THE ASSOCIATION BETWEEN HIGH BODY MASS INDEX AND PREGNANCY OUTCOMES AMONG WOMEN WHO DELIVERED AT WEBUYE COUNTY HOSPITAL IN 2019: A RETROSPECTIVE COHORT STUDY

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DECLARATION

This is dissertation is my original work, carried out with the guidance of my supervisors; references made to work done by others have been indicated.

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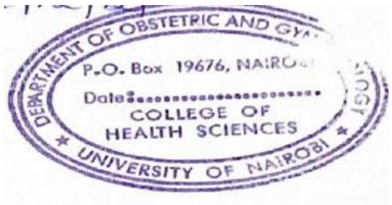

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DEDICATION

I dedicate this dissertation to Almighty God for strength, life and wisdom.

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LIST OF ABBREVIATIONS

AMPATH-	Academic Model Providing Access To Healthcare
ANC-	Antenatal Clinic
ANCOVA-	Analysis Of Covariance
AVD-	Assisted Vaginal Delivery
BMI-	Body Mass Index
CEC-	Chief Executive Committee
COH-	Commissioner of Health
CP-	Cerebral Palsy
EMBLEM-	Epidemiology of Burkitt Lymphoma in East-African Children and Minors
ERC-	Ethics and Research Committee
GDM-	Gestational Diabetes Mellitus
HDPs-	Hypertensive Disorders of Pregnancy
HIC-	High Income Countries
HMT-	Hospital Management
KDHS-	Kenya Demographics and Health Survey
KNH-	Kenyatta National Hospital
KOGS-	Kenya Obstetrical and Gynecological Society
LBW-	Low Birth Weight
LGA-	Large for Gestational Age
LMIC-	Low-Income and Middle-Income Countries
NICU-	Newborn Intensive Care Unit
PROM-	Premature Rupture of Membranes
RDS-	Respiratory Distress Syndrome
RR-	Relative Risk
SES-	Social Economic Status
SGA-	Small-For-Gestational Age
SPSS-	Statistical Package for Social Scientists
SVD-	Spontaneous Vertex Delivery
TOLAC-	Trial of Labor After Caesarian Delivery
UN-	United Nations
VTE-	Venous Thromboembolism
WC-	Waist Circumference
WCH-	Webuye County Hospital
WHO-	World Health Organization

DEFINITIONS OF TERMS

BMI: Previously known as the Quetelet index. It is a measure of the individual nutritional status calculated as weight in kilograms divided by person's height in meters squared (kg/m2)

BMI Classification:

Below 18.5 kg/m2- Underweight

18.5–24.9 kg/m2- Normal weight (normal BMI)

25.0–29.9 kg/m2- Overweight

30.0–34.9 kg/m2- Class I obesity

35.0–39.9 kg/m2- Class II obesity

Above or 40.0 kg/m2- Class III obesity

High BMI includes any class above normal (BMI above 25)

ABSTRACT

Background: High BMI is associated with adverse pregnancy outcomes, high rate of caesarean sections, and high health care costs in the developed world, but its association with adverse pregnancy outcomes in Kenya has not been studied comprehensively.

Objectives: To determine the association between high BMI and adverse pregnancy outcomes at Webuye County Hospital (WCH) in 2019

Methodology: A retrospective cohort study was carried out at Webuye County Hospital (WCH). The hospital charts of 178mothers with high BMI (exposed group) were compared with 172who had normal BMI (non-exposed group). Participants were recruited before 20 weeks of gestation aged 18-50 years with BMI >18.5kg/m2. Women with BMI <18.5kg/m2 and multiple gestations were excluded. Data was analyzed using SPSS version 23. Maternal and perinatal outcomes such as hypertensive disorders of pregnancy, preterm and post term delivery, mode of delivery, poor fifth minute Apgar score of below 7, respiratory distress syndrome, large for gestation age, small for gestation age, and mortality were compared using the Chi square test and Man-Whitney U test. Relative risk was the measure of association. P value <0.05 was significant.

Results: Three hundred and fifty (350) comprising women with high BMI (178) and normal BMI (172) were recruited and data compared. Demographic factors of women with high and normal BMI were similar. The risk of hypertensive disorders (RR=1.18, 95% CI), caesarian sections (RR=1.19, 95% CI=0.91-1.49, P=0.187), and post-partum hemorrhage (RR=1.31, 95% CI=0.58-1.84, P=0.435) were higher among overweight and obese women compared to those with a normal BMI but the difference were not statistically significant. Poor Apgar at 5 minutes was statistically significantly higher among women who had a high BMI (2.3%) compared to normal BMI (0.0%) (P=0.048). However, after adjusting for demographic and reproductive characteristics, the difference was not significant (0.985).Risk of preterm births (RR=0.97, 95% CI=0.72-1.25, P=0.873), stillbirths (RR=0.97, 95% CI=0.72-1.25, P=0.873), and Large for gestation age (RR=0.65, 95% CI=0.18-1.38, P=0.386) was lower with higher BMI compared to normal BMI but not significantly.

Conclusion: High BMI compared to normal BMI was not associated with adverse maternal but was marginally associated with adverse perinatal outcomes, predominantly low Apgar score at 5 minutes

Key Words: Body Mass Index, Maternal Outcomes, perinatal Outcomes

1.0 CHAPTER ONE: INTRODUCTION

The nutritional status of the mother is vital to fetal and maternal well-being. BMI, which is a reliable measure of adiposity is weight (kg)/height squared (m^2).

