trend is also similar to the county and national levels.

According to the KNBS & ICF(2023), the wealth index of respondents in the rural setting gradually decreased from those in the lowest wealth quantile to those in the highest wealth quantile. This finding is in line with those of this study that indicated a declining trend with most respondents classified in the lower wealth category followed by middle then upper wealth category.

3.5.2 Nutrition Status

3.5.2.1 Body Mass Index

A majority of the respondents (57.5%) were categorized as of normal weight regarding BMI, however, this number was slightly lowerthan that reported, 58.3%, in the national survey conducted in 2022.On the other hand, the percentage of underweight, 8.5%, and overweight, 20.8%, women in this study are similar to those of the national survey,8.1% and 21.6% , respectively. A substantial increase in the number of obese women was noted from previous health surveys, in 2014, 7% of women of reproductive age in the county were obese; this has doubled to 13.2% as per this study. The nutrition transition and patterns in rural areas in East Africa that are characterized by greater intake of processed foods, carbohydrate rich and micronutrient poor foods may have contributed to the current increase (Sarfo et al., 2021). Nevertheless, findings on the percentage (33.9%) of overweight or obese women in this study

are consistent with those of Mkuu et al. (2018) andKNBS &ICF(2023), at national level and Vihiga County level, respectively, where 1 in 3 women of reproductive age are estimated to be either overweight or obese.

3.5.2.2 Waist Circumference and Waist to Hip Ratio

The current study reported an average waist circumference of 80.76 cm, this figure is similar to those reported in a nationwide survey by the MoH-Kenya (2015) that reported an average of 79.1cm. However, the number of women reported to be at higher probability of morbidity due to a greater waist hip ratio of >0.85 was higher at 36% compared to findings from this study that reported 25% of the women. The most likely reason for divergent findings is the differences in the inclusion criteria of the studies; the nationwide study included women older than 49 years and evidence exists that suggests higher waist hip ratio is positively correlated with increase in age.

3.5.3 Sociodemographic risk factors of obesity

According to this study, age was significantly associated with and significantly predicted the women's BMI, Waist Circumference and Waist Hip Ratio; older women, ≥36 years had an increased risk of having a higher BMI (OR= 1.44), WC (OR= 3.02) and WHR (OR= 1.004) as compared to women ≤35 years old. These findings corroborate those of Mukora-Mutseyekwa *et al.*, (2019), Yaya, Ekholuenetale and Bishwajit, (2018)Chowdhury, Adnan and Hassan, (2018) that identified a higher risk of overweight and obesity among older women than 35 years of age. It is postulated that older age is accompanied by a decrease in physical activity and greater intake of high energy foods among women (Alemu & Atnafu, 2014; Mukora-Mutseyekwa et al., 2019).

Marital status was also correlated to obesity among respondents in this study; it significantly predicted BMI (OR=0.00), WC (OR=5.40) and WHR (1.33). The link between marital status and obesity has been found in several studies (Abrha et al., 2016; Yaya et al., 2018; Yaya & Ghose, 2019b). This study reported that single and separated women had a higher likelihood of having central obesity compared to their married counterparts, OR=5.40 and OR=3.6, respectively while separated women had an increased risk (OR=1.33) compared to the divorced. This finding diverges with those in several studies that reported married women as having a higher risk of central obesity compared to their single counterparts (Abrha et al., 2016; Yaya et al., 2018; Yaya

& Ghose, 2019b). However, this finding coincides with the findings of Hosseini et al., (2020) that found increased risk of central obesity among single or separated women compared to the married. The study postulated that social network and participation with quality relationships offered protection against central obesity among the married women.

In addition, the risk of obesity, particularly higher waist circumference was increased among women with no education compared to those with primary school education(OR= 0.003); this finding contradicts those of other studies that identified increase in the risk of obesity with increase in level of education (Abrha et al., 2016; Chowdhury et al., 2018; Yaya et al., 2018). This may be because basic level of education may increase awareness and understanding to importance of a healthy diet, or even awareness to health promotion messages.Initially, gross household income was significantly associated with BMI and WC, however, after controlling for confounding effects between variables the association was negated. The lack of correlation between household income and obesity in this study differs the findings of Abrha, Shiferaw and Ahmed, (2016); Chowdhury, Adnan and Hassan, (2018); Yaya, Ekholuenetale and Bishwajit, (2018); Yaya and Ghose, (2019). This may be because of the influence of marital status and education level to the income of respondents.

3.6 Conclusion

The prevalence of obesity among WRA in Vihiga County by BMI status has nearly doubled since 2014 while the average WC was higher than the national average. Contrastingly, the WHR of respondents was lower than the national average. Higher rates of obesity were especially prevalent among women who are older, single or separated and those with no formal education. Since risk factors such as age are non-modifiable, sensitization strategies to prevent obesity are therefore imperative among this target group if the county is to achieve its health objective of minimizing the exposure to health risk factors, such as obesity. Furthermore, single and separated women in the county should be encouraged to engage in social participation and engagement whether in schools, church, table banking to reduce their risk of central obesity. Further research should identify the modifiable risk factors of obesity among WRA in the area to facilitate sustainable interventions to curb the obesity pandemic.

CHAPTER FOUR
MODIFIABLE RISK FACTORS OF OBESITY AMONG WOMEN OF REPRODUCTIVE AGE IN VIHIGA COUNTY

4.1 Abstract

Introduction: The number of obese women in Kenya is higher than that of men. The etiology of obesity is multifactorial with modifiable factors such as diet and physical activity significantly contributing to the burden among women. Advances in research has identified other modifiable risk factors including food security, knowledge, attitude, practices such as contraceptive use, sleep patterns, eating out of home and time of last meal . There are limited studies providing context on the rural population on the modifiable risk factors of obesity among WRA. Therefore, this study paper aimed at assessing modifiable factors of obesity and identifying the modifiable risk factors of obesity among this target group.

Methodology: A cross-sectional study was used, utilizing survey methodology and semi-structured questionnaires to collect data on modifiable factors contributing to obesity. Data analysis encompassed both descriptive and inferential statistics, including percentages, frequencies, chi-square/ fisher's exacttests, and regression analysis.

Results: The number of children born to a woman, time of consumption of the last meal of the day and the frequency of consumption of flesh meats were modifiable risk factors to the BMI of the women. Increase in the number of children increased the likelihood of a high BMI by 2.13 times (95% CI, 1.16-3.93), $p<0.05$, while late eating and frequently consuming flesh meats increased the women's risk to obesity regarding BMI by 3.50 (95% CI, 1.19-10.32) and 3.32 (95% CI,1.04-10.58) times, respectively, $p<0.05$. Modifiable risk factors to central obesity included, the number of children born to a woman (OR=7.51;95% CI, 1.69-33.88), frequently consuming flesh meat (OR=20.45, 95% CI, 1.20-348.62), frequently consuming white tubers or roots (OR=0.05, 95% CI, 0.01-0.72) and frequently consuming organ meats (OR=0.01, 95% CI, 0.009-0.12), $p<0.05$. The latter two were protective against central obesity. Contrastingly, frequently consuming sugar increased the risk of metabolic disorders regarding waist hip ratio by 1.015 times (95% CI, 1.000-1.028), $p<0.05$.

Conclusion and Recommendations: The modifiable risk factors of obesity among women of reproductive age in Vihiga County reported in this study were mainly dietary. It is therefore imperative for the County to implement setting specific interventions including nutrition education targeting dietary and lifestyle habits with the aim of preventing and managing obesity among the target group. Further, raising awareness on the influence of parity on obesity will be necessary, the County can include, in addition to educating the women on proper nutrition during pregnancy, physical activity interventions to help manage the extra weight gained during pregnancy among the women.

4.2 Introduction

Obesity rates in the world have tripled since 1975 (WHO, 2016) with the prevalence of obesity, worldwide, is approximately 2.1 billion (World Population Review, 2019). Low and middle-income countries (LMICs) especially in sub-Saharan Africa are now experiencing the challenge of an increasing trend in obesity rates (WHO, 2016). Between 1980 to 2013, the number of obese individuals increased from 857 million to 2.1 trillion (Ng et al., 2014). In Kenya, local studies report a high overweight and obesity prevalence of 43.4% among women (Mkuu et al., 2018); a prevalence higher than that of her neighboring countries such as Uganda (37.21%) and Tanzania (28%) (Ahmed et al., 2020;Yaya & Ghose, 2019).

The causal pathways and factors influencing obesity are diverse and complex ranging from economic, demographic and behavioral factors. Behavioral changes that are primary risk factors of obesity include physical inactivity and consumption of unhealthy diets which according to Koome (2016), are rich in calories, salt, refined sugar and fat. Advances in research have revealed other putative factors that may be contributing to the obesity burden including food insecurity, level of nutritional knowledge, attitude and practices, sleep patterns, consumption of ready to eat meals and time of day of meal consumption (chrononutrition).

Food insecurity has been associated with under and over-nutrition, via inadequate dietary diversity (Banerjee et al., 2020; Coleman-Jensen et al., 2020; Hendriks, 2015). Three mechanisms have been postulated in the association between food security and obesity including nutrition, psychological and "insurance" hypothesis pathways (Te Vazquez et al., 2021). For example, in the nutrition pathway, intake of poor quality diets characterized by diets rich in saturated fats, sodium, sugar, and highly processed foods were linked to food insecurity (Becerra et al., 2015; Rabbitt et al., 2016); these foods tend to be cheaper per calorie compared to healthy foods such as lean protein, fruits, and vegetables (Stepler, 2015; Weigel & Armijos, 2019). Thus, food insecure individuals had greater BMI and waist circumference and were more susceptible to obesity (Banerjee et al., 2020). Evidence also suggests that food insecure women had a higher probability of being obese compared to food secure women (Odunitan-Wayas et al., 2021) and male counterparts (Banerjee et al., 2020; Lukwa et al., 2022).

A high level of nutritional knowledge is acknowledged to effect dietary intake (Pirouznia, 2001). According to Acheampong and Haldeman (2013), associations exists between nutrition knowledge and attitude, attitude and BMI, and beliefs and diet quality. Furthermore, other studies have shown the role of nutritional attitude in influencing diet quality and promoting good nutritional practices (Aggarwal et al., 2014; Sichert-Hellert et al., 2011). Increase in one's nutritional knowledge enhances beliefs, self-efficacy and attitudeto consuming a healthy diet and alikely increase in physical activity (Acheampong & Haldeman, 2013).

Sleep signifies one of a number of developing nontraditional factors that contribute to energy balance (McAllister et al., 2009)and has been linked to the development of obesity(Ardern & Kanagasabai, 2019). According to a systematic review by Watson *et al.* (2015), regularly sleep periods of less than 7 hours every night was linked to unfavorable health effects, including increase in weight, obesity and metabolic disorders. In addition, the presence of sleeping problems has been linked to unhealthy habits including, decreased physical activity, decreased consumption of fruit and vegetables and cigarette and alcohol use (Sa et al., 2020). Consumption of ready to eat meals has increased over the years due to less time dedicated to preparing meals (Hillier-Brown et al., 2017). Working women have been shown to prefer ready to eat meals due to limited time (Story & French, 2004). Eating out of home is positively associated with weight gain (Lytle, 2009). Also, it has constantly been related to higher intake of energy and saturated fats and decreased intake of fruits and vegetables consequently, low fiber intake (Rosenheck, 2008; World Health Organization, 2003).

Furthermore, chrononutrition, described as the interaction between meal timing, metabolism and the circadian rhythm has been implicated as a factor contributing to the obesity burden. The circadian rhythm influences metabolism, digestion and hunger. According to Bernardes da Cunha et al., (2023), adults who consume their last meal after 10 p.m. were at a higher risk of central obesity as compared to those who had their last meal at 6:40 p.m. Other studies, randomized controlled trials (Ruddick-Collins et al., 2022; Vujović et al., 2022), have linked late eating with increased feelings of hunger; a plausible cause of increased food intake resulting in increased weight. Despite evidence of increased prevalence of obesity among WRA in Vihiga County, Kenya, there is scarcity of context specific studies i.e. county level data, assessing the

modifiable risk factors of obesity among this target group. Strengthening the collection and analysis of sex diversified data for improved clinical nutrition and the prevention and management of diet related non communicable diseases and clinical nutrition is among the key outcomes of the Vihiga County Nutrition Action Plan (2023-2027) (County Government of Vihiga, 2023). In addition, minimizing the exposure to health risk factors, such as obesity and reversing and stopping the increasing burden of non-communicable diseases (Vihiga County, 2021). Therefore, this study sought to determine the modifiable risk factors of obesity among WRA in Vihiga County.

4.3 Materials and Methodology

The study design, research context/ study setting,study population, sampling design, recruitment and training of enumerators, ethics in research and during fieldwork and data quality control are as described in the sociodemographic correlates of obesity among women of reproductive age paper (Sections 3.3 to 3.9).

4.3.1 Data Collection Methods

4.3.1.1 Factors of Obesity

The FAO guidelines guided the assessment of knowledge, attitude and practices (KAP) (FAO, 2014).

i. Knowledge Assessment

Knowledge assessment was carried out using a KAP exam. Knowledge score was calculated by dividing questions correctly answered by the total number of questions on knowledge. The score was multiplied by 100 and expressed as a percentage. Participants who scored > 80%, 50%-80% or <50% were considered to have high, moderate or poor knowledge, respectively.

$$\text{Knowledge Percentage} = \frac{\text{Number of questions on knowledge answered correctly}}{\text{Total number of questions on knowledge}} \times 100$$

Equation 1

ii. Attitude Assessment

A three point scale, positive, negative and neutral, were utilized to determine the respondents' attitude towards factors of obesity. According to FAO (2014), respondents with minimal education may be confused when asked to select among five options as compared to three. Total score on attitude were computed as a percentage see equation 2:

Attitude Percentage= $\frac{\text{Number of questions on attitude answered correctly}}{} \times 100$

Total number of questions on attitude

Equation 2:

Those who scored > 80%, 50%-80% or <50% were considered to have high, moderate or poor attitudes.

iii. Practice Assessment

Assessment of practices was done through questions that were based on outcome-evaluation perspective to determine whether knowledge provided is being put into practice. Correct answers/appropriate practice was divided by the total number of practice questions to compute an overall score. The score was then converted to percentage, see equation 3; respondents were considered to have high, moderate or poor practice if they scored >80%, 50%-80% or <50%, respectively.

$$\text{Practice Assessment} = \frac{\text{Correctly answered questions on practice}}{\text{Total Number of Questions on practice}} \times 100$$

Equation 3:

iv. Sleep

Sleep was assessed using open ended questions; respondents were asked to state, on average, how many hours they slept during the weekdays and weekends.

v. Food Consumption Patterns/ Dietary Practices

Dietary practice was assessed using a dietary diversity questionnaire by the Food and Nutrition Technical Assistance (FANTA) (Swindale & Bilinsky, 2005). Participants were required to recall consumption of foods from 12 food groups in the past 1 week, those who consumed 9-12 food groups were considered to have a high individual dietary diversity, those who consumed 5-8 and 1-4 food groups were of average and low dietary diversity, respectively. An additional food group deemed 'ready to eat meals' RTEs was included in the questionnaire. Similarly to the other food groups, respondents recalled if they had consumed any RTEs in the past week and the frequency of consumption.

vi. Physical Activity

Physical activity was assessed using the standardized World Health Organization, Global Physical Activity Questionnaire (2008). Indicators used to measure the participants physical activity levels include the mean metabolic equivalent of task per week(MET) per minute per week and total weighted average of time spent doing physical activity in a week. Both were expressed as continuous variables.

vii. Food Insecurity

Food Insecurity was assessed using the standardized USAID (Food and Technical Assistance) Household Food Insecurity Access Scale (HFIAS) (2007).