High BMI is now classified as a global epidemic not only from a medical point of view but also from a social one and is a major contributor to poor health globally(1). World Health Organization (WHO) has categorized it as the most common metabolic disorder facing the 21st century following its alarming increase worldwide .(2)

Globally, raised BMI has more than tripled over the last 30 years with around 39% of adults pre-obese in 2016, and 13% were obese whereby 11% were men and 15% were women(3). Many LMIC's are now facing a "double burden" of disease whereby the burden of infectious diseases and under nutrition still exist and now an increase in diseases associated to obesity and overweight(4). Overweight and obesity is however preventable(5)

Worldwide, approximately 8% of deaths were related to obesity according to a survey done in 2017 by the Global Burden of Disease Collaborative Network in Seattle, United States(6)and this rose from 4.5% in 1990.High BMI is also responsible for about 4.7 million premature adult deaths every year(7,8) by being a risk factor for several of the world's leading causes of mortality, including heart disease, stroke, diabetes and various types of cancer.

Estimates show that up to one-quarter of maternal and perinatal mortalities can be associated to maternal high BMI(4). Another emerging issue directly impacting on maternal health that has been observed in several studies worldwide is that the rate of high BMI is greater in women than among their male counterparts worldwide(9). Regional studies have also reported a greater prevalence of high BMI in women than among men in Kenya; for instance in a local study,34% of men were in the high BMI category compared to 43.4% in women(10).

The objective of this study by Ettarh et al on overweight, obesity, and perception of body image among slum residents in Nairobi, Kenya, 2008–2009 was to determine the prevalence of overweight and obesity and examine perceptions of body size differentiated by sex and other determinants among slum dwellers in Nairobi, Kenya. This translates to higher proportions of women entering pregnancy with high BMI leading to higher rates of adverse pregnancy outcomes. This burdens an already resource strained health systems in developing countries. While the lifestyle change in sub-Saharan Africa shows the increasing prevalence of obesity in the urban poor, few studies have been carried out in rural areas.

Antenatally, obesity increases the risk of maternal comorbidities such as hypertensive disorders of pregnancies(11),Gestational diabetes mellitus(GDM)(12), thromboembolism(13), and Intrauterine fetal demise(14). High BMI is also associated with adverse labor outcomes with overweight women unlikely to experience spontaneous labor, normal deliveries with increased risk of caesarean deliveries and prolonged labor(15). Postnatally, obese women have a longer postnatal hospital stay, are unlikely to successfully breastfeed, and are at an augmented risk of acquiring postnatal infections(16). Adverse perinatal outcomes such as stillbirth, congenital anomalies, increased risk of NICU admission, and neonatal demise are also associated to high maternal BMI(16,17).

Rates of high BMI in the reproductive age women is on the rise in low-income and middle-income countries (LMICs) (19) such as Kenya. Recent data points to increasing rates of urbanization, decreased physical activity and consumption of high calorie and fat diets as the major contributors to higher rates of obesity.(20). Sub-Saharan African women also face greater adverse pregnancy outcomes than their global counterparts; therefore, high BMI further aggravates maternal and child health challenges (21).Living in urban areas, high levels of education and high income are some of the predictors for high BMI in Kenya that can be linked to a shift in consumption behaviors(22).One such study by Christensen DL in 2008 on Obesity and regional fat distribution in Kenyan populations: Impact of ethnicity and urbanization ,in Nairobi Kenya found that the higher prevalence of obesity in urban areas could be associated with high-income women residing in such areas having greater access to high fat ,high caloric and low fiber foods (23).However few studies have focused on a rural population. Other predictors highlighted were increased alcohol intake, advanced maternal age, increased parity, inadequate consumption of vegetables and fruits and increased physical inactivity(24).

Sociodemographic characteristics impacting maternal obesity are not well documented in Kenya. They should be identified for targeted therapeutic and preventative measures. Ethnic disparities in obesity prevalence and other factors such as increasing parity that have been associated with increased risk of maternal obesity with the resultant adverse pregnancy outcomes(25). Therefore comprehending the role of such factors could aid in optimization of prenatal and antenatal care(26).

Ritho et al on the effect of body mass index on pregnancy outcome at Kenyatta National Hospital: a Cohort Study in 2012concluded that raised BMI was associated with a greater risk of adverse maternal outcomes and obstetric interventions. Recommendations from this study included more studies on high BMI should be carried nationwide to cover a more diverse population of varied SES and ethnicity that still remains unexplored as most current studies have focused on an urban population(27).

This study strives to bridge that gap and determine association of high BMI on pregnancy outcomes in a largely rural setup comprising of largely participants in the low SES and to identify relevant associated sociodemographic characteristics. This was a retrospective cohort study conducted through a review of medical files of women with high BMI (exposed) and normal BMI (non-exposed) at WCH. The incidence of adverse maternal and perinatal outcomes for each group was determined and compared.

2.0 CHAPTER TWO: LITERATURE REVIEW

2.1 BMI Definition and Categories

Most of the current literature on BMI and its effect on pregnancy are from HIC. It is therefore necessary to examine the effects of maternal anthropometric characteristics on maternal and perinatal outcomes in communities undergoing a socioeconomic transition coupled to a dynamic nutritional status experienced across the population. Kenya is such a population(28).
As much as the standard BMI criteria for the non-gravid population might not apply well to the gravid population for a number of reasons such as rapid increases in maternal weight in a short period of time and rapid loss of this gained weight over a short interval during delivery, still no pregnancy specific standard BMI definition exists. Pregnant women are therefore classified as overweight or underweight based on their non-gravid standard definition of BMI. For the purpose of this study, first trimester to first half of pregnancy (below 20 weeks gestation)BMI was used to reflect the maternal aspect effect as accurately as possible.
BMI is defined as a person's weight in kilograms divided by the square of the person's height in meters (kg/m2)(29).
BMI is divided into the following categories for adults over 20 years old.

Table 1:Nutritional status(30)

BMI (kg/m2)	**Nutritional status**
Below 18.5	Underweight
18.5–24.9	Normal weight
25.0–29.9	Pre-obesity
30.0–34.9	Obesity class I
35.0–39.9	Obesity class II
Above 40	Obesity class III

BMI is preferred as it is easy to calculate and measures are routinely taken during hospital contacts and hence is the most frequently utilized tool to associate risk of health problems with the weight at any population level. In the 19th century, a scientist named Adolphe Quetelet was the first to describe it(31).It gained traction in the 1970s and based on the Seven Countries study where researchers concluded that BMI demonstrated to be a reliable and reproducible tool for correlation of degree of adiposity and obesity related health problems(29).

However, as it is only dependent on weight and height and does not take into account physical activity levels, gender and different levels of adiposity based on age it is not entirely perfect. It is therefore expected to overestimate and underestimate adiposity in some cases. Other additive measures as waist circumference (WC) for measures of adiposity exist but are seldom taken although studies have shown no significant clinical difference between the two in predicting morbidities associated with obesity. It is however important to note that elevated WC has higher predictive ability on mortality risk than BMI(32).

2.2 Local and Global Studies on BMI Prevalence, Determinants, and Effects on Pregnancy

Local studies on BMI and its effect on pregnancy or even the general population are few and most of them focus on high BMI. In Kenya prevalence studies showed a higher prevalence of high BMI in women than in men with a particular study by Ettarh et al on overweight, obesity, and perception of body image among slum residents in Nairobi, Kenya in 2008–2009 quoting rates of up to 43.4% in women and 34% in men(10).This translates to higher proportions of women entering pregnancy with high BMI leading to higher rates of adverse pregnancy outcomes.

Steyn NP et al on dietary, social, and environmental determinants of obesity in Kenyan women in 2011 concluded above normal BMI was greatly prevalent in Kenya with rates of up to 43.3%with urbanization appearing to be the most vital determinant since most of the women living in urban areas tended to be in the high income group(33).

Christensen DL et al in 2008 on regional fat distribution and obesity in diverse Kenyan populations focusing on effect of urbanization and ethnicity. The prevalence of high BMI classified as obesity (15.5% vs. 5.1%) and overweight (39.8% vs. 15.8%) was greater in the urban vs. rural population. Among the Kenyan ethnic groups, Maasai had the highest overall high fat accumulation.(23)

Ettarh R et al on-body image perception among slum dwellers in Nairobi in 2008 found that 17.3% of men and 43.4% of women had high BMI. More than half (around53%) of the participants with high BMI underestimated their weight. However, in all the BMI categories, approximately one-third of men and women strongly preferred larger body size and this was an overwhelming concern considering the adverse effects associated with obesity.(10)

Mbochi R.W. et al on predictors of high BMI in non-gravid women in Nairobi County, Kenya in 2012 concluded that on the predictors of obesity, nutrition transition to higher caloric-low fiber foods, higher socio-economic status, increased physical inactivity and alcohol intake were the most prevalent associated factors compared to the women in the low SES groups(34).

Therefore, most of the local studies have focused on an urban population and this study tried to focus more on a rural population.

Regionally, In Africa there is a deficiency of data on maternal obesity and underweight effects on pregnancy and this study is designed to add more information on adverse pregnancy effects of high BMI to the already deficient data pool

A systematic review was carried out in Africa to investigate maternal obesity in Africa. It aimed to evaluate prevalence, socio-demographic associations and adverse pregnancy outcomes. Secondary objectives assessed existing interventions in connection to the knowledge and attitudes of parturient women and healthcare providers towards maternal high BMI. It was carried out and published in17 October 2016 by Ojochenemi J. Onubi et al. Prevalence rates ranged from 6.5% to 50.7%, with older and multiparous mothers more likely to be overweight. Overweight mothers had increased risks of adverse maternal outcomes. However, normal BMI and low BMI mothers were more likely to have low-birth weight babies. The conclusions drawn were that Africa's current and rising levels of high BMI are already having significant adverse effects. Interventions that are therefore culturally adaptable and tailored to the African population should be developed(35).This can only be done by carrying out more ethnic diverse BMI studies to exploring the regional effects of a rising BMI on the African population.

Florent Ymele Fouelifack et al in Cameroon in 2015 on associations of body mass index and gestational weight gain with term pregnancy outcomes in urban Cameroon: a retrospective cohort study in a tertiary hospital concluded that abnormal BMI (high or low BMI)was **not** associated with adverse pregnancy outcomes in the cohort of different ethnic and racial groups of Cameroonian women(36).

Idris U Takai et al in 2017 on body mass index and pregnancy outcomes: A 3-year retrospective study from a low-resource setting that concluded that Obesity in pregnancy is relatively common in Nigeria (15.3%) and is associated with adverse feto- maternal outcomes when compared to the underweight subjects 8.8%(37).

This study sought to support or contradicts the above findings of effect of high BMI on pregnancy outcomes which will further guide policy formation.

Globally, many studies have been carried out on effects of BMI on pregnancy outcomes although most of them focus on above normal BMI. Highlighted below are a few such studies and their conclusions:

Yazdani S et al in 2012 explored the association between maternal Body Mass Index and pregnancy outcomes on 1000 Iranian women and concluded that women with an above-normal Body Mass Index had greater incidences of hypertensive disorders of pregnancy, induction of labor, caesarean deliveries, pre-term labor, and LGA than women with a normal BMI(38).

Vinturache et al in 2014 on Pre-pregnancy Body Mass Index (BMI) and delivery outcomes in a Canadian population concluded that even among women with low risk singleton pregnancies getting prenatal care, overweight women were at increased risk of obstetrical interventions intrapartum. This highlighted the importance of directed maternal care of pregnant women with increased BMI in to improve the maternal and neonatal outcomes(39).