4.3.2 Nutrition status of respondents

The assessment of the nutrition status of respondents is as described in section 3.3.5 of the sociodemographic correlates of obesity among women of reproductive age paper.

4.3.3 Data Analysis

Data was analyzed using both descriptive and inferential statistics using statistical package for social sciences (IBM Corp. Released 2017. IBMSPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp). The knowledge, attitude and practices scores were first evaluated for reliability using Cronbach's alpha. Consistency in the KAP scores was established using a Cronbach's alpha of ≥ 0.7. Physical activity analysis was done according to the global physical activity questionnaire analysis guideline whereby for the MET-min/week physical activity indicator, the number of days spent doing vigorous activity and the number of hours spent in each day were multiplied to get the total amount of time spent. To get the MET value, the total amount spent doing vigorous physical activity would be multiplied by 8, a standard MET value for any vigorous activity. For respondents who participated in moderate physical activity, the total amount of time spent doing the activity would be multiplied by 4, a standard MET value to this group. Respondents were classified based on the WHO recommendations as having met or not met the guidelines.

Descriptive statistics was used to summarize data on modifiable factors of obesity. Inferential statistics including chi-square, in case assumptions of such tests are violated, the fisher's exact test was used while logistic and linear regressions were used to determine associations between the variables. Generalized linear model was employed to determinethe risk factors of obesity.

4.4 Results

4.4.1 Knowledge, Attitude and Practices

4.4.1.1 Nutrition Knowledge Score

The aggregate nutrition knowledge score of respondents was computed using 5 (question 2,3,6,9 and 10) out 10 questions that were asked following a reliability test that produced a Cronbach's alpha of > 0.737. The mean nutritional knowledge of the women was 24.97 ± 12.83 and a median of 26.56 (IQR: 15.63-34.37). The minimum score was 0% while the maximum score was 59.38%, upon categorization, 93.4% of respondents were ranked as having poor nutritional knowledge while 5.7% had moderate nutritional knowledge as per this study's indicators.

4.4.1.2 Attitude Score

The cumulative attitude score was computed using 13 out of 14 questions; the question "do you think you are likely to be obese" was deleted following a Cronbach's alpha of less than 0.7. The respondents had a mean attitude score of 71.26 ± 19.87 and a median of 76.92 (IQR: 61.54-84.62). The scores ranged from a minimum of 0% to a maximum of 100%. Respondents were categorized into those with negative attitude (13.2%), neutral attitude (66.0%), and positive attitude (20.8%) towards obesity.

4.4.1.3 Practice Score

Two variables, time slept during weekdays and time slept during weekends, proved reliable in testing for practice among respondents producing a Cronbach's alpha of 0.769. The average practice score was 50±45.25 with a median score of 50%. The scores ranged between 0.00 and 100.00; 40.6%, 18.9% and 40.6% were classified as having poor, neutral and good practices.

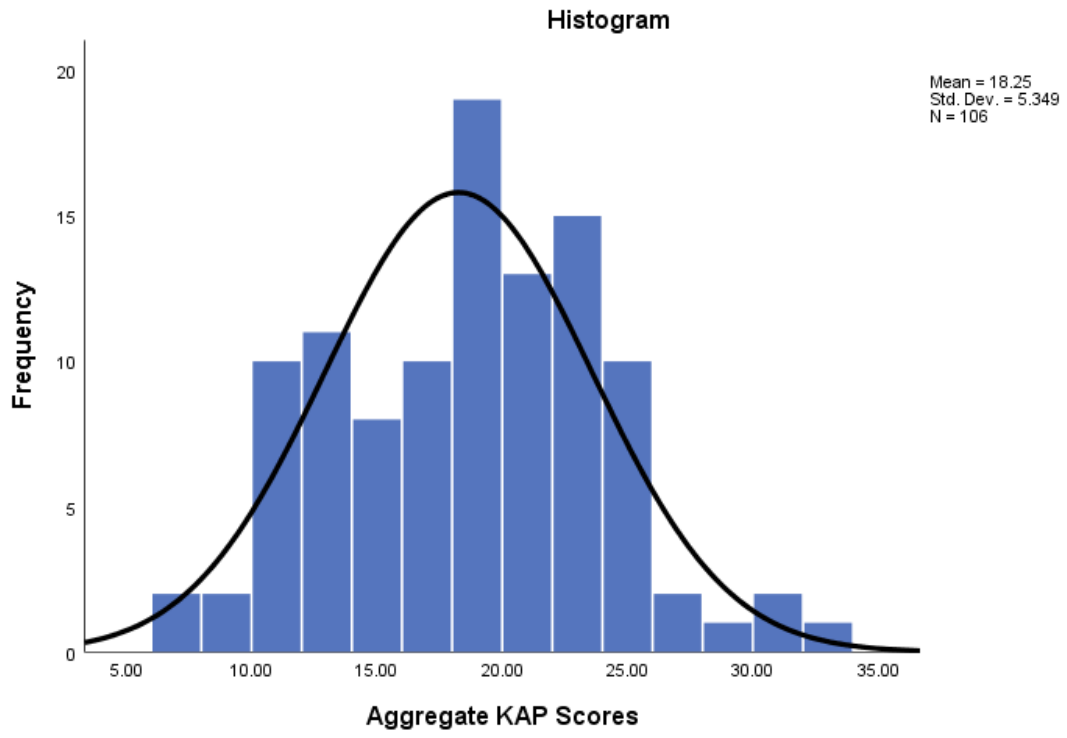

Figure 4 1: Aggregate KAP scores of respondents

a) Sleep

Out of all the respondents (n=106) only two women (1.9%) slept for less than 7 hours during the weekdays and weekends, which is below the recommended hours of sleep regarding the National Sleep Foundation Guidelines. Contrastingly, 47.2% and 50% of the women slept for more than the recommended 9 hours during weekdays and weekends, respectively. Only 51% and 48% of the respondents slept for the recommended 7-9 hours per night during both weekdays and weekends, respectively. The average amount of hours slept on a weekday was 9:19 ± 1:46 hours with a median of 9:00 hours (IQR: 8:00-10:00) and a range of 6:00-13:00 hours whereas the average amount of hours slept during the weekend was 9:29 ± 1:54 hours with a median of 9:05 (IQR: 8:00-10:04), ranging between 5:30- 13:25 hours. There was no significant difference (paired t-test, p=0.394) between the mean hours slept during the weekends and weekday by the respondents.

b) Consumption of Ready to Eat Meals (RTEs)

Majority of the respondents 60.4% did not consume ready-to-eat meals. However, 15.1% and 11.3% of them consumed RTEs twice and thrice a week, respectively. Daily consumption of RTEs was done by 4.7% of the women. Taste of RTEs was reported by most respondents (35.8%) as the main reason for their purchase. Other reasons included convenience and price that were reported by 13.2% and 5.7%, respectively.

4.4.2 Nutrition Intake

The nutrition intake of respondents was evaluated using the dietary diversity score.

4.4.2.1 Individual Dietary Diversity Score

The individual dietary diversity score (IDDS) of respondents was categorized into two main groups: moderate and high dietary diversity with 8 (7.5%) and 98 (92.5%) respondents respectively. The average dietary diversity score was 9.0472 ± 1.91 and a median of 9.00 (IQR: 7.75-10.25). The dietary diversity scores ranged between 5-12.

Three food groups: Cereals, Vegetables and Oils & fats, of the twelve, were consumed by more than half of the respondents whose diet was of moderate dietary diversity (7.5%). On the contrary, more than 50% of women with high dietary diversity scores (92.5%) consumed all twelve food groups.

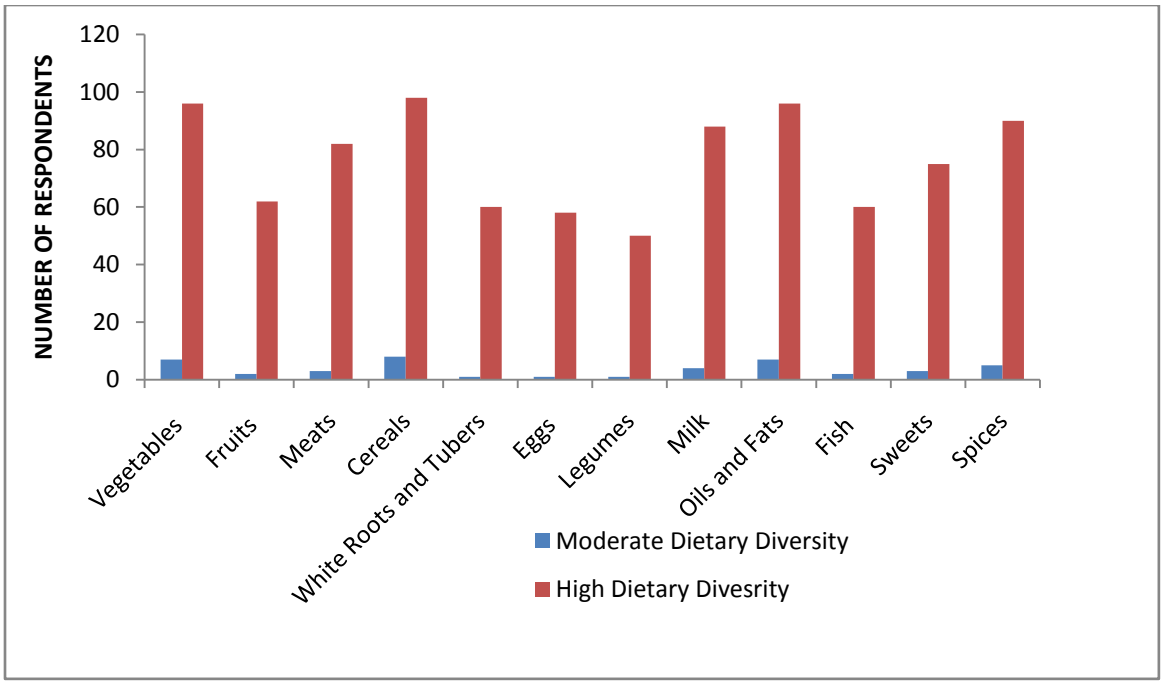

Figure 4 2: Food group consumption among respondents regarding IDDS

4.4.2.2 Women Dietary Diversity Score

An evaluation of dietary intake using the women dietary diversity score (WDDS) categorized respondents into three groups: those with low, moderate and high dietary diversity scores scored by 1.9%, 51.9% and 46.2% respondents respectively. The mean WDDS was 6.44 ± 1.57 with a median of 6.00 (IQR: 5.00-8.00). The WDDS ranged between 3 - 9.

Respondents with low WDDS (n=2) consumed two main food groups: starchy staples and dark green leafy vegetables, out of a total of 9 food groups. In addition, to these two food groups, more than half of respondents with moderate WDDS (n=55) consumed an additional four food groups including other fruits, meat, fish and milk and milk products. A statistically significant difference was noted between the two groups regarding the four additional food groups; other fruits (Fishers exact test, $p<0.001$), meat (Fishers exact test, $p= 0.044$), fish (Fishers exact test, $p= 0.006$), milk and milk products (Fishers exact test, $p<0.001$). All nine food groups were consumed by >50% of women with high WDDS (n=49), see Figure 4 3 below.

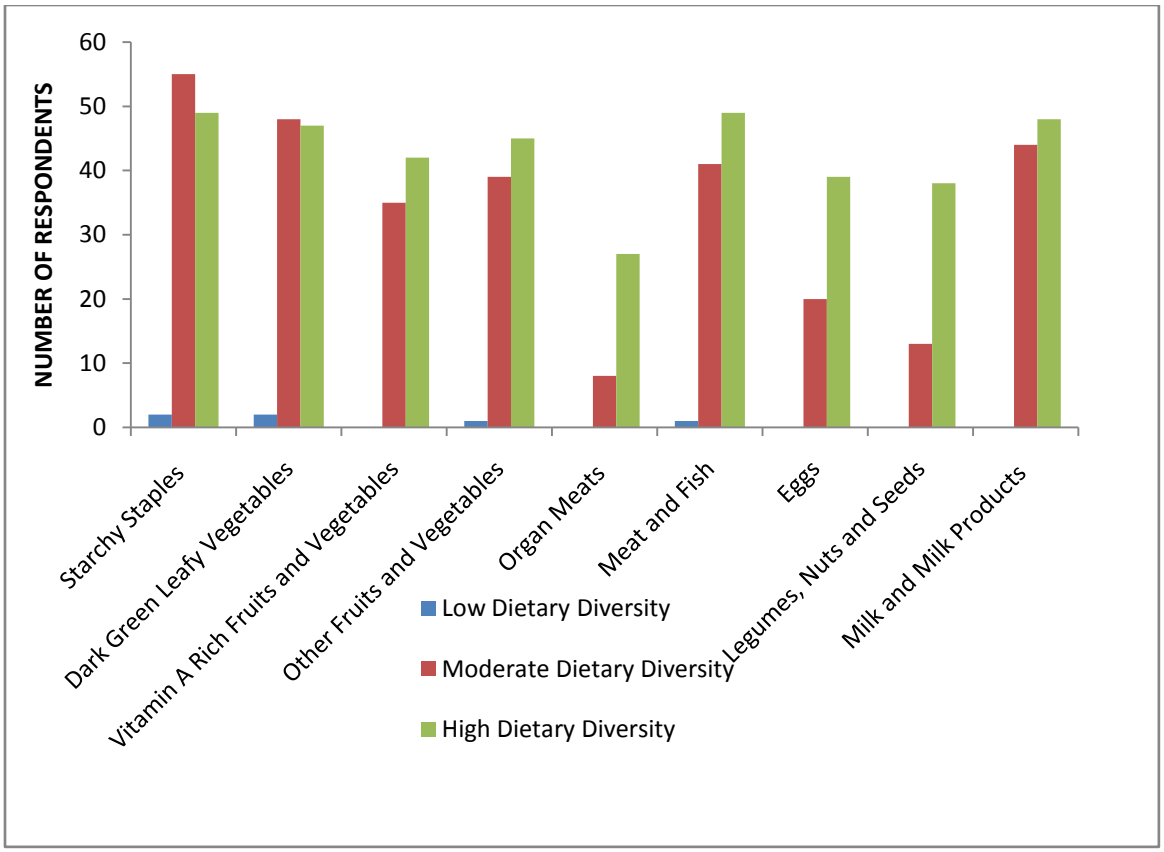

Figure 4 3: Food group consumption among respondents regarding WDDS

4.4.2.3 Food Consumption Frequency

Food consumption frequency of each food group ranged between never and seven days in the past one week. Cereals, other vegetables, milk and milk products, spices and condiments, sugar and oils and fats were consumed by most of the respondents daily. Contrastingly, white roots and tubers, vitamin A rich vegetables, vitamin A rich fruits, other fruits, organ meat, eggs, fish and sea food, legumes and nuts were rarely consumed, 0-2 days a week, by majority of the respondents.