2.3 High BMI and Pregnancy Outcomes

Pathophysiology of overweight and obesity and its effects are well documented. Adipose tissue is categorized as an endocrine organ. It causes dysregulatory effect on metabolic, vascular and inflammatory pathways in multiple organ systems if it occurs in excess physiologically, and so adversely affecting maternal and perinatal outcomes (41,42)For example, insulin resistance a consequence of high BMI and inflammatory pathways abnormalities affects placental development (11)and performance, and has been related to development of hypertensive disorders of pregnancy (25).

Maternal high BMI has been linked to genetic changes and long-term offspring outcomes caused by accumulated fetal exposure to lipids, glucose, insulin and inflammatory cytokines. Exposure to the above in utero can lead to transient or permanent changes in fetal metabolic programming a phenomenon known as the Barker hypothesis (44), resulting in adverse adult health outcomes.

Antepartum it's been connected to early pregnancy loss. During a systematic review in 2011 by Boots C et al in Chicago, United States of America of half-dozen retrospective studies of girls with high BMI a complete of twenty eight, 538 women, the rates of over one miscarriage were as follows: , 11.8 % in overweight category, 16.6 % in obese category and 10.7% in normal BMI category(45). In another meta-analysis by Cavalcante et al in 2019 England, obese women with a previous history of perennial miscarriage were at raised future risk of pregnancy losses in comparison to with women with a standard BMI (45,46).

Another associated risk with raised BMI is hypertensive disorders of pregnancy. During a systematic review by O'Brien et al in 2003 in the United States of America of thirteen cohort studies consisting of about 1.4 million girls, the associated risk of hypertensive disorders of pregnancy doubled with every five to seven kg/m2 rise in pre-conceptional BMI after changes for confounders like diabetes , chronic high blood pressure and multiple gestations was done(47).

Indicated and spontaneous preterm birth has been linked to raised BMI. High BMI will increase the chance of induced preterm delivery, mainly because of high BMI related maternal disorders, like pre-eclampsia and diabetes. Women with a BMI of above 25 kg/m2 were at an increased risk of preterm birth compared to women with a BMI of less than 25 kg/m2 during a 2010 systematic review by McDonald SD et al in developed and developing countries with the risk accumulating with each increasing BMI class(18).

Several associated risks intrapartum are slow progress of labor where maternal raised BMI seems to possess an impact progression of labor that's not dependent of fetal size but related to maternal size. In a retrospective cohort study of 612 nulliparous women by Polónia et al in Portugal in 2018with spontaneous vertex deliveries, the median period of active phase of labor from four to ten cm was considerably longer for each woman with high BMI(overweight and obese) as compared with women with normal BMI (7.5, 7.9, and 6.2 hours, respectively(48).

Other intrapartum risks are raised risk for induction enhanced risk for prolonged inductions and induction failure because of their raised risk for pregnancy complications (49,50). Wolfe et al on the effect of maternal obesity on the rate of failed induction of labor in 2007 Ohio, USA concluded that obese women twice as unlikely to have successful induction as normal BMI women, and the risk was shown to accrue with each increasing category of obesity (51).

Raised BMI may be a risk factor for caesarean delivery both elective and emergency, and the risk increases with each increasing unit of BMI. The risk of caesarean delivery increased by seven percent with each increasing unit of pre-pregnancy BMI as demonstrated by Brost et al in a prospective study in 1997 in USA. Obesity-related morbidities such as preeclampsia, macrosomia, and greater risk of preterm and post-term deliveries accounted for a few of increased risk of caesarean delivery (52–54).

Numerous studies have systematically shown that a trial of labor after a caesarean delivery (TOLAC) is unlikely seemingly to lead to childbirth in obese gravidas. Bujold et al on the role of maternal body mass index in outcomes of vaginal births after cesarean for instance in 2005 concluded that maternal body mass index correlated inversely with the rate of successful vaginal birth after caesarean. For this reason, BMI is one of the variables used in calculators that estimate a woman’s possibilities of getting a vaginal birth following a previous cesarean delivery (55–61).

Women with high BMI undergoing medical anesthesia are likely to have multiple attempts during placement, hypotension and unintentional dural puncture. Obesity is one of the prognosticative factors of a difficult airway in case general anesthesia is required(47,48).In the postpartum period, obesity is a well-known risk factor for venous thromboembolism whereat carries an independent risk for venous thromboembolism (VTE) that may be a major contributor maternal morbidity and mortality (64) .

Women with a high BMI are also at a greater risk for postnatal infection (wound dehiscence, endometritis ,episiotomy), in spite of use of prophylactic antibiotics and mode of delivery .It is believed that poor vascularity of subcutaneous tissue in obesity and formation of hematomas and seromas is responsible for the augmented risk of wound infection(63,65,66).

In a meta-analysis of sixty two studies in 2014 by Molyneaux et al in from five bibliographic databases of obesity associated mental illnesses throughout pregnancy and postnatal period noted a raised risk for postnatal depression in overweight and obese women(67).

Neonatal complications related to raised BMI are many and a few of them include congenital anomalies, cardiac malformations, neural tube defects and limb reduction abnormalities where the risk appears to accumulate with each unit increase in BMI. The mechanism for these associations isn't well outlined however is likely associated with associate degree altered nutritional setting throughout fetal development(68).

Obesity is also a risk factor for birth asphyxia, perinatal death and infant death as shown in a 2014 systematic review and meta-analysis of cohort studies from PubMed and Embase databases by Aune et al where even slight rises in maternal BMI multiplied the risk of perinatal death and child death (17).Some of the reasons postulated were increased rates of hypertensive disorders and Diabetes in these women compared to non-obese women, altered metabolic pathways with hyperlipidemia and oxygen desaturation caused by sleep apnea(69).