4.4.3 Physical Activity

Physical activity of the respondents was evaluated using weighted mean metabolic equivalent of task per week (MET), total time expended in physical activity and weighted setting specific physical activity.

4.4.3.1 Total Physical Activity MET- minutes/week

The respondents accrued a total weighted mean MET- minutes per week of 5509.43± 5084.642 and a total weighted median of 3990.00 (IQR: 1680.00-8490) MET-minutes per week; this ranged between 0-28800 MET- minutes per week. Upon classification based on the World Health Organization MET indicator, 8.5% did not meet the recommendations (>600 MET) while 91.5% met the WHO recommendation of an accrued total >600 MET- minutes per week. No significant association was established between physical activity MET-minutes/week and KAP (Fishers exact test, p= 0.599), marital status (Fishers exact test, p= 0.152), wealth index (Fishers exact test, p= 0.152), age (Fishers exact test, p= 0.680), education level (Fishers exact test, p= 0.603), food security (Fishers exact test, p= 0.648) and gross household income (Fishers exact test, p= 0.482).

4.4.3.2 Total Weighted Physical Activity: Mean/median time of total

The total time spent in physical activity by respondents produced a weighted average of 115.51±99.37 minutes/ week and weighted median of 83.21(IQR: 38.57-176.79) minutes per week. Total time spent doing physical activity ranged between 0-514.29 minutes per week. Classification based on WHO indicators categorized 76.4% of respondents having met the recommendations while 23.6% of respondents having not met the recommendations of amassing a total of 150 or 75 minutes of moderate or vigorous physical activity in a week, respectively. Food security status statistically predicted the total weighted physical activity of the respondents (logistic regression, p=0.015); a unit increase in the food security score was linked with an 85.6% (ExpB=0.144) decreased odds in meeting the weekly recommendation of amassing ≥150 and ≥75 minutes of moderate and vigorous physical activity respectively.

4.4.3.3 Setting Specific Physical Activity (mean/median) weighted

Work related physical activity reported the highest weighted mean time of 48.69 ± 31.91 minutes per week spent in physical activity among the respondents. This was followed by recreation related physical activity with a weighted average of 28.72 ± 32.69 minutes per week. Travel related physical activity reported the lowest weighted mean of 18.82 ± 27.36 minutes.

4.4.4 Food Security

Half of the respondents 50% were food secure while 34% were mildly food insecure. On the other hand, 16%, were moderately and severely food insecure.

4.4.5 Additional modifiable factors

a) Timing of last meal and frequency of meals

The mean number of meals consumed among the women was 2.92 ±0.613 and ranged between 1 to 5 meals in a day. Majority of respondents, 73.6%, consumed 3 meals in a day followed by those (17%) consuming 2 meals per day. Women consuming 1, 4, and 5 meals in a day were 0.9%, 5.7% and 2.8%, respectively. The last meal of the day was consumed later than 8pm by 67% of respondents whereas 33% consumed the last meal of the day earlier than 8pm.

b) Parity among respondents

Slightly over half (51%) of the respondents reported having children, while the remaining (49%) did not have any children.

c) Smoking and Alcohol Use

Only two and one respondents reported smoking and consuming alcohol, respectively.

d) Contraceptive use

A third (31.1%) of the women reported using contraceptives while 68.9% did not use contraceptives.

Modifiable factors of obesity correlates and anthropometric measurements

4.4.6 Modifiable factors of obesity and Body Mass Index

A fisher's exact test was used to test the link between BMI and number of hours slept during weekends and weekdays, consumption of ready to eat meals, individual and women's dietary diversity scores, physical activity in MET-minutes/week and total weighted, time of last meal, smoking, alcohol, contraceptive use and parity of respondents.

Table 4 1 (a) on page 55, highlights the associations between these modifiable factors and BMI. Out of the 13 variables, a significant ($p<0.05$) association was established between the food security scores and BMI (Fishers exact test, $p=0.023$), the use of contraceptives and BMI (Fishers exact test, $p=0.003$) and parity, whether the woman had children or not and BMI (Fishers exact test, $p= 0.002$), see table 4 1 (a) below.

4.4.7 Modifiable factors of obesity and WC

Chi-square test was used to test the link between waist circumference and number of hours slept by respondents, consumption of RTEs, time of last meal, contraceptive use and parity. Contrastingly, fisher's exact test was used to determine the link between waist circumference and dietary diversity scores, physical activity, food security status, smoking and alcohol use. Table 4 1 (b) on page 58 reports a significant ($p<0.05$) association between waist circumference and consumption of RTEs (Chi-square test, $p=0.019$), physical activity MET-min/week (Fishers exact test, $p=0.002$), total weighted physical activity (Fishers exact test, $p=0.045$), food security status (Fishers exact test, $p=0.009$), contraceptive use (Chi-square test, $p=0.041$) and parity (Chi-square test, $p=0.001$).

4.4.8 Modifiable factors of obesity and Waist Hip Ratio (WHR)

Similarly, chi-square test was applied to determine the link between waist hip ratio and the number of hours slept by respondents, consumption of RTEs, total weighted physical activity, and time of last meal, contraceptive use and parity. A fisher's exact test was used to test the relationship between WHR and dietary diversity scores, physical activity MET-min/week, food security status, smoking and alcohol use. Table 4 1 (c) below on page 59 shows that among the 13 variables tested, no significant ($p>0.05$) association was established between the variables and WHR.

***Table 4 1*: Associations between modifiable factors of obesity and nutrition status**
Table 4 1 (a): Associations between modifiable factors of obesity and BMI

			BMI Classification				
Variable		**N**	**Underweight (%)**	**Normal (%)**	**Overweight (%)**	**Obese (%)**	**P-value**
Hour slept (weekday)							0.27
	<6 or >9 hours	51	8	61	25	6	
	7-9 hours	55	9	55	16	20	
Hours slept (weekend)							0.19
	<6 or >9 hours	55	9	62	24	5	
	7-9 hours	51	8	53	18	22	
RTE Consumption							
	Yes	42	14	64	14	7	0.16
	No	64	5	53	25	17	
IDDS score							0.69
	Moderate DD	8	0	63	38	0	
	High DD	98	9	57	19	14	
WDDS score							
	Low DD	2	0	100	0	0	0.69
	Moderate DD	59	9	55	18	18	
	High DDD	45	8	59	24	8	
PA MET-min/week							0.13
	<600	9	0	33	33	33	
	≥ 600	97	9	60	20	11	
Total weighted PA							0.39
	<150mins	25	4	48	28	20	
	≥ 150mins	81	10	60	19	11	
Food Security							**0.023**
	Food Secure	18	6	39	33	22	
	Food Insecure	88	9	61	18	11	
Time of last meal							0.80
	≤ 8 p.m.	71	8	61	18	13	
	>8 p.m.	35	9	51	26	14	
Smoker	Yes	2	0	50	50	0	0.67
	No	104	9	57	20	13	
Alcohol use	Yes	1	0	100	0	0	1.00
	No	105	9	58	21	13	
Contraceptive Use							**0.003**
	Yes	33	3	42	24	30	
	No	74	11	64	19	5	
Has Children	Yes	54	2	50	28	20	**0.002**
	No	52	15	65	13	6	

Table 4 1 (b): Associations between modifiable factors of obesity and waist circumference

			Waist Circumference Classification			
Variable		**N**	**Normal (%)**	**High Risk (%)**	**Very High Risk (%)**	**P-value**
Hour slept (weekday)						0.477
	<6 or >9 hours	51	60	20	20	
	7-9 hours	55	60	13	27	
Hours slept (weekend)						0.792
	<6 or >9 hours	55	60	18	22	
	7-9 hours	51	61	14	25	
RTE Consumption						
	Yes	42	74	17	10	**0.019**
	No	64	52	16	33	
IDDS score						0.437
	Moderate DD	8	63	0	38	
	High DD	98	60	17	22	
WDDS score						0.407
	Low DD	2	50	50	0	
	Moderate DD	59	64	11	25	
	High DDD	45	57	20	22	
Physical Activity						**0.002**
	<600 MET/ min	9	11	44	44	
	≥ 600 MET/min	97	65	13	22	
Physical Activity						**0.045**
	<150mins	25	44	32	24	
	≥ 150mins	81	65	11	23	
Food Security						**0.009**
	Food Secure	18	33	39	28	
	Food Insecure	88	66	11	23	
Time of last meal						0.305
	≤ 8 p.m.	71	59	20	21	
	>8 p.m.	35	63	9	29	
Smoker	Yes	2	50	50	0	0.350
	No	104	61	15	24	
Alcohol use	Yes	1	100	0	0	1.00
	No	105	60	16	24	
Contraceptive Use						**0.041**
	Yes	33	45	15	39	
	No	74	67	16	16	
Has Children	Yes	54	48	13	39	**0.001**
	No	52	73	19	8	

*High Risk- Increased risk of central obesity

Table 4 1 (c): Associations between modifiable factors of obesity and waist hip ratio

Variable		N	Waist Hip Ratio Classification Normal(%)	High Risk* (%)	P-value
Hour slept (weekday)					0.265
	<6 or >9 hours	51	61	20	
	7-9 hours	55	60	13	
Hours slept (weekend)					0.080
	<6 or >9 hours	55	60	18	
	7-9 hours	51	61	14	
RTE Consumption					
	Yes	42	74	17	0.822
	No	64	52	16	
IDDS score					0.417
	Moderate DD	8	63	0	
	High DD	98	60	17	
WDDS score					0.584
	Low DD	2	50	50	
	Moderate DD	59	64	11	
	High DDD	45	57	20	
Physical Activity					0.690
	<600 MET/ min	9	11	44	
	≥ 600 MET/min	97	65	13	
Physical Activity					1.000
	<150mins	25	44	32	
	≥ 150mins	81	65	11	
Food Security					0.553
	Food Secure	18	33	39	
	Food Insecure	88	66	11	
Time of last meal					1.000
	≤ 8 p.m.	71	59	20	
	>8 p.m.	35	63	9	
Smoker	Yes	2	50	50	1.000
	No	104	61	15	
Alcohol use	Yes	1	100	0	1.000
	No	105	60	16	
Contraceptive Use					0.235
	Yes	33	45	15	
	No	74	67	16	
Has Children	Yes	54	48	13	0.075
	No	52	73	19	

*High Risk- Increased risk of metabolic disorders

4.4.9 Modifiable risk factors of obesity

4.4.9.1 Modifiable Risk Factors of BMI

A linear regression model was fitted for all the factors assessed under section 4.4.6 in addition, independent variables of the KAP scores, food frequency of consumption of every of the 16 food groups, frequency of consumption of meals in a day and number of children and the response variable BMI. A significant association was established for the number of children a respondent had (p=0.015, beta=0.758); a unit increase in number of children resulted in a 0.758 increase in the BMI of the woman. In addition, a significant association was established between BMI and the time of last meal (OR=3.50; 95% CI, 1.19-10.32) and frequency of consumption of flesh meat (OR=3.32; 95% CI, 1.04-10.58). See Table 4 2 (a) below.

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Table 4 2: Modifiable risk factors of obesity and anthropometric measurements among WRA in Vihiga County.

Tables 4 2 illustrates the modifiable risk factors of BMI (table 4 2 a), waist circumference (Table 4 2 b) and waist hip ratio (Table 4 2 c)

Table 4 2 (a) shows that the more children a woman had they were 2.13 times more likely to be obese compared to those with less children. Moreover, increase in the frequency of consumption of flesh meat per week and consuming the last meal of the day past 8pm increased the likelihood of a woman in the County having a high BMI by 3.32 times and 3.50 times, respectively.

Table 4 2 (a): Modifiable risk factors of BMI among WRA

			95% CI for OR		
Factor	**N**	**OR**	**Lower**	**Upper**	**P-value**
Number of hours slept (weekday)	106	0.93	0.35	2.51	0.891
Number of hours slept (weekend)	106	0.92	0.35	2.40	0.862
Consumption of RTEs	106	0.24	0.03	1.96	0.180
IDDS	106	1.02	0.29	3.64	0.974
WDDS	106	0.74	0.19	2.95	0.675
Physical Activity (MET/min-week)	106	1.00	0.99	1.00	0.503
Physical Activity (Total Weighted)	106	0.98	0.95	1.02	0.346
Food Security Score	106	0.84	0.70	1.01	0.068
Time of last meal	106	3.50	1.19	10.32	**0.023**
Smoking Status	106	9.62	0.00	5.04	0.631
Alcohol Use	106	0.44	0.00	6.87	0.920
Contraceptive Use	106	4.78	0.55	41.19	0.155
Knowledge Score	106	1.06	0.83	1.35	0.653
Attitude score	106	1.01	0.68	1.49	0.978
Practice Score	106	1.66	0.31	8.98	0.559
Number of children	106	2.13	1.16	3.93	**0.015**
Number of meals consumed in a day	106	0.99	0.17	5.77	1.000
Frequency of consumption of a food group					
Cereals	106	1.66	0.58	4.82	0.350
White tubers or roots	106	0.38	0.13	1.14	0.085
Dark green vegetables	106	1.15	0.52	2.54	0.726
Other vegetables	106	1.27	0.51	3.17	0.606
Vitamin A rich fruits	106	2.48	0.99	6.23	0.054
Other fruits	106	0.66	0.21	2.07	0.480
Organ meat	106	0.66	0.15	2.89	0.586
Flesh meat	106	3.32	1.04	10.58	**0.043**
Eggs	106	0.61	0.19	1.94	0.402
Fish and seafood	106	1.50	0.30	7.49	0.623
Legumes/nuts and seeds	106	1.67	0.38	7.33	0.495
Milk and milk products	106	1.16	0.57	2.35	0.678
Oils and fats	106	0.27	0.07	1.09	0.065
Sugar	106	0.96	0.49	1.88	0.916
Spices and condiments	106	1.05	0.46	2.36	0.916

4.4.9.2 Modifiable Risk Factors of Waist Circumference

A generalized linear regression was fitted for all the factors assessed under section 4.4.7 in addition, independent variables of the KAP scores, food frequency of consumption of every of the 16 food groups, frequency of consumption of meals in a day and number of children and the response variable WC. A significant association was established for the number of children a respondent had (p=0.009, OR= 7.51: 95% CI, 1.67-33.88); increase in the number of children increased the likelihood by 7.51 times of having central obesity. Similarly, frequently consuming flesh meats increased the risk of central obesity by 20.45 times (OR=20.45; 95% CI, 1.20-348.62) $p<0.05$. Furthermore a statistically significant association was noted between the frequency of consumption of white roots and tubers and frequency of consumption of organ meats; however, increasing the frequency of consumption of the two food group was protective against central obesity (OR=0.05; 95% CI, 0.01-0.72) and (OR=0.01; 95% CI, 0.009-0.2), respectively.

Table 4 2 (b) below reports the modifiable risk factors of central obesity among the women of reproductive age in Vihiga County.

Table 4 2 (b): Modifiable risk factors of waist circumference among WRA

			95% CI for OR		
Factor	**N**	**OR**	**Lower**	**Upper**	**P-value**
Number of hours slept (weekday)	106	0.44	0.04	5.16	0.517
Number of hours slept (weekend)	106	2.03	0.20	21.12	0.552
Consumption of RTEs	106	0.01	0.00	2.57	0.108
IDDS	106	0.27	0.01	5.86	0.401
WDDS	106	4.45	0.15	131.43	0.387
Physical Activity (MET/min-week)	106	1.00	1.00	1.00	0.428
Physical Activity (Total Weighted)	106	0.95	0.87	1.04	0.295
Food Security Score	106	0.78	0.50	1.22	0.280
Time of last meal	106	7.27	0.51	103.03	0.143
Smoking Status	106	0.00	0.00	20.54	0.622
Alcohol Use	106	2.00	0.00	5.00	0.469
Contraceptive Use	106	78.86	0.41	105.26	0.103
Knowledge Score	106	1.15	0.63	2.09	0.656
Attitude score	106	1.38	0.52	3.64	0.518
Practice Score	106	2.97	0.05	186.86	0.606
Number of children	106	7.51	1.67	33.88	**0.009**
Number of meals consumed in a day	106	1.30	0.02	94.13	0.905
Frequency of consumption of a food group					
Cereals	106	0.03	0.16	3.09	0.643
White tubers or roots	106	0.05	0.01	0.72	**0.027**
Dark green vegetables	106	0.94	0.14	6.49	0.948
Other vegetables	106	0.59	0.06	5.52	0.644
Vitamin A rich fruits	106	5.63	0.59	54.05	0.135
Other fruits	106	0.36	0.02	5.86	0.476
Organ meat	106	0.01	0.009	0.12	**0.002**
Flesh meat	106	20.45	1.20	348.62	**0.037**
Eggs	106	0.56	0.03	9.50	0.690
Fish and seafood	106	5.39	0.11	275.34	0.402
Legumes/nuts and seeds	106	5.54	0.15	202.84	0.351
Milk and milk products	106	0.75	0.13	4.31	0.750
Oils and fats	106	0.63	0.02	19.31	0.789
Sugar	106	1.63	0.30	8.85	0.573
Spices and condiments	106	1.20	0.16	8.74	0.857

4.4.9.3 Modifiable Risk Factors of Waist Hip Ratio

Similarly, generalized linear regression analysis was fitted for all factors assessed under section4.4.8 and the independent variables of KAP scores, food frequency of intake of the 16 food groups, number of meals eaten in a day and number of children to account for confounders. A statistically effect association was established between WHR and the frequency of consumption of sugar (OR- 1.015; 95% CI, 1.002-1.028), $p< 0.05$.

Table 4 2 (c) below shows that frequently consuming sugar in a week among the respondents resulted in an increased risk of metabolic disorders by 1.015 times.

Table 4 2 (c): Modifiable risk factors of waist hip ratio among WRA

			95% for OR		
Factor	**N**	**OR**	**Lower**	**Upper**	**P-value**
Number of hours slept (weekday)	106	1.004	0.986	1.023	0.674
Number of hours slept (weekend)	106	1.001	0.983	1.018	0.934
Consumption of RTEs	106	1.002	0.963	1.042	0.934
IDDS	106	0.993	0.970	1.016	0.538
WDDS	106	1.008	0.983	1.034	0.519
Physical Activity (MET/min-week)	106	1.000	1.000	1.000	0.908
Physical Activity (Total Weighted)	106	1.000	0.999	1.001	0.800
Food Security Score	106	1.003	1.000	1.007	0.076
Time of last meal	106	0.998	0.977	1.018	0.815
Smoking Status	106	0.990	0.835	1.175	0.912
Alcohol Use	106	0.924	0.690	1.238	0.598
Contraceptive Use	106	0.997	0.958	1.037	0.869
Knowledge Score	106	1.004	0.999	1.008	0.089
Attitude score	106	1.003	0.996	1.011	0.399
Practice Score	106	1.001	0.970	1.032	0.975
Number of children	106	1.009	0.998	1.021	0.123
Number of meals consumed in a day	106	0.980	0.948	1.013	0.229
Frequency of consumption of a food group					
Cereals	106	1.000	0.989	1.011	0.974
White tubers or roots	106	1.001	0.981	1.021	0.919
Dark green vegetables	106	1.000	0.985	1.016	0.975
Other vegetables	106	0.993	0.976	1.011	0.431
Vitamin A rich fruits	106	1.008	0.992	1.026	0.332
Other fruits	106	0.980	0.960	1.001	0.064
Organ meat	106	0.984	0.958	1.011	0.245
Flesh meat	106	1.016	0.994	1.039	0.162
Eggs	106	0.994	0.973	1.015	0.588
Fish and seafood	106	1.011	0.981	1.041	0.484
Legumes/nuts and seeds	106	1.001	0.973	1.030	0.932
Milk and milk products	106	0.995	0.982	1.009	0.473
Oils and fats	106	0.999	0.973	1.025	0.926
Sugar	106	1.015	1.002	1.028	**0.025**
Spices and condiments	106	1.005	0.990	1.020	0.550

4.5 Discussion

4.5.1 Modifiable risk factors of obesity among women of reproductive age in Vihiga County

4.5.1.1 Modifiable risk factors of high BMI

The current study reported that the number of children born to a woman, the frequency of consumption of flesh meat and the time of consumption of the last meal of the day were risk factors of obesity, $p<0.05$. The link between parity, particularly the number of children and BMI has been explored (Al Kibria et al., 2019; Mamun & Finlay, 2015; Were et al., 2020). According to Mamun & Finlay, (2015), parity could result in obesity due to pre and post-partum weight gain and retention, respectively, regardless of a nutrient deficit food supply. It is postulated that during pregnancy, caloric requirements and the basal metabolic rate increase gradually throughout the trimesters in support of fetal development; half of the weight gained is attributed to the fetus while 25% is attributed to increase in breast tissue and blood volume, this leaves the remaining 25% as maternal fat that is often retained following child birth (Champion & Harper, 2020).

Frequently consuming flesh meats by women in this study increased the risk of having a high BMI by 3.32 times. This finding collaborate those of Paulo et al., (2022) that reported a higher likelihood of obesity among women of reproductive age who frequently consumed flesh meat in Tanzania. Animal flesh meat contain high amounts of saturated fats and are rich in energy (Keding et al., 2013; Paulo et al., 2022), thus, frequent consumption amidst sedentary lifestyle may lead to accumulation of fat in the body and consequently, obesity.Women who ate later than 8 p.m. were at higher risk of obesity, they were 3.50 times more likely to be obese; this finding corroborates that of Bernardes da Cunha et al., (2023) that reported that individuals who had their last meal on average at 2203 hours had a higher probability of high BMI compared to those who ate their last meal on average at 1838 hours. Increase in melatonin during the night as bedtime approaches impairs glucose tolerance that can lead to increased adiposity and obesity (Lopez-Minguez et al., 2019).

4.5.1.2 Modifiable risk factors of high Waist Circumference

According to this study, waist circumference was associated with the number of children a woman had, frequency of consumption of organ meats, frequency of consuming white tubers and roots, and the frequency of consumption of flesh meat. The more children a woman had, they

were 7.51 times more likely to have central obesity and this may be due to pre-partum weight gain and post-partum weight retention (Mamun & Finlay, 2015) for reasons similar to those explained for BMI. The consumption of white tubers and roots and organ meats was protective against high waist circumference. Increase in consumption of white tubers and roots was reported to be positively correlated with increase in central obesity in one study (Peng et al., 2019). Nonetheless, the study classified white tubers and roots as one of a few food groups that characterized the urban diet; the food group was not evaluated in isolation. Furthermore the divergence in findings, this study reports the food group protective against obesity, may be due to the high fiber levels in white tubers and roots; evidence suggests that high fiber consumption is associated with low adiposity (Sawicki et al., 2021).

In one study there was no association between consumption of organ meats and central obesity but some flesh, particularly processed meats were linked to central obesity due to their high energy and saturated fats content (Keding et al., 2013; Khodayari et al., 2022). The protective factor of organ meats against central obesity, as reported in this study, may be due to their rich iron content. Iron deficiency and anemia particularly in women has been positively correlated with central obesity (Jordaan et al., 2020; Kerkadi et al., 2021).

4.5.1.3 Modifiable risk factors of Waist Hip Ratio

This study reported that frequently consuming sugar increased the risk of having increased risk of metabolic disorders by 1.015 times. The link between sugar intake and adiposity is attributed to high caloric content of sugar that is coupled with low satiety from sugar, and in the long term increase in insulin secretion and storage of fat (Ardeshirlarijani et al., 2021).

4.6 Conclusion

This study paper provides the first evidence of modifiable risk factors of obesity among WRA in Vihiga County.The time of last meal, number of children born to a woman and frequency of consumption of flesh meat were modifiable risk factors of BMI whereas, the number of children born to a woman , frequently consuming white tubers or roots, flesh meats and organ meats were modifiable risk factors of waist circumference. Furthermore, frequently consuming sugar increased the risk of metabolic disorders regarding waist hip ratio. Dietary factors were majorly implicated as determinants of obesity, it is imperative for the county government to increase sensitization and nutrition education focusing on diets and diet quality.

CHAPTER FIVE
GENERAL CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This is the first study based on published peer-reviewed articles that provides county level evidence on the prevalence of obesity and its determinants among women of reproductive age in Vihiga County, a largely rural setting. This study identified that the sociodemographic profile of the women was largely youthful with most women aged between 15-21 years. Majority of them had attained secondary school education and their gross household income ranged between 1000-5000 Kenya Shillings ($7-35).

In addition, the study showed that the prevalence of obesity has almost doubled, 13.2%, since 2014 where the reported prevalence was 7%. Almost half of the women had central obesity with 25.5% of them having increased risk of metabolic disorders regarding their waist hip ratio. Obesity in the county among women of reproductive age was caused by both non modifiable and modifiable risk factors. The non-modifiable risk factors of obesity were age, marital status and education level. Contrastingly, the modifiable risk factors were mainly dietary including, frequency of consumption of flesh meat that had the most effect by increasing the women's risk to obesity by 20.45 times, frequently consuming sugar and, two that were protective against obesity including frequently consuming white tubers or roots and frequently consuming organ meats. The number of children born to a woman also increased the women's risk of having a high BMI, waist circumference and waist hip ratio.

This study has significant policy consequences, since the prevalence of obesity in the county is on an increasing trend; there is scarcity of studies that have explored the determinants of the rising burden of obesity among women of reproductive age. Prioritization and implementation of strategies to prevent and manage obesity among the target group requires accessibility to up to date data on the risk factors of obesity. The current study has provided the relevant risk factors of obesity that will be critical in informing policy approaches targeting prevention of obesity as a risk factor in the county and minimizing and halting the rising burden of NCDs as highlighted in the health policy objectives in the Vihiga county integrated development plans 2023-2027.

5.2 Recommendations

This study explored a sub-national study setting which are often overlooked but provide critical data in the national nutrition assessment data. From this study, it emerged that the following suffice as short-term actions of addressing increasing obesity rates among women:

1. Routine obesity screening should be included in the primary care package at health and hospital institutions and at community level to ease early detection of women at high risk of obesity, consequently, prevention and early management of obesity.
2. Sensitization strategies including nutrition education and promotion is critical in increasing awareness of the modifiable risk factors of obesity which were mainly dietary and lifestyle related.
3. Raising awareness on the influence of non-modifiable risk factors such as age and marital status will be significant in reducing the obesity burden for example; encouraging women to attain some level of basic education and increasing accessibility to basic education among the target group may reduce the risk of central obesity among women in the county.
4. Policy makers and the County government need to acknowledge the identified risk factors during planning, prioritization, design, implementation and evaluation of interventions targeting the reduction of the obesity burden in the county
5. Future research is required to determine the most effective weight gain prevention and management interventions among women of reproductive age in Vihiga County to ensure prevention and management approaches employed are cost effective, efficient and sustainable.
6. Future research should explore other risk factors that may have not been identified in this study i.e. iron deficiency or anemia may be one of the risk factors of obesity as reported by findings of this study. In depth analysis should be done in this topic area.