Offspring of obese girls are additional risk to be delivered preterm that exposes them to long-term and the short term sequelae of prematurity. Pre-conceptional BMI and gestational weight gain play a very pivotal role in deciding the birth weight. Numerous studies have demonstrated a linear relationship between birth weight and pre conceptional weight placing the obese gravida at an exaggerated risk of delivering a large for gestational age (LGA) child (70–72)with resultant sequalae of shoulder dystocia and higher likelihood of developing obesity later in life. Ludwig et al for instance in 2010 on the association between pregnancy weight gain and birth weight in New Jersey, USA concluded that maternal weight gain and obesity during pregnancy increases birth weight independently of genetic factors.

Maternal obesity also raises the risk of childhood obesity in their offspring by up to threefold. When both parents are obese the risk can increase up to 15-fold.Therefore local study on impact of partner obesity on childhood obesity can be interesting starting point. Transient or permanent changes in the fetal metabolic pathways as a result of excess in utero exposure to nutrients in a phenomenon theorized as the Barker hypothesis(Developmental Origins of Health and Disease (73–76), increases the risk of developing adult diseases that are associated to these pathways such as hypertension, diabetes, obesity and cardiovascular disease.

Intra uterine changes and lactational exposure of maternal obesity and can lead to adverse neurodevelopmental effects leading to maladaptive programming of the fetal brain and poor neuro-development. Mechanisms postulated include: oxidative stress, neuroinflammation and dysregulated insulin, leptin, glucose, dopaminergic and serotonergic signaling. Some of the psychiatric and neurodevelopmental disorders include autism spectrum disorders , attention deficit hyperactivity disorder, schizophrenia, depression , anxiety and eating disorders .The increased risk of asphyxia in obesity also predisposes offspring to cerebral palsy (CP) and epilepsy(77–79).

The majority of the studies referenced above were carried out in high income countries with predominantly Caucasian populations where health care is optimized. Therefore, we need to carry out more studies in developing countries such as Kenya where resources are scarce so that tailor made local guidelines to help prevent and manage complications arising from overweight and obesity can be formulated. This is also in line with the one of the current Big four agenda being championed by the current regime of universal health coverage.

2.4 Conceptual Framework

2.4.1 Conceptual Framework Narrative

Women were stratified as exposed (above normal BMI) and non-exposed (normal BMI). Determinants of BMI are well known and some of them include dietary factors such as frequency of eating; behavioral and social factors such as socioeconomic status; Genetic (dysmorphic) factors such as Chromosomal abnormalities and sedentary lifestyle. These determinants stratified women in the various BMI classes. In the overweight and obese women, it is increasingly recognized that dysregulated metabolic, vascular , inflammatory and nutrient sensing pathways can lead to fetoplacental dysfunctions and abnormal intrauterine that not only affects pregnancy and neonatal outcomes but also the long term health of the infant as opposed to women with normal BMI who have adequate fetoplacental functions and normal intrauterine environment .

Therefore, women with a high BMI have an increased risk of adverse maternal and perinatal outcomes with resultant higher number of healthcare admissions and higher associated maternity costs.

Obesity is global epidemic and it has a huge impact on maternal morbidity and mortality with up to a quarter of all pregnancy complications associated with obesity. Prevalence of obesity is on the rise in Kenya as communities undergo a socioeconomic transition with a diverse nutritional status across the population. Most of the current evidence on BMI is however from high income countries. The rising obesity prevalence can negatively impact the already high maternal and infant mortality rate and therefore it is important to establish local up-to-date baseline information on BMI and its possible consequences for mothers and babies. This study therefore aims to prove the adverse effects of high BMI on pregnancy outcomes.

Outcomes of interest included:

High and normal BMI for Sociodemographic characteristics

Maternal-Hypertensive disorders of pregnancy, preterm and post term delivery, PROM, mode of delivery-SVD, AVD, Breech delivery and caesarian section with indications, duration of hospital stay and postpartum hemorrhage.

Perinatal outcomes of interest include SGA, LGA, RDS, fifth minute Apgar score <7 and perinatal deaths.