REFERENCES

Abrha, S., Shiferaw, S., & Ahmed, K. Y. (2016). Overweight and obesity and its socio-demographic correlates among urban Ethiopian women: Evidence from the 2011 EDHS. *BMC Public Health*, *16*(1), 1–7. https://doi.org/10.1186/s12889-016-3315-3

Acheampong, I., & Haldeman, L. (2013). Are nutrition knowledge, attitudes, and beliefs associated with obesity among low-income hispanic and African American women caretakers? *Journal of Obesity*, *January 1*. https://doi.org/10.1155/2013/123901

Aggarwal, A., Monsivais, P., Cook, A. J., & Drewnowski, A. (2014). Positive attitude toward healthy eating predicts higher diet quality at all cost levels of supermarkets. *Journal of the Academy of Nutrition and Dietetics*, *114*(2), 266–272. https://doi.org/10.1016/j.jand.2013.06.006

Ahmed, K. Y., Rwabilimbo, A. G., Abrha, S., Page, A., Arora, A., Tadese, F., Beyene, T. Y., Seiko, A., Endris, A. A., Agho, K. E., & Ogbo, F. A. (2020). Factors associated with underweight, overweight, and obesity in reproductive age Tanzanian women. *PLOS ONE*, *15*(8), e0237720. https://doi.org/10.1371/JOURNAL.PONE.0237720

Al Kibria, G. M., Swasey, K., Hasan, M. Z., Sharmeen, A., & Day, B. (2019). Prevalence and factors associated with underweight, overweight and obesity among women of reproductive age in India. *Global Health Research and Policy*, *4*(1), 1–12. https://doi.org/10.1186/S41256-019-0117-Z/TABLES/4

Alaei, M., Pourshams, A., Altaha, N., Goglani, G., & Jafari, E. (2013). Obtaining informed consent in an illiterate population. *Middle East Journal of Digestive Diseases*, *5*(1), 37–40. https://doi.org/10.15171/middleeastjdi.v5i1.1093

Alemu, E., & Atnafu, A. (2014). Prevalence of Overweight and/or Obesity and Associated Factors among High School Adolescents in Arada Sub city, Addis Ababa, Ethiopia. *Journal of Nutrition & Food Sciences*, *04*(02), 261. https://doi.org/10.4172/2155-9600.1000261

Alkema, L., Chou, D., Hogan, D., Zhang, S., Moller, A.-B., Gemmill, A., Fat, D. M., Boema, T., & Temmerman, M. (2016). National, Regional ang Global levels and trend in MMR

between 1990 and 2015. *The Lancet*, *387*(10017), 462–474. https://doi.org/10.1016/S0140-6736(15)00838-7.National

Ardern, C. I., & Kanagasabai, T. (2019). Sleep, Abdominal Obesity, and Metabolic Syndrome. In *Nutrition in the Prevention and Treatment of Abdominal Obesity* (2nd ed.). Elsevier Inc. https://doi.org/10.1016/b978-0-12-816093-0.00001-x

Ardeshirlarijani, E., Jalilpiran, Y., Daneshzad, E., Larijani, B., Namazi, N., & Azadbakht, L. (2021). Association between sugar-sweetened beverages and waist circumference in adult populations: A meta-analysis of prospective cohort studies. *Clinical Nutrition ESPEN*, *41*, 118–125. https://doi.org/10.1016/j.clnesp.2020.10.014

Arenas, D. J., Thomas, A., Wang, J. C., & DeLisser, H. M. (2019). A Systematic Review and Meta-analysis of Depression, Anxiety, and Sleep Disorders in US Adults with Food Insecurity. In *Journal of General Internal Medicine* (Vol. 34, Issue 12, pp. 2874–2882). Springer. https://doi.org/10.1007/s11606-019-05202-4

Banerjee, S., Radak, T., Khubchandani, J., & Dunn, P. (2020). Food Insecurity and Mortality in American Adults: Results From the NHANES-Linked Mortality Study. *Https://Doi.Org/10.1177/1524839920945927*, *22*(2), 204–214. https://doi.org/10.1177/1524839920945927

Baron, K. G., Reid, K. J., Kern, A. S., & Zee, P. C. (2009). Role of Sleep Timing in Caloric Intake and BMI. *Obesity*, *19*(7), 1374–1381. https://doi.org/10.1038/oby.2011.100

Becerra, B. J., Sis-Medina, R. C., Reyes, A., & Becerra, M. B. (2015). Association between food insecurity and serious psychological distress among hispanic adults living in poverty. *Preventing Chronic Disease*, *12*(11). https://doi.org/10.5888/pcd12.150334

Benjamin, E. J., Virani, S. S., Callaway, C. W., Chamberlain, A. M., Chang, A. R., Cheng, S., Chiuve, S. E., Cushman, M., Delling, F. N., Deo, R., De Ferranti, S. D., Ferguson, J. F., Fornage, M., Gillespie, C., Isasi, C. R., Jiménez, M. C., Jordan, L. C., Judd, S. E., Lackland, D., … Muntner, P. (2018). Heart disease and stroke statistics - 2018 update: A report from the American Heart Association. *Circulation*, *137*(12), E67–E492. https://doi.org/10.1161/CIR.0000000000000558

Bernardes da Cunha, N., Teixeira, G. P., Madalena Rinaldi, A. E., Azeredo, C. M., & Crispim, C. A. (2023). Late meal intake is associated with abdominal obesity and metabolic disorders related to metabolic syndrome: A chrononutrition approach using data from NHANES 2015–2018. *Clinical Nutrition*, *42*(9), 1798–1805. https://doi.org/10.1016/j.clnu.2023.08.005

Bishwajit, G. (2017). Household wealth status and overweight and obesity among adult women in Bangladesh and Nepal. *Obesity Science and Practice*, *3*(2), 185–192. https://doi.org/10.1002/osp4.103

Biswas, T., Magalhaes, R. J. S., Townsend, N., Das, S. K., & Mamun, A. (2020). Double Burden of Underweight and Overweight among Women in South and Southeast Asia: A Systematic Review and Meta-analysis. *Advances in Nutrition (Bethesda, Md.)*, *11*(1), 128–143. https://doi.org/10.1093/ADVANCES/NMZ078

Boney, C. M., Verma, A., Tucker, R., & Vohr, B. R. (2005). Metabolic syndrome in childhood: Association with birth weight, maternal obesity, and gestational diabetes mellitus. *Pediatrics*, *115*(3). https://doi.org/10.1542/peds.2004-1808

Champion, M. L., & Harper, L. M. (2020). Gestational Weight Gain: Update on Outcomes and Interventions. In *Current Diabetes Reports* (Vol. 20, Issue 3, pp. 1–10). Springer. https://doi.org/10.1007/s11892-020-1296-1

Chowdhury, M. A. B., Adnan, M. M., & Hassan, M. Z. (2018). Trends, prevalence and risk factors of overweight and obesity among women of reproductive age in Bangladesh: a pooled analysis of five national cross-sectional surveys. *BMJ Open*, *8*(7), e018468.

Chowdhury, M. A. B., Uddin, M. J., Haque, M. R., & Ibrahimou, B. (2016). Hypertension among adults in Bangladesh: Evidence from a national cross-sectional survey. *BMC Cardiovascular Disorders*, *16*(1), 1–10. https://doi.org/10.1186/s12872-016-0197-3

Chowdhury, M. A. B., Uddin, M. J., Khan, H. M. R., & Haque, M. R. (2015). Type 2 diabetes and its correlates among adults in Bangladesh: a population based study. *BMC Public Health*, *15*(1), 1–11. https://doi.org/10.1186/s12889-015-2413-y

Christensen, D. L., Eis, J., Hansen, A. W., Larsson, M. W., Mwaniki, D. L., Kilonzo, B., Tetens, I., Boit, M. K., Kaduka, L., Borch-Johnsen, K., & Friis, H. (2008). Obesity and regional fat distribution in Kenyan populations: Impact of ethnicity and urbanization. *Annals of Human Biology*, *35*(2), 232–249. https://doi.org/10.1080/03014460801949870

Coleman-Jensen, A., Rabbitt, M., & Singh, A. (2020). *Household Food Security in the United States in 2019*.

County Government of Vihiga. (2023). *County Integrated Development Plan 2023-2027* (Vol. 3). https://vihiga.go.ke/financial_announceme/county-integrated-development-plan-2023-2027/

Cowen, P. J. (2002). Cortisol, serotonin and depression: All stressed out? In *British Journal of Psychiatry* (Vol. 180, Issue FEB., pp. 99–100). https://doi.org/10.1192/bjp.180.2.99

Dashti, S. H., Scheer, A. F., Jasques, F. P., Lamon-fava, S., & Ordovas, J. M. (2015). Short Sleep Duration and Dietary Intake : Epidemiologic Evidence , Mechanisms , and Health Implications. *Adv Nutr.*, *6*(6), 648–659. https://doi.org/10.3945/an.115.008623.648

Demmler, K. M., Ecker, O., & Qaim, M. (2017). Supermarket Shopping and Nutritional Outcomes: A Panel Data Analysis for Urban Kenya. *GlobalFood Discussion Paper*, *102*(March), 91. https://doi.org/10.1016/j.worlddev.2017.07.018

Ding, C., Lim, L. L., Xu, L., Pik, A., & Kong, S. (2018). Sleep and Obesity. *Journal of Obesity and Metabolic Syndrome*, *27*(1), 4–24.

Duffey, K. J., Gordon-larsen, P., Steffen, L. M., Jr, D. R. J., & Popkin, B. M. (2009). Regular Consumption from Fast Food Establishments Relative to Other Restaurants Is Differentially Associated with Metabolic Outcomes in Young Adults 1 , 2. *The Journal of Nutrition*, *139*(11), 2113–2118. https://doi.org/10.3945/jn.109.109520.The

FAO. (2009). Declaration of the World Summit on Food Security. *World Food Summit, November 2009*, 16–18. https://reliefweb.int/report/world/declaration-world-summit-food-security-wsfs-20092

FAO. (2012). Coming to terms with terminology. *Rome: The Nutrition and Consumer Protection*

Division of the Food and Agriculture Organization.

Fisher, A. L. J. S. J. T. (1991). *Handbook for family planning operations research design. 2nd ed. TT -. 1991*.

Food and Agriculture Organization. (2014). Guidelines for assessing nutrition-related Knowledge , Attitudes and Practices manual. In *Control* (Vol. 19, Issue 1). https://doi.org/10.3354/ame037063

Hasan, E., Khanam, M., & Shimul, S. N. (2020). Socio-economic inequalities in overweight and obesity among women of reproductive age in Bangladesh: a decomposition approach. *BMC Women's Health*, *20*(1), 1–11. https://doi.org/10.1186/s12905-020-01135-x

Hashan, M. R., Das Gupta, R., Day, B., & Al Kibria, G. M. (2020). Differences in prevalence and associated factors of underweight and overweight/obesity according to rural-urban residence strata among women of reproductive age in Bangladesh: Evidence from a cross-sectional national survey. In *BMJ Open* (Vol. 10, Issue 2, p. e034321). British Medical Journal Publishing Group. https://doi.org/10.1136/bmjopen-2019-034321

Hashan, M. R., Rabbi, M. F., Haider, S. S., & Gupta, R. Das. (2020). Prevalence and associated factors of underweight, overweight and obesity among women of reproductive age group in the Maldives: Evidence from a nationally representative study. *PLOS ONE*, *15*(10), e0241621. https://doi.org/10.1371/JOURNAL.PONE.0241621

Hausmann-Muela, S., & Ribera, J. (2003). Healthseeeking behavior and health system response. *DCPP Working Paper No. 14*, 1–37. http://pass-international.org/site/images/stories/publications/DCPP_Working_Paper_14_No_Health_seeking_behaviour_and_the_health_system_response.pdf

Hendriks, S. L. (2015). The food security continuum: a novel tool for understanding food insecurity as a range of experiences. *Food Security*, *7*(3), 609–619. https://doi.org/10.1007/S12571-015-0457-6

Hillier-Brown, F. C., Summerbell, C. D., Moore, H. J., Routen, A., Lake, A. A., Adams, J., White, M., Araujo-Soares, V., Abraham, C., Adamson, A. J., & Brown, T. J. (2017). The

impact of interventions to promote healthier ready-to-eat meals (to eat in, to take away or to be delivered) sold by specific food outlets open to the general public: a systematic review. *Obesity Reviews*, *18*(2), 227–246. https://doi.org/10.1111/obr.12479

Hosseini, Z., Veenstra, G., Khan, N. A., & Conklin, A. I. (2020). Associations between social connections, their interactions, and obesity differ by gender: A population-based, cross-sectional analysis of the Canadian Longitudinal Study on Aging. *PLoS ONE*, *15*(7 July). https://doi.org/10.1371/JOURNAL.PONE.0235977

Howard, S., Adams, J., & White, M. (2012). Nutritional content of supermarket ready meals and recipes by television chefs in the United Kingdom : cross sectional study. *BMJ*, *7607*(December), 1–10. https://doi.org/10.1136/bmj.e7607

Hunter-Adams, J., Battersby, J., & Oni, T. (2019). Food insecurity in relation to obesity in peri-urban Cape Town, South Africa: Implications for diet-related non-communicable disease. *Appetite*, *137*, 244–249. https://doi.org/10.1016/j.appet.2019.03.012

Id, S. A. B., Mumbo, A. A., Alak, A. C. D., Sebit, W., Ndung, J. M., Rumunu, J., & Bie, S. (2018). Knowledge , attitudes and practices about human African trypanosomiasis and their implications in designing intervention strategies for Yei county , South Sudan. *PLOS Neglected Tropical Diseases*, *12*(10), 1–20.

Jensen, G. L., Hsiao, P. Y., & Wheeler, D. (2012). Adult nutrition assessment tutorial. *Journal of Parenteral and Enteral Nutrition*, *36*(3), 267–274. https://doi.org/10.1177/0148607112440284

Jordaan, E. M., Van den Berg, V. L., Van Rooyen, F. C., & Walsh, C. M. (2020). Obesity is associated with anaemia and iron deficiency indicators among women in the rural Free State, South Africa. *South African Journal of Clinical Nutrition*, *33*(3), 72–78. https://doi.org/10.1080/16070658.2018.1553361

Keding, G. B., Msuya, J. M., Maass, B. L., & Krawinkel, M. B. (2013). Obesity as a public health problem among adult women in rural Tanzania. *Global Health Science and Practice*, *1*(3), 359–371. https://doi.org/10.9745/GHSP-D-13-00082

Kelly, B., King, L., Chapman, K., Boyland, E., Bauman, A. E., & Baur, L. A. (2015). A hierarchy of unhealthy food promotion effects: Identifying methodological approaches and knowledge gaps. In *American Journal of Public Health* (Vol. 105, Issue 4, pp. e86–e95). Am J Public Health. https://doi.org/10.2105/AJPH.2014.302476

Kenya National Bureau of Statistics. (2019). 2019 Kenya Population and Housing Census Volume 1: Population by County and Sub-County. In *2019 Kenya Population and Housing Census: Vol. I* (Issue November). https://www.knbs.or.ke/?wpdmpro=2019-kenya-population-and-housing-census-volume-i-population-by-county-and-sub-county

Kerkadi, A., Ali, R. M., Shehada, A. A. H., AbouHassanein, E. A., Moawad, J., Bawadi, H., & Shi, Z. (2021). Association between central obesity indices and iron status indicators among Qatari adults. *PLoS ONE*, *16*(4 April). https://doi.org/10.1371/journal.pone.0250759

Khodayari, S., Sadeghi, O., Safabakhsh, M., & Mozaffari-Khosravi, H. (2022). Meat consumption and the risk of general and central obesity: the Shahedieh study. *BMC Research Notes*, *15*(1), 1–9. https://doi.org/10.1186/s13104-022-06235-5

Kiarie, H. et al. (2019). Lifestyle Diseases– An Increasing Cause Of Health Loss. *Policy Brief*.