2.4.2 Diagrammatic Representation of Conceptual Framework

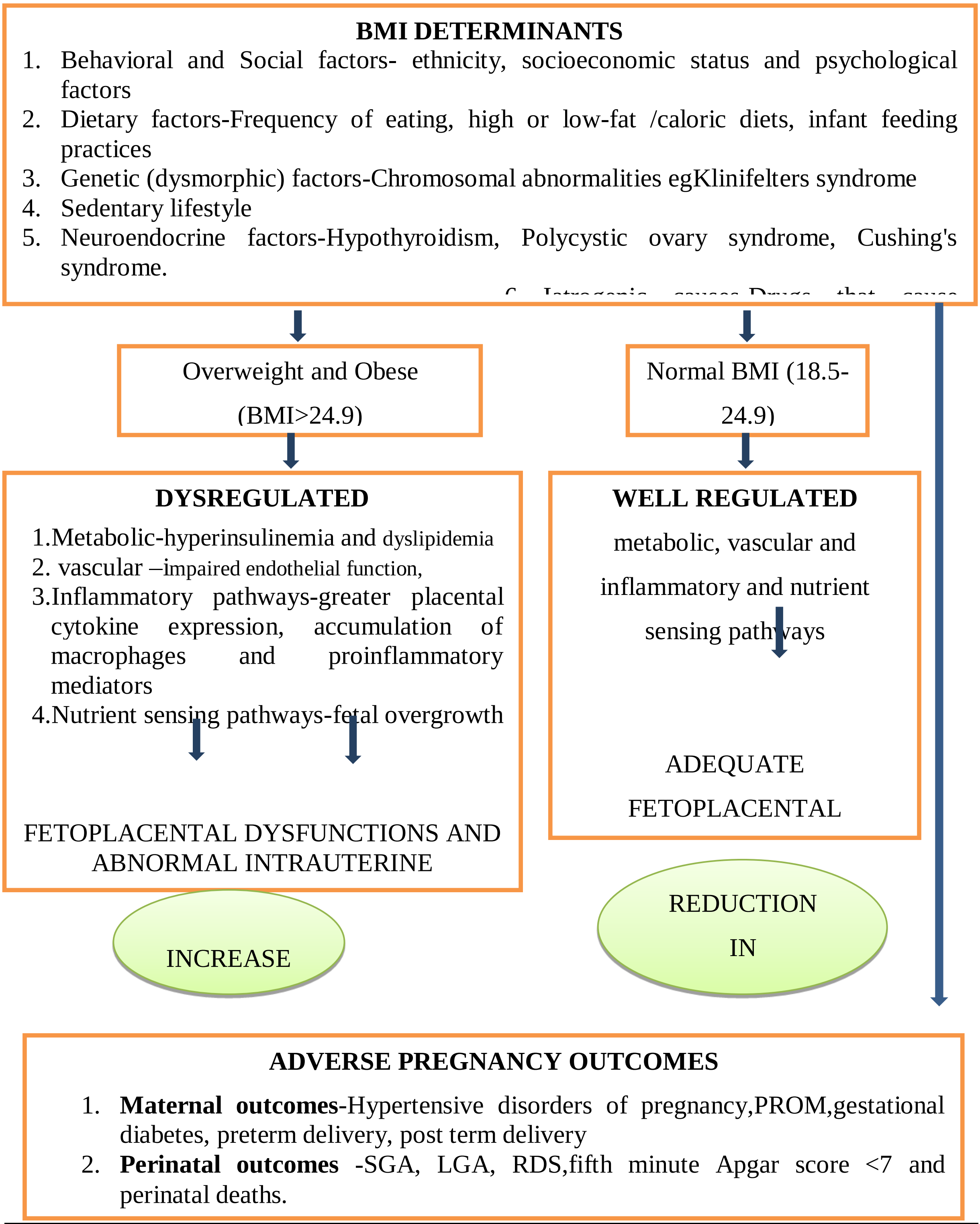

Figure 1. Conceptual framework

2.5 Theoretical Framework

Theoretical Domains Framework elucidated by Phillips et al guided the conduction of this study. This theory covers three themes, which provide a useful framework for health professionals assessing barriers to implementation of projects. Developed through expert consensus, TDF includes factor validation and analysis for analyzing clinical behavior change. It has 84 contracts in 14 domains evaluating psychological and behavioral health conditions such as obesity.

2.6 Study Justification

Local guidelines regarding ideal body mass index (BMI) are adopted from international organizations such as WHO due to paucity of local data on BMI. The cutoffs provided by WHO as guidelines can underestimate the risk associated with high BMI as has been proven in some studies in South Asian populations. In this population, the degree of cardiovascular risk in relation of percentage of body fat is attained at a much lower BMI in these South Asian subjects when compared to other populations globally. The results suggest that the relationship between percent body fat and BMI varies with different ethnic groups and hence cut-off points for overweight and obesity for definitions of different categories of BMI should be population-specific. This suggests that revision of the standard WHO BMI cut off guidelines provided is necessary to define overweight and obesity among different ethnic groups.

Majority of the evidence and data on BMI is generated and mainly on Caucasian populations. Limited local data is available supporting standard international guidelines such as the WHO guidelines on whether the results are appropriate for a Kenyan population and the few studies done have focused on the urban population. Therefore, there is an urgent need to determine the contextual relevance of these recommendations in Kenya and to thoroughly assess the contributions of body mass index to pregnancy outcomes in diverse population groups of varied SES and ethnicity in order to adopt culturally appropriate interventions and ethnic specific interventions to improve mother and child health.

Kenya has also been experiencing an economic and social transition fueled by urbanization that is influencing nutritional, population demographics and the health status especially among pregnant women(33). Therefore, diseases associated with obesity such as hypertension and diabetes mellitus are on the rise. Further research into effects of the shift in dietary and lifestyle pattern on women of the reproductive age needs to be done as data in this area is limited.

2.7 Research Question

Is high BMI associated with adverse pregnancy outcomes among women who delivered at Webuye county hospital in 2019?

2.8 Null Hypothesis

There is no association between high Body Mass Index and adverse pregnancy outcomes among women who delivered at Webuye County Hospital in 2019.

2.9 Objectives

2.9.1 Broad Objective

To determine the association between high Body Mass Index and adverse pregnancy outcomes at Webuye County Hospital in 2019.

2.9.2 Specific Objectives

Among women who delivered at Webuye County Hospital in 2019:

- **a)** To determine the sociodemographic characteristics of all the study participants.
- **b)** To determine the association between high Body Mass Index and adverse maternal outcomes
- **c)** To determine the association between high Body Mass Index and adverse perinatal outcomes

3.0 CHAPTER THREE: STUDY METHODOLOGY

3.1 Study Design

This was a retrospective cohort study conducted through a review of medical files for women with high BMI (exposed) and normal BMI (non-exposed) who delivered at the Webuye County hospital. The cumulative incidence rate of adverse pregnancy (maternal and perinatal) outcomes for each group was determined and compared

3.2 Study Site

This study was carried out in Webuye county hospital (WCH). WCH is strategically located to serve a catchment population of about 500,000 people covering mainly Bungoma County, Busia County, Kakamega County, Trans-Nzoia County and even some western parts of Uganda. It currently has a total bed capacity of 217 with approximately 150% bed occupancy rates serving around 150-200 patients daily suffering from diverse conditions mainly from rural population and of low socioeconomic status therefore would be an ideal study site.

The theatre on average operates on approximately 125 to 145 patients per month and has one general surgeon and obstetrician and more than 10 residents attached to the family medicine department of Moi University. The hospital is in close partnership with NGO's and AMPATH through UN which offers family and public health care, Moi University through the department of family medicine, EMBLEM which conducts research through Moi Teaching and Referral Hospital in various medical fields such as cervical cancer.

The hospital also has a medical training college offering a vast range of courses such as an internship Centre for clinical officers, pharmacists and medical officers as well as a training facility for other medical professionals like Family medicine residents. The obstetrics unit is headed by the resident Obstetrician and consists of one antenatal ward, one postnatal ward, labor ward, and gynecology ward all with a cumulative bed capacity of 40. Antenatal and post-natal clinics run every week and have a cumulative average attendance of 60 patients per week. An average of 300 monthly deliveries are carried out in WCH with around a third of the total deliveries being caesarian deliveries (100) and the rest being spontaneous vaginal deliveries (200). The maternity operating theatre is situated in the labor ward and carries out an average of 5 obstetric and gynecological operations per day. The hospital management is done through the HMT whose chairman is the medical superintendent. The hospital management board, COH and the CEC Bungoma County, ratifies decisions. The medical superintendent is assisted by the hospital administrator, the nursing officer in charge and the heads of other departments in running the hospital.

3.3 Study Population

The study population was files of pregnant women who attended ANC at or before 20 weeks of gestation at WCH in the period of 1stJanuary 2019 to 31stDecember 2019.Files were chosen retrospectively from a centralized database of clinical records of pregnant women with both normal and high BMI2019 at WCH. Since this was a retrospective study, the data on BMI was retrieved from ANC booklets from clinic attendances where height and weight of women are recorded during antenatal visits. WCH uses a standardized procedure for determining BMI.

3.3.1 Inclusion Criteria

a) Women who delivered at WCH with complete WCH antenatal records.
b) Women who delivered at WCH with BMI more than 18.5kg/m2
c) Women who delivered at WCH who had WCH antenatal bookings at or before 20 weeks of gestation. (KDHS 2014 only 20 % of women had their first ANC visit in the hence if we limited to 13 weeks the desired sample size would not be achievable).
d) Women who delivered at WCH who attended ANC at WCH regardless of age.

3.3.2 Exclusion criteria-records of:

a) Women who delivered at WCH who were underweight (BMI less than 18.5kg/m2).The study sought to only prove the effects of adiposity on pregnancy outcomes.
b) Women who delivered at WCH with multiple gestations.
c) Women who delivered at WCH on drugs that might alter BMI like tricyclic antidepressants.

3.4 Sample Size Calculation and Sampling Procedure

3.4.1 Sample Size Determination

The assumptions for the calculation of the sample size have been derived from a study by Ding et al (85), where the prevalence of pregnancy complications in high maternal BMI was estimated to be 8.81% among pregnant women and the prevalence of pregnancy complications among normal pregnant women with normal BMI is about 1.432%.In order to demonstrate statistical significance between these two groups, with a confidence level of 95% and power of the 80%, the minimum required number of subjects to be delivered in each group was 172. We added 20% to the sample size in order to compensate for incomplete records, if any.

$$n = \frac{\left(Z\alpha\sqrt{\left(1+\frac{1}{\mathrm{m}}\right)\mathrm{p}*(1-\mathrm{p}*)} \; + \; Z\beta\sqrt{\mathrm{P0}\,\frac{1-\mathrm{P0}}{\mathrm{m}} + \mathrm{P1}(1-\mathrm{p1})}\right)^2}{(P0-P1)^2}$$

This **Fleiss** formula for calculation of sample size in cohort studies(86) gives the minimum number of case subjects required whereby:

Zα= Standard normal variate for level of significance

Zα = 1.96

m= Number of exposed subject per experimental subject

M = 1 (with equal number of exposed and non-exposed)

Zβ= Standard normal variate for power or type 2 error (Standard normal variant for For 80% power it is 0.84)

Zβ = 0.84

P0 = Probability of events in non-exposed group

P0 = 0.01432

P1= Probability of events in exposed group p

P1 = 0.0881

$$\mathrm{P}* = \frac{\mathrm{P1} + \mathrm{MP0}}{\mathrm{M}+1}$$

$= \frac{0.0881+1(0.01432)}{1+1} = \frac{0.10242}{2} = 0.05121$

$$n = \frac{\left(1.96\sqrt{\left(1+\frac{1}{1}\right)\times 0.05121(1-0.05121)} \; + \; 0.84\sqrt{0.01432\,\frac{1-0.01432}{1} + 0.0881(1-0.0881)}\right)^2}{(0.01432-0.0881)^2}$$

$$n = 138 \text{ per arm}$$

Correcting for a potential incomplete records rate of 20% (r =0.20) give us:

$\frac{n}{(1-r)} = \frac{138}{(1-0.20)}$ = 172 per arm.

For each group we needed to enroll 172 cases/participants.

Total minimum sample size = 172×2 = 344 cases/participants

This formula gave the minimum number of case subject required to detect

3.4.2 Sampling Procedure

Consecutive sampling was used in this study. A total of 3741 deliveries were carried out in WCH in 2019.Patients who met the eligibility criteria were recruited consecutively from medical records of women who delivered in WCH from January to December of 2019 and attended ANC in WCH until the sample size was reached. Averages of 30 participants were recruited every month. Information on BMI was obtained from ANC booklets attached to the delivery files and calculated from height and weight routinely taken at the first antenatal visit. The exposed group entailed mothers who were booked in ANC before 20 weeks of gestation with a high BMI (≥25kg/m2) with complete hospital charts and eventually delivered in WCH in 2019.