Kissebah, A. H., Freedman, D. S., & Peiris, A. N. (1989). Health risks of obesity. *Medical Clinics of North America*, *73*(1), 111–138. https://doi.org/10.1016/S0025-7125(16)30695-2

Kite, J., Gale, J., Grunseit, A., Li, V., Bellew, W., & Bauman, A. (2018). From awareness to behaviour: Testing a hierarchy of effects model on the Australian Make Healthy Normal campaign using mediation analysis. *Preventive Medicine Reports*, *12*(August), 140–147. https://doi.org/10.1016/j.pmedr.2018.09.003

KNBS, & ICF. (2023). *Kenya Demographic and Health Survey 2022: Volume 1*. https://dhsprogram.com/publications/publication-fr380-dhs-final-reports.cfm

Koirala, M., Bajracharya, S., & Koirala, L. (2019). Risk Factors for Obesity in Nepalese Women : A Cross-sectional Study. *Journal of Lumbini Medical College*, *7*(2), 93–99.

Koome, M. M. (2016). *Household's knowledge, attitude and food handling practices, consumption of traditional fermented milk and risk factors for adult overweight and obesity*

in Isiolo Central sub County.

Kulie, T., Slattengren, A., Redmer, J., Counts, H., Eglash, A., & Schrager, S. (2011). Obesity and women's health: An evidence-based review. *Journal of the American Board of Family Medicine*, *24*(1), 75–85. https://doi.org/10.3122/jabfm.2011.01.100076

Launiala, A. (2009). How much can a KAP survey tell us about people's knowledge, attitudes and practices? Some observations from medical anthropology research on malaria in pregnancy in Malawi. *Anthropology Matters*, *11*(1), 1–13. http://www.anthropologymatters.com/index.php?journal=anth_matters&page=article&op=view&path[]=31&path[]=53

Lopez-Minguez, J., Gómez-Abellán, P., & Garaulet, M. (2019). Timing of breakfast, lunch, and dinner. Effects on obesity and metabolic risk. In *Nutrients* (Vol. 11, Issue 11). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/nu11112624

Lukwa, A. T., Odunitan-Wayas, F., Lambert, E. V., & Alaba, O. A. (2022). Can Informal Savings Groups Promote Food Security and Social, Economic and Health Transformations, Especially among Women in Urban Sub-Saharan Africa: A Narrative Systematic Review. In *Sustainability (Switzerland)* (Vol. 14, Issue 6, p. 3153). Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/su14063153

Lytle, L. A. (2009). Measuring the Food Environment. State of the Science. *American Journal of Preventive Medicine*, *36*(4 SUPPL.), 1–18. https://doi.org/10.1016/j.amepre.2009.01.018

Mamun, A. A., & Finlay, J. E. (2015). Shifting of undernutrition to overnutrition and its determinants among women of reproductive ages in the 36 low to medium income countries. *Obesity Research and Clinical Practice*, *9*(1), 75–86. https://doi.org/10.1016/j.orcp.2014.03.001

Mangemba, N. T., & San Sebastian, M. (2020). Societal risk factors for overweight and obesity in women in Zimbabwe: A cross-sectional study. *BMC Public Health*, *20*(1), 1–8. https://doi.org/10.1186/S12889-020-8215-X/TABLES/2

MapTools. (2023). *UTM Grid Zones of the World*.

Mathers, C. D., & Loncar, D. (2006). Projections of global mortality and burden of disease from 2002 to 2030. *PLoS Medicine*, *3*(11), 2011–2030. https://doi.org/10.1371/journal.pmed.0030442

McAllister, E. J., Dhurandhar, N. V., Keith, S. W., Aronne, L. J., Barger, J., Baskin, M., Benca, R. M., Biggio, J., Boggiano, M. M., Eisenmann, J. C., Elobeid, M., Fontaine, K. R., Gluckman, P., Hanlon, E. C., Katzmarzyk, P., Pietrobelli, A., Redden, D. T., Ruden, D. M., Wang, C., … Allison, D. B. (2009). Ten putative contributors to the obesity epidemic. *Critical Reviews in Food Science and Nutrition*, *49*(10), 868–913. https://doi.org/10.1080/10408390903372599

McGuire, W. J. (1984). Public communication as a strategy for inducing health-promoting behavioral change. *Preventive Medicine*, *13*(3), 299–319. https://doi.org/10.1016/0091-7435(84)90086-0

Mehboob, B., Safdar, N. F., & Zaheer, S. (2016). obesity among Pakistani women : A Systematic Review Socio-economic , environmental and demographic determinants of rise in obesity among Pakistani women: A Systematic Review. *Journal of the Pakistan Medical Association*, *66*(9), 1165–1172.

Mkuu, R., Barry, A., Yonga, G., Nafukho, F., Wernz, C., Gilreath, T., Chowdhury, M. A. B., & Shevon Harvey, I. (2021). Prevalence and factors associated with overweight and obesity in Kenya. *Preventive Medicine Reports*, *22*, 101340. https://doi.org/10.1016/j.pmedr.2021.101340

Mkuu, R. S., Epnere, K., Chowdhury, M. A. B., Abdul, M., & Chowdhury, B. (2018). Prevalence and Predictors of Overweight and Obesity Among Kenyan Women. *Preventing Chronic Diseases*, *15*(44), 1–10. https://doi.org/10.5888/pcd15.170401

MoH-Kenya. (2015). Kenya STEPwise Survey for Non Communicable Diseases Risk Factors 2015 Report. *Public Health*, *5*(7), 8–210. https://doi.org/10.1007/s11605-008-0794-2

MOH. (2014). *Kenya Health Policy*. https://doi.org/10.1007/s13398-014-0173-7.2

Mukora-Mutseyekwa, F., Zeeb, H., Nengomasha, L., & Adjei, N. K. (2019). Trends in

prevalence and related risk factors of overweight and obesity among women of reproductive age in Zimbabwe, 2005–2015. *International Journal of Environmental Research and Public Health*, *16*(15), 2758. https://doi.org/10.3390/ijerph16152758

Myers, C. A., Beyl, R. A., Martin, C. K., Broyles, S. T., & Katzmarzyk, P. T. (2020). Psychological mechanisms associated with food security status and BMI in adults: A mixed methods study. *Public Health Nutrition*, *23*(14), 2501–2511. https://doi.org/10.1017/S1368980020000889

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., Mullany, E. C., Biryukov, S., Abbafati, C., Abera, S. F., Abraham, J. P., Abu-Rmeileh, N. M. E., Achoki, T., Albuhairan, F. S., Alemu, Z. A., Alfonso, R., Ali, M. K., Ali, R., Guzman, N. A., … Gakidou, E. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*, *384*(9945), 766–781. https://doi.org/10.1016/S0140-6736(14)60460-8

Nguyen-Duy, T. B., Nichaman, M. Z., Church, T. S., Blair, S. N., & Ross, R. (2003). Visceral fat and liver fat are independent predictors of metabolic risk factors in men. *American Journal of Physiology - Endocrinology and Metabolism*, *284*(6 47-6), 1065–1071. https://doi.org/10.1152/ajpendo.00442.2002

NIH. (1998). Executive summary of the clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults. *Archives of Internal Medicine*, *158*(17), 1855–1867. https://doi.org/10.1001/archinte.158.17.1855

Nishida, C., Borghi, E., Branca, F., & de Onis, M. (2017). Global trends in overweight and obesity. *IARC Working Group Report 10: Energy Balance and Obesity*, *1*(May), 1–8.

Nuttall, F. Q. (2015). Body mass index: Obesity, BMI, and health: A critical review. *Nutrition Today*, *50*(3), 117–128. https://doi.org/10.1097/NT.0000000000000092

Odunitan-Wayas, F. A., Faber, M., Mendham, A. E., Goedecke, J. H., Micklesfield, L. K., Brooks, N. E., Christensen, D. L., Gallagher, I. J., Myburgh, K. H., Hunter, A. M., & Lambert, E. V. (2021). Food security, dietary intake and foodways of urban low-income

older south african women: An exploratory study. *International Journal of Environmental Research and Public Health*, *18*(8). https://doi.org/10.3390/ijerph18083973

Oti, S. O., van de Vijver, S. J. M., Agyemang, C., & Kyobutungi, C. (2013). The magnitude of diabetes and its association with obesity in the slums of Nairobi, Kenya: Results from a cross-sectional survey. *Tropical Medicine and International Health*, *18*(12), 1520–1530. https://doi.org/10.1111/tmi.12200

Paulo, H. A., Mosha, D., Mwanyika-Sando, M., Mboya, I. B., Madzorera, I., Killewo, J., Leyna, G. H., Msuya, S. E., & Fawzi, W. W. (2022). Role of dietary quality and diversity on overweight and obesity among women of reproductive age in Tanzania. *PLOS ONE*, *17*(4), e0266344. https://doi.org/10.1371/JOURNAL.PONE.0266344

Pawloski, L. R., Curtin, K. M., Gewa, C., & Attaway, D. (2012). Maternal-child overweight/obesity and undernutrition in Kenya: A geographic analysis. *Public Health Nutrition*, *15*(11), 2140–2147. https://doi.org/10.1017/S1368980012000110

Peng, W., Liu, Y., Liu, Y., Zhao, H., & Chen, H. (2019). Major dietary patterns and their relationship to obesity among urbanized adult Tibetan pastoralists. *Asia Pacific Journal of Clinical Nutrition*, *28*(3), 507–519. https://doi.org/10.6133/apjcn.201909_28(3).0010

Pervanidou, P., & Chrousos, G. P. (2011). Stress and obesity/metabolic syndrome in childhood and adolescence. *International Journal of Pediatric Obesity*, *6*(SUPPL. 1), 21–28. https://doi.org/10.3109/17477166.2011.615996

Pirouznia, M. (2001). The association between nutrition knowledge and eating behavior in male and female adolescents in the US. *International Journal of Food Sciences and Nutrition*, *52*(2), 127–132. https://doi.org/10.1080/09637480020027000-8

Pouliot, M.-C., Després, J., Lemieux, S., Moorjani, S., Bouchard, C., Tremblay, A., Nadeau, A., & Lupien, P. J. (1994). Marie-Christine Pouliot,. *The American Journal of Cardiology*, *73*(1), 460–468.

Poulsen, M. N., Bailey-Davis, L., Pollak, J., Hirsch, A. G., & Schwartz, B. S. (2019). Household Food Insecurity and Home Food Availability in Relation to Youth Diet, Body Mass Index,

and Adiposity. *Journal of the Academy of Nutrition and Dietetics*, *119*(10), 1666–1675. https://doi.org/10.1016/j.jand.2019.01.001

R Core Team. (2022). *R: A language and environment for statistical computing.* R Foundation for Statistical Computing.

Rabbitt, M. P., Smith, M. D., & Coleman-Jensen, A. (2016). Food security among hispanic adults in the United States, 2011-2014. In *Food Insecurity Among Hispanics and Immigrants in the U.S.: Selected Analyses* (pp. 1–48). https://ideas.repec.org/p/ags/uersib/262144.html

Roberts, A. L., Chen, J., Kelleman, M., Keeffe, M. O., Roychoudhury, A., & Jones, P. J. H. (2011). Short sleep duration increases energy intakes but does not change energy expenditure in normal-weight individuals 1 – 3. *American Journal of Clinical Nutrition*, *94*(2), 410–416. https://doi.org/10.3945/ajcn.111.013904.INTRODUCTION

Rosenheck, R. (2008). Fast food consumption and increased caloric intake: A systematic review of a trajectory towards weight gain and obesity risk. *Obesity Reviews*, *9*(6), 535–547. https://doi.org/10.1111/j.1467-789X.2008.00477.x

Ruddick-Collins, L. C., Morgan, P. J., Fyfe, C. L., Filipe, J. A. N., Horgan, G. W., Westerterp, K. R., Johnston, J. D., & Johnstone, A. M. (2022). Timing of daily calorie loading affects appetite and hunger responses without changes in energy metabolism in healthy subjects with obesity. *Cell Metabolism*, *34*(10), 1472-1485.e6. https://doi.org/10.1016/j.cmet.2022.08.001

Russell-Bennett, R., Leo, C., Rundle-Thiele, S., & Drennan, J. (2016). A Hierarchy-of-Effects Approach to Designing a Social Marketing Game. *Journal of Nonprofit and Public Sector Marketing*, *28*(2), 105–128. https://doi.org/10.1080/10495142.2014.988081

Sa, J., Choe, S., Cho, B. Y., Chaput, J. P., Kim, G., Park, C. H., Chung, J., Choi, Y., Nelson, B., & Kim, Y. (2020). Relationship between sleep and obesity among U.S. And South Korean college students. *BMC Public Health*, *20*(1), 1–11. https://doi.org/10.1186/s12889-020-8182-2

Sarfo, J., Pawelzik, E., & Keding, G. B. (2021). Dietary patterns as characterized by food processing levels and their association with the health outcomes of rural women in East Africa. *Nutrients*, *13*(8), 2866. https://doi.org/10.3390/NU13082866/S1

Sarma, H., Saquib, N., Hasan, M. M., Saquib, J., Rahman, A. S., Khan, J. R., Uddin, M. J., Cullen, M. R., & Ahmed, T. (2016). Determinants of overweight or obesity among ever-married adult women in Bangladesh. *BMC Obesity*, *3*(1). https://doi.org/10.1186/S40608-016-0093-5

Sawicki, C. M., Lichtenstein, A. H., Rogers, G. T., Jacques, P. F., Ma, J., Saltzman, E., & McKeown, N. M. (2021). Comparison of indices of carbohydrate quality and food sources of dietary fiber on longitudinal changes in waist circumference in the framingham offspring cohort. *Nutrients*, *13*(3), 1–16. https://doi.org/10.3390/nu13030997

Sichert-Hellert, W., Beghin, L., De Henauw, S., Grammatikaki, E., Hallström, L., Manios, Y., Mesana, M. I., Molnár, D., Dietrich, S., Piccinelli, R., Plada, M., Sjöström, M., Moreno, L. A., & Kersting, M. (2011). Nutritional knowledge in European adolescents: Results from the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study. *Public Health Nutrition*, *14*(12), 2083–2091. https://doi.org/10.1017/S1368980011001352

Silverman, J., Krieger, J., Kiefer, M., Hebert, P., Robinson, J., & Nelson, K. (2015). The Relationship Between Food Insecurity and Depression, Diabetes Distress and Medication Adherence Among Low-Income Patients with Poorly-Controlled Diabetes. *Journal of General Internal Medicine*, *30*(10), 1476–1480. https://doi.org/10.1007/s11606-015-3351-1

Stepler, R. (2015). *Statistical portrait of Hispanics in the United States, 1980--2103*. https://www.pewresearch.org/hispanic/2016/04/19/2014-statistical-information-on-hispanics-in-united-states/

Steyn, N. P., Parker, W. ah, Nel, J. H., Ayah, R., & Mbithe, D. (2011). Dietary, social, and environmental determinants of obesity in Kenyan women. *Scandinavian Journal of Public Health*, *39*(1), 88–97. https://doi.org/10.1177/1403494810384426

Story, M., & French, S. (2004). International Journal of Behavioral Food Advertising and Marketing Directed at Children and Adolescents in the US. *International Journal of*

Behavioral Nutrition and Physical Activity, *17*, 1–17. https://doi.org/10.1186/1479-5868-1-3

Swindale, A., & Bilinsky, P. (2005). Household Dietary diversity Score (HDDS) for Measurement of Household food Access: Indicator Guide. Food and Nutrition Technical Assistance. *The Journal of Nutrition*, *138*(12). www.fantaproject.org

Tanwi, T. S., Chakrabarty, S., & Hasanuzzaman, S. (2019). Double burden of malnutrition among ever-married women in Bangladesh: A pooled analysis. *BMC Women's Health*, *19*(1), 1–8. https://doi.org/10.1186/S12905-019-0725-2/TABLES/2

Te Vazquez, J., Feng, S. N., Orr, C. J., & Berkowitz, S. A. (2021). Food Insecurity and Cardiometabolic Conditions: a Review of Recent Research. *Current Nutrition Reports*, *10*(4), 243–254. https://doi.org/10.1007/S13668-021-00364-2/TABLES/2

Townsend, M. S., Peerson, J., Love, B., Achterberg, C., & Murphy, S. P. (2001). Food insecurity is positively related to overweight in women. *Journal of Nutrition*, *131*(6), 1738–1745. https://doi.org/10.1093/jn/131.6.1738

USAID. (2011). *THE KAP SURVEY MODEL*.

Vihiga County. (2021). *Vihiga Second County Integrated Development Plan 2018-2022 Mid-Term Report* (Issue August). https://vihiga.go.ke/wp-content/uploads/2022/07/CIPD-B5-size-final-draft2c.pdf

Vujović, N., Piron, M. J., Qian, J., Chellappa, S. L., Nedeltcheva, A., Barr, D., Heng, S. W., Kerlin, K., Srivastav, S., Wang, W., Shoji, B., Garaulet, M., Brady, M. J., & Scheer, F. A. J. L. (2022). Late isocaloric eating increases hunger, decreases energy expenditure, and modifies metabolic pathways in adults with overweight and obesity. *Cell Metabolism*, *34*(10), 1486-1498.e7. https://doi.org/10.1016/j.cmet.2022.09.007

Wajchenberg, B. L., Giannella-Neto, D., Da Silva, M. E. R., & Santos, R. F. (2002). Depot-specific hormonal characteristics of subcutaneous and visceral adipose tissue and their relation to the metabolic syndrome. *Hormone and Metabolic Research*, *34*(11–12), 616–621. https://doi.org/10.1055/s-2002-38256

Watson, N. F., Badr, M. S., Belenky, G., Bliwise, D. L., Buxton, O. M., Buysse, D., Dinges, D. F., Gangwisch, J., Grandner, M. A., Kushida, C., Malhotra, R. K., Martin, J. L., Patel, S. R., Quan, S., & Tasali, E. (2015). Recommended Amount of Sleep for a Healthy Adult: A Joint Consensus Statement of the American Academy of Sleep Medicine and Sleep Research Society. *Sleep*, *38*(8), 1161–1183. https://doi.org/10.5665/sleep.4716

Weigel, M. M., & Armijos, R. X. (2019). Food Insecurity, Cardiometabolic Health, and Health Care in U.S.-Mexico Border Immigrant Adults: An Exploratory Study. *Journal of Immigrant and Minority Health, 21*, 1085–1094. https://doi.org/10.1007/s10903-018-0817-3

Wen, S., & Lee, H. (2016). The impact of sleep amount and sleep quality on glycaemic control in type 2 diabetes. A systematic review and meta-analysis. *Sleep Medicine Reviews, 31*, 91–101. https://doi.org/10.1016/j.smrv.2016.02.001

Were, J. M., Stranges, S., & Creed, I. F. (2020). Fertility is a Key Predictor of the Double Burden of Malnutrition Among Women of Child-Bearing Age in Sub-Saharan Africa. *Journal of Global Health*, *10*(2). https://doi.org/10.7189/jogh.10.020423

WHO. (2008). *Waist Circumference and Waist-Hip Ratio Report of a WHO Expert Consultation* (Issue December).

WHO. (2014a). *Global Status Report On Noncommunicable Diseases 2014*.

WHO. (2014b). World Health Organization. Global Health Estimates: Deaths by Cause, Age, Sex and Country, 2000-2012. *Geneva, WHO*, *9*.

WHO. (2015). *Projections of mortality and causes of death, 2015 and 2030*. https://doi.org/10.34161/johta.2015.3.2.001

Wildman, R. P., Muntner, P., Reynolds, K., McGinn, A. P., Rajpathak, S., Wylie-Rosett, J., & Sowers, M. R. (2008). The obese without cardiometabolic risk factor clustering and the normal weight with cardiometabolic risk factor clustering prevalence and correlates of 2 phenotypes among the US population (NHANES 1999-2004). *Obstetrical and Gynecological Survey*, *63*(12), 783–784.

https://doi.org/10.1097/01.ogx.0000338100.83483.58

World Health Organization. (2003). *Globalization,Diets and Noncommunicable Diseases*. http://www.who.int/iris/handle/10665/42609

World Health Organization. (2016). *Obesity and overweight Fact Sheet*.

World Health Organization. (2021a). *Noncommunicable diseases*.

World Health Organization. (2021b). *Obesity and Overweight*. https://doi.org/10.1007/springerreference_223608

Wu, C. H., Lin, C. Y., Hsieh, Y. P., Strong, C., Meshki, C., Lin, Y. C., & Tsai, M. C. (2019). Dietary behaviors mediate the association between food insecurity and obesity among socioeconomically disadvantaged youth. *Appetite*, *132*, 275–281. https://doi.org/10.1016/j.appet.2018.10.013

Yaya, S., Ekholuenetale, M., & Bishwajit, G. (2018). Differentials in prevalence and correlates of metabolic risk factors of non-communicable diseases among women in sub-Saharan Africa: Evidence from 33 countries. *BMC Public Health*, *18*(1), 1–13. https://doi.org/10.1186/S12889-018-6085-2/TABLES/4

Yaya, S., & Ghose, B. (2019a). Trend in overweight and obesity among women of reproductive age in Uganda: 1995–2016. *Obesity Science & Practice*, *5*(4), 312–323. https://doi.org/10.1002/OSP4.351

Yaya, S., & Ghose, B. (2019b). Trend in overweight and obesity among women of reproductive age in Uganda: 1995–2016. *Obesity Science & Practice*, *5*(4), 312–323. https://doi.org/10.1002/OSP4.351

Ziraba, A. K., Fotso, J. C., & Ochako, R. (2009). Overweight and obesity in urban Africa: A problem of the rich or the poor? *BMC Public Health*, *9*, 1–9. https://doi.org/10.1186/1471-2458-9-465

APPENDIX 1: INFORMED CONSENT FORM

Hello, my name is _____ I am working together with Sonia Khavere Khatsalwa, a master's student at the University of Nairobi. I (Sonia Khavere) am doing a study that wishes to find out the causes of obesity among women aged between 15-49 years.

You will be asked to answer questions about yourself e.g. age, the work you do,amount of money you earnetc. and those that will test your knowledge, attitude and practice when it comes to factors that may cause obesity such as sleep, the foods you eat, food security ,and how active you are. Measurements of your weight, height, waist and hips will be taken. Thisprocess may take 45minutes- 1 hour of your time. **There are no costs, you will not be harmed by participating and anyinformation you give will be kept confidential/ private** as numbers will be used in place of your names.

Your participation in the study is voluntary; if you have any problem at all, you are allowed to say no and to stop being in the study. However, I hope that you will take part in/ join the study as the information you give is very important. As a participant, the results and potential recommendations drawn from this study will be shared with you through printed and translated newsletters and posters with a summary of the results which will be distributed in the community. In case of any questions/ comments about the results a talk will be organized by the research team and your local chief to address the same. Reports and discussion meetings will also be used to share findings of the study with the department of health of the county and national government.

In case of any problem or for any questions, you can contact me (Sonia Khavere) through my mobile number: 0719306014 or e-mail: katekhavere@gmail.com.

I have read / been read to the consent and have understood and I am willing to participate in the study: YES □ NO □

Signature of the respondent_____

Signature of the interviewer _____

Date _____

APPENDIX 2: VIHIGA COUNTY QUESTIONNAIRE

SECTION ONE

Interviewername

_____

Intervieweename

_____

Household number

_____

Date of Interview

_____

(yyyy-mm-dd)

Time of Interview (start time)

_____

(hh:mm)

Sub County

- ☐ Hamisi
- ☐ Sabatia

Ward residency

- ☐ Shamakhokho
- ☐ Shiviringa
- ☐ Busali
- ☐ Wodanga

Age in years

Do you live alone?

- [ ] Yes
- [ ] No

Did you go to school?

- [ ] Yes
- [ ] No

If yes, please indicate your highest level of education that you completed

- [ ] Kindergarten
- [ ] PrimarySchool
- [ ] HighSchool
- [ ] Tertiary (college/polytechnic)
- [ ] University
- [ ] Other
- [ ] Don'tknow

If other, please state what level of education you have attained

What is your marital status?

- [ ] Single
- [ ] Married
- [ ] Separated
- [ ] Widowed

What is your occupation?

- [ ] Farmer
- [ ] Casuallaborer
- [ ] Employed
- [ ] Self-employed

- [ ] Unemployed
- [ ] Other

If other, please state your occupation

_____

Do you follow any dietary habits?

- [ ] Yes
- [ ] No

If yes, please indicate which dietary habit (s)

- [ ] Vegetarian
- [ ] Vegan(noanimals'products;nomeat/honey/eggs/milk)
- [ ] No porkmeat
- [ ] No cereal-based products
- [ ] No dairyproducts
- [ ] Other
- [ ] Don'tknow

If other, please state the dietary habit you practice

_____

SOCIODEMOGRAPHIC STATUS

What is your gross household income?

_____

Please describe the home where you live

- [ ] Self-Owned
- [ ] Hosted by parentorrelative
- [ ] Payrent
- [ ] Other

If other, please specify

_____

How many rooms does your house have?

_____

What material is your house walls made of?

- [ ] Concrete
- [ ] Ironsheet
- [ ] Roofingtiles
- [ ] Grassthatched
- [ ] Combination of soil, plant and cow dung material

What is your house's roofing material?

- [ ] Concrete
- [ ] Ironsheet
- [ ] Roofingtiles
- [ ] Grassthatched
- [ ] Wood
- [ ] Combinationofsoil,plantandcowdungmaterial
- [ ] Other

If other, please specify

_____

What is the main type of cooking fuel?

- [ ] Kerosene
- [ ] Electricity
- [ ] Firewood
- [ ] Charcoal
- [ ] Gas

- [ ] Other

If other, please specify

_____

Do you own any of the following?

- [ ] Hand mill
- [ ] Sickle
- [ ] Axe
- [ ] Livestock
- [ ] Hoe
- [ ] Tractor
- [ ] Plough
- [ ] Land
- [ ] Wheelbarrow

Which of the following are owned by your family?

- [ ] Television
- [ ] Radio
- [ ] DVDplayer
- [ ] Bicycle
- [ ] Car
- [ ] Mobilephones
- [ ] Computer
- [ ] Refrigerator

Do you have electricity?

- [ ] Yes
- [ ] No

What is the source of your drinking water?

- [ ] Tapwater
- [ ] Borehole

- [ ] Protectedwell
- [ ] Rainwater
- [ ] Pond/lake
- [ ] River/stream
- [ ] Other
- [ ] Don'tknow

If other, please specify

Do you treat your water?

- [ ] Yes
- [ ] No

If yes, how do you treat your water?

- [ ] Boiling
- [ ] Water guard/ Chlorine Other

If other, please specify

Do you have latrines in the household?

- [ ] Yes
- [ ] No

When do you wash your hands?

- [ ] After visiting thetoilet
- [ ] Beforepreparing/handlingfood
- [ ] Beforebreastfeeding
- [ ] Compulsory washing at outlets due toCovid19
- [ ] After handlinggarbage
- [ ] After cleaning a baby's bottom/ changing a napkin
- [ ] Other

- [ ] Don'tknow

If other, please specify

Do you have a garbage pit ?

- [ ] Yes
- [ ] No

SECTION 2: OBESITY

NUTRITION KNOWLEDGE

Can you tell me the reasons that may cause a person to be overweight or obese?

- [ ] Excessiveintakeofdietshighinenergy/fats
- [ ] Excessive intake ofsugar
- [ ] Excessive intake ofsalt
- [ ] Low intake of fruits, vegetablesand dairy
- [ ] Lack of/ inadequate physicalactivity
- [ ] Lackofknowledgeorawarenessoffoodlabels
- [ ] Frequently consuming ready to eat meals/ eating outofhome
- [ ] Not sleeping for 7-8hours
- [ ] Other
- [ ] Don'tknow

If other, please specify

What are the health problems that occur when a person is overweight/ obese?

- [ ] Heart/CardiovascularDisease
- [ ] High bloodpressure
- [ ] Diabetes
- [ ] Certain typesofcancers

- [ ] Respiratorydifficulties
- [ ] Musculoskeletalproblems
- [ ] Skinproblems
- [ ] Infertility
- [ ] Reduced qualityof life
- [ ] PrematureDeath
- [ ] Other
- [ ] Don'tknow

If other, please state problems caused due to overweight and obesity

_____

How can a person prevent becoming overweight or obese?

- [ ] Reduce intake of high energy/fatfoods
- [ ] Reduce intake ofsugar
- [ ] Reduce intake ofsalt
- [ ] Eatvegetablesandfruitsmoreoften
- [ ] Eat dairy moreoften
- [ ] Eat legumes/ whole grains products
- [ ] Read foodlabels
- [ ] Sleep 7-8hours
- [ ] Reduceconsumptionofreadytoeatmeals/eatingfoodpreparedawayfromhome
- [ ] Increase physicalactivity
- [ ] Other
- [ ] Don'tknow

If other, please specify

_____

How many calories on average should a woman consume in a day?

_____

How many minutes of moderate physical activity are recommended in a week?

_____

What food groups are important for one to be healthy?

- [ ] Carbohydrates
- [ ] Proteins
- [ ] Fruits
- [ ] Vegetables
- [ ] Fats
- [ ] Dairy
- [ ] Other
- [ ] Don'tknow

If other, please specify the food group

_____

How much of salt in teaspoons is recommended to be consumed in a day?

_____

How much of sugar, honey, sweeteners in teaspoons should you consume in a day

_____

How many hours of sleep a night is recommended for an adult aged 18-60 years?

_____

Food prepared out of home can contain which nutrients in large amounts

- [ ] Energy
- [ ] Sugar
- [ ] Salt
- [ ] Fats
- [ ] Cholesterol
- [ ] Don'tknow

- [ ] Other

If other, specify

ATTITUDE

Do you think you are likely to become obese?

- [ ] Yes
- [ ] No
- [ ] Notsure

If not likely: can you please tell me why it is not likely?

Do you think being obese is dangerous?

- [ ] Yes
- [ ] No
- [ ] Not sure

If no, can you tell me the reason why you think it is not dangerous?

Do you think sleeping for the recommended 7-8 hours can prevent obesity?

- [ ] Yes
- [ ] No
- [ ] Nosure

If no, can you tell me the reason why you don't think it can prevent obesity?

How good do you think it is to sleep for 7-8 hours every day?

- [ ] Good
- [ ] Notgood
- [ ] Notsure

If not good, can you tell me the reasons why it is not good?

How difficult is it for you to always sleep for 7-8 hours every day?

- [ ] Difficult
- [ ] Notdifficult
- [ ] Notsure

If difficult: can you tell me the reason why it is difficult?

Do you think consuming food not prepared from home can cause obesity?

- [ ] Yes
- [ ] No
- [ ] Notsure

If no, can you tell me the reasons why it cannot cause obesity?

Do you think consuming a lot of salt can cause obesity?

- [ ] Yes
- [ ] No
- [ ] Notsure

If no, can you tell me why it cannot cause obesity?

Do you think consuming a lot of sugar can cause obesity?

- [ ] Yes
- [ ] No
- [ ] Notsure

If no, can you tell me why it cannot cause obesity?

Do you think consuming a lot of fat can cause obesity?

- [ ] Yes
- [ ] No
- [ ] Notsure

If no, can you tell me why it cannot cause obesity?

Do you think reading food labels can prevent obesity?

- [ ] Yes
- [ ] No
- [ ] Notsure

If no, can you tell me why it cannot cause obesity?

How good do you think it is to always consume food prepared only a home

- [ ] Good
- [ ] Notgood
- [ ] Not sure

If not good, can you tell me the reasons why it is not good

How difficult is it for you to consume food only prepared at home?

- [ ] Difficult

- [ ] Notdifficult
- [ ] Notsure

If difficult, can you tell me the reasons why it is difficult?

_____

Howdoyoufeelabouteatinglesse.g.havingsmallerportions,eatingslowlyandfollowingappetite/satietysignals eatinglessfattyandsugaryfoods,etc?

- [ ] Good
- [ ] Notgood
- [ ] Notsure

If not good, can you tell me the reasons why it is not good?

_____

Howgooddoyouthinkitistodosomephysicalactivitysuchaswalkingfor30minutesaday,running, ordoinga sport?

- [ ] Good
- [ ] Notgood
- [ ] Not sure

If not good can you tell me the reasons why it is not good?

_____

PRACTICES

What time do you usually sleep during weekdays?

hh:mm

_____

What time do you usually sleep during the weekends?

hh:mm

_____

What time do you usually wake up during the weekdays?

hh:mm

_____

What time do you usually wake up during the weekends?

hh:mm

_____

Why do you sleep and wake up at the above times?

_____

Do you buy food that is already prepared / not prepared at home?

- [ ] Yes
- [ ] No

If yes, how often?

_____

What attracts you to already prepared food?

- [ ] Convenience
- [ ] Taste
- [ ] Price
- [ ] Other

If other, please specify:

_____

Have you been diagnosed with any of the following?

- [ ] Diabetes
- [ ] Hypertension/ highbloodpressure

- ☐ Heartdisease
- ☐ Cancer
- ☐ Depression
- ☐ Other

If other, please specify

SECTION THREE: NUTRITION STATUS

ANTHROPOMETRIC MEASUREMENTS

Weight Trial1:

_____

Weight Trial2:

_____

Weight Trial3:

_____

Height Trial1:

_____

Height Trial2:

_____

Height Trial3:

_____

Waist Circumference1:

_____

Waist Circumference2:

_____

Waist Circumference3:

_____

Hip Circumference 1:

_____

Hip Circumference 2:

_____

Hip Circumference 3:

_____

SECTION FOUR:

DIETARY ASSESSMENT

Have you consumed these foods in the last 7 days?

Cereals:Ugali,Rice,Wheat,Sorghum,milletoranyothergrainsorfoodsmadefromthese(e.g.bread ,noodles, porridge or other grainproducts)

- ☐ Yes
- ☐ No

If yes, how often:

_____

White Roots & Tubers: White; potatoes, yam, cassava, other foods made from roots

- ☐ Yes
- ☐ No

If yes, how often

_____

Vitamin A Rich Vegetables: Pumpkin, carrot, squash, and sweet potato that is orange inside, red sweet pepper

- ☐ Yes
- ☐ No

If yes, how often:

_____

Dark Green Leafy Vegetables: dark green leafy vegetables locally available vitamin A rich leaves such as amaranth, cassava leaves, kale, spinach

- ☐ Yes
- ☐ No

If yes, how often:

_____

Other Vegetables: other vegetables (e.g. tomato, onion, eggplant) + other locally available vegetables

- ☐ Yes
- ☐ No

If yes, how often?

_____

Vitamin A Rich Fruits : ripe mango, cantaloupe, apricot (fresh or dried), ripe papaya, dried peach, and 100% fruit juice made from these + other locally available vitamin A rich fruits

- ☐ Yes
- ☐ No

If yes, how often?

_____

Other Fruits: other fruits, including wild fruits and 100% fruit juice made from these

- [ ] Yes
- [ ] No

If yes, how often?

_____

Organ Meat: liver, kidney, heart or other organ meats or blood-based foods

- [ ] Yes
- [ ] No

If yes, how often?

_____

Flesh Meats: beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, insects

- [ ] Yes
- [ ] No

If yes, how often?

_____

Eggs: eggs from chicken, duck, guinea fowl or any other egg

- [ ] Yes
- [ ] No

If yes, how often?

_____

Fish & Seafood: fish

- [ ] Yes
- [ ] No

If yes, how often?

_____

Legumes, Nuts & Seeds: dried beans, dried peas, lentils, nuts, seeds or foods made from these (eg. hummus, peanut butter)

- [ ] Yes
- [ ] No

If yes, how often?

_____

Milk & Milk Products: milk, cheese, yogurt or other milk products

- [ ] Yes
- [ ] No

If yes, how often?

_____

Oil & Fats: oil, fats or butter added to food or used for cooking

- [ ] Yes
- [ ] No

If yes, how often?

_____

Sweets:sugar,honey,sweetenedsodaorsweetenedjuicedrinks,sugaryfoodssuchaschocolates,candies,cookiesand cakes

- [ ] Yes
- [ ] No

If yes, how often?

_____

Spices,Condiments,Beverages:spices(blackpepper,salt),condiments(soysauce,hotsauce),coffee,tea,alcoholic beverages

- ☐ Yes
- ☐ No

If yes, how often?

_____

Did You Eat Anything (Meal Or Snack) prepared OUTSIDE the Home In The Last 7 Days

- ☐ Yes
- ☐ No

If yes, how often?

_____

SECTION FIVE:

PHYSICAL ASSESSMENT

Does your work involve vigorous-intensity activity that causes large increases in breathing or heart rate like [carrying or lifting heavy loads, digging or construction work] for at least 10 minutes continuously?

- ☐ Yes
- ☐ No

In a typical week, on how many days do you do vigorous- intensity activities as part of your work?

_____

Doesyourworkinvolvemoderate-

intensityactivitythatcausessmallincreasesinbreathingorheartratesuchasbrisk walking[orcarryinglightloads]foratleast10minutescontinuously?

- [ ] Yes
- [ ] No

In a typical week, on how many days do you do moderate- intensity activities as part of your work?

_____

How much time do you spend doing moderate-intensity activities at work on a typical day in minutes?

_____

TRAVEL TO AND FROM PLACES

Do you walk or use a bicycle (pedal cycle) for at least 10 minutes continuously to get to and from places?

- [ ] Yes
- [ ] No

In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?

_____

How much time do you spend walking or bicycling for travel on a typical day?

_____

RECREATIONAL ACTIVITIES

How much time do you spend doing vigorous-intensity activities at work on a typical day in minutes?

_____

Doyoudoanyvigorous-intensitysports,fitnessorrecreational(leisure)activitiesthatcauselargeincreasesin

breathingorheartratelike[runningorfootball,]foratleast10minutescontinuously?

- ☐ Yes
- ☐ No

In a typical week, on how many days do you do vigorous- intensity sports, fitness or recreational (leisure) activities?

_____

How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day in minutes?

_____

SECTION SIX:

FOOD SECURITY

Inthepastfourweeks,didyouworrythatyourhouseholdwouldnothaveenoughfood?

- ☐ Yes
- ☐ No

If yes, howoften did this happen

- ☐ Rarely (once or twice in the past four weeks)
- ☐ Sometimes (three to ten times in the past four weeks)
- ☐ Often (more than ten times in the past four weeks)

In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because ofalackofresources?

- ☐ Yes
- ☐ No

If yes, howoften did this happen

- ☐ Rarely (once or twice in the past four weeks)
- ☐ Sometimes (three to ten times in the past four weeks)

- [ ] Often (more than ten times in the past four weeks)

In the pastfour weeks,did you orany householdmember have toeat alimited variety offoods dueto a lackofresources?

- [ ] Yes
- [ ] No

If yes, howoften did this happen

- [ ] Rarely (once or twice in the past four weeks)
- [ ] Sometimes (three to ten times in the past four weeks)
- [ ] Often (more than ten times in the past four weeks)

Inthepastfourweeks,didyouoranyhouseholdmemberhavetoeatsomefoodsthatyoureallydidnot wanttoeatbecauseofalackofresourcestoobtainothertypesoffoods?

- [ ] Yes
- [ ] No

If yes, howoften did this happen

- [ ] Rarely (once or twice in the past four weeks)
- [ ] Sometimes (three to ten times in the past four weeks)
- [ ] Often (more than ten times in the past four weeks)

In the pastfour weeks, didyou or anyhousehold member haveto eat asmaller meal thanyou felt youneeded becausetherewasnotenoughfood?

- [ ] Yes
- [ ] No

If yes, howoften did this happen

- [ ] Rarely (once or twice in the past four weeks)
- [ ] Sometimes (three to ten times in the past four weeks)
- [ ] Often (more than ten times in the past four weeks)

In the past four weeks, did youor any other household member have toeat fewer meals in a day becausethere wasnotenoughfood?

- [ ] Yes
- [ ] No

If yes, howoften did this happen

- [ ] Rarely (once or twice in the past four weeks)
- [ ] Sometimes (three to ten times in the past four weeks)
- [ ] Often (more than ten times in the past four weeks)

Inthepastfourweeks,wasthereevernofoodtoeatofanykindinyourhouseholdbecauseoflackofresourcestogetfood?

- [ ] Yes
- [ ] No

If yes, howoften did this happen

- [ ] Rarely (once or twice in the past four weeks)
- [ ] Sometimes (three to ten times in the past four weeks)
- [ ] Often (more than ten times in the past four weeks)

Inthepastfourweeks,didyouoranyhouseholdmembergotosleepatnighthungrybecausetherewasnotenoughfood? In the past four weeks, did you or any household member go to sleep at night hungry because there was notenoughfood?

- [ ] Yes
- [ ] No

If yes, howoften did this happen

- [ ] Rarely (once or twice in the past four weeks)
- [ ] Sometimes (three to ten times in the past four weeks)
- [ ] Often (more than ten times in the past four weeks)

In the past four weeks, did you or any household member go a whole day and night without eating anything becausetherewasnotenoughfood?

- [ ] Yes
- [ ] No

If yes, howoften did this happen

- ☐ Rarely (once or twice in the past four weeks)
- ☐ Sometimes (three to ten times in the past four weeks)
- ☐ Often (more than ten times in the past four weeks)

MISCELLANEOUS

Do you smoke?

- ☐ Yes
- ☐ No

Do you have any children?

- ☐ Yes
- ☐ No

If yes, how many?

_____

Are you on any contraceptives?

- ☐ Yes
- ☐ No

If yes, please specify (Pills, IUD (hormonal/ non hormonal)

_____

At what time do you consume your last meal of the day?

hh:mm

_____

How many meals do you consume in a day?

- ☐ Onemeal
- ☐ Twomeals

- [ ] Threemeals
- [ ] Fourmeals
- [ ] More than 4meals

Do you consume alcohol?

- [ ] Yes
- [ ] No

How many glasses do you take on average in one sitting?

_____

Where do you get access to nutritional information?

- [ ] Television
- [ ] Radio
- [ ] Newspaper
- [ ] Hospital
- [ ] Internet
- [ ] Other

If other, please specify

_____

Time of interview (end time)

hh:mm

_____