The hospital files were checked and women who met the inclusion criteria recruited until the sample size was reached. The non-exposed group entailed mothers who were booked in ANC before 20 weeks of gestation with a normal BMI (18.5–24.9kg/m2) with complete hospital charts and eventually delivered in WCH in 2019. Pregnancy outcome records were retrieved from the delivery files. Files were retrieved from hospital archives, checked, and qualified mothers recruited until the sample size was reached. This procedure was appropriate for this study because of the small proportion of the exposed group compared to general population. It was also less prone to selection bias.

3.5 Study Variables

Table 2:Study Variables

Objective	Exposure Variable	Outcome Variable	Source of Data
To compare the Sociodemographic characteristics among women who delivered at WCH in 2019	Maternal age, marital status, ethnicity, Area of Residence, Educational Level and Occupation of participant and spouse and parity.	High BMI Normal BMI	Medical Records
To determine the association of high BMI and Maternal Outcomes	High BMI	Hypertensive disorders of pregnancy, , , preterm delivery, gestational diabetes post term delivery, PROM ,mode of delivery-SVD, AVD, Breech delivery and caesarian section with indications and its indication, postpartum hemorrhage and duration of hospital stay.	Medical Records
To determine association of high BMI and perinatal outcomes	High BMI	SGA, LGA, RDS, fifth minute Apgar score <7 and perinatal deaths.	Medical Records

3.6 Data Collection Procedure

All the records of the patients eligible for the study period were retrieved from the hospital registry. The major source of the data for this study was the WCH central registry and health records and information unit in the maternity department. The files and registers of patients that satisfied the inclusion criteria for the study were reviewed and relevant information extracted. The data was collected by a research assistant or by the principal investigator. The collection data tool was structured to help for collection of data.

3.7 Training of the Research Team

The research team comprising the research assistants who were qualified nurses stationed at WCH and the data manager were taken through training on collection of data processes and process of retrieval of data files from the registry by the principal investigator. The team was trained on eligibility criteria, enrolment issues, data collection and entry the standard operating procedure and as on data collection methods, sampling of patients, confidential and ethical issues that were to be addressed when performing the study.

3.8 Quality Assurance Procedures

The questionnaires were pre- tested in a peripheral hospital and analyzed before it was administered to the study participants. The research assistants were trained on appropriate interview techniques and filling the data extraction tool. Recording of outcomes were entered after thorough scrutiny. Unique identifiers were assigned to all the study participants. If double entries were discovered, one of the data extraction tools was withdrawn, discarded and serialization rectified. Information filled on the questionnaires was checked for any errors and corrected.

3.9 Ethical Considerations

The study proposal was submitted to the KNH/UON ERC for approval before the commencement of the study. Permission from the department of obstetrics and gynecology UON and the WCH administration was also sort in order to carry out the study. Since the study is retrospective the patients' consent was both required but requested a waiver for consent for the study from the ethics committee. Confidentiality of patient's data was also maintained.

3.10 Data Management and Analysis Methods

The data collected was uploaded into the SPSS version 23 software for cleaning, coding and analysis. Descriptive data on socio-demographic, obstetric, and neonatal outcomes were analyzed and presented as proportions in tables. The Levene's test was used to assess the homogeneity of the data variables between the two groups. The numerical variables such as age and BMI were presented as means and the difference in means or medians calculated using the Mann-Whitney U test Relative risk was the measure of association. P value <0.05 was significant. Bivariable analysis were done to compare the maternal-Hypertensive disorders of pregnancy, preterm and post term delivery, PROM, induction of labor and its indications, caesarian deliveries and indications, duration of hospital stay and postpartum hemorrhage. Multivariable analysis was done using Cox regression and Analysis of Covariance.

Perinatal outcomes of interest included RDS, SGA, LGA, fifth minute Apgar score <7 in 5 minutes and perinatal deaths between the exposed and the non-exposed groups. A p value of 0.05 was taken as statistically significant.

3.11 Dissemination of Study Findings

Study findings will be disseminated in form of a dissertation to the department of Obstetrics and Gynecology of the University of Nairobi, Kenyatta National Hospital Research Department, the KNH/UoN Ethics review committee and the Webuye County Academic Department. A presentation will be made at the annual KOGS conference after completion of the study and a manuscript published in a peer reviewed journal of Obstetrics and Gynecology.

3.12 Outcome Measures

Outcomes of interest included:

High and normal BMI for Sociodemographic characteristics

Maternal-: Hypertensive disorders of pregnancy, preterm and post term delivery, PROM, induction of labor and its indications, caesarian deliveries and indications, duration of hospital stay and postpartum hemorrhage.

Perinatal outcomes of interest include RDS, SGA, LGA, fifth minute Apgar score <7 and perinatal deaths

4.0 CHAPTER FOUR: RESULTS

4.1 Study Flow Chart

The hospital charts of369patients of a total of 3741 deliveries in WCH between January 1 and December 31 2019 with high BMI (N-189) and normal BMI (N=180) were reviewed. Among the 189with high BMI, 11 were excluded, 10 for having unclear health records. One hundred and seventy-eight (178) met the inclusion criterion and were recruited and demographic, medical, maternal, and perinatal data collected and analyzed. Among the 180 with normal BMI, eight were eliminated for having unclear health records. One hundred and seventy-two (172) met the inclusion criterion and were recruited and data collected and analyzed (Figure 2).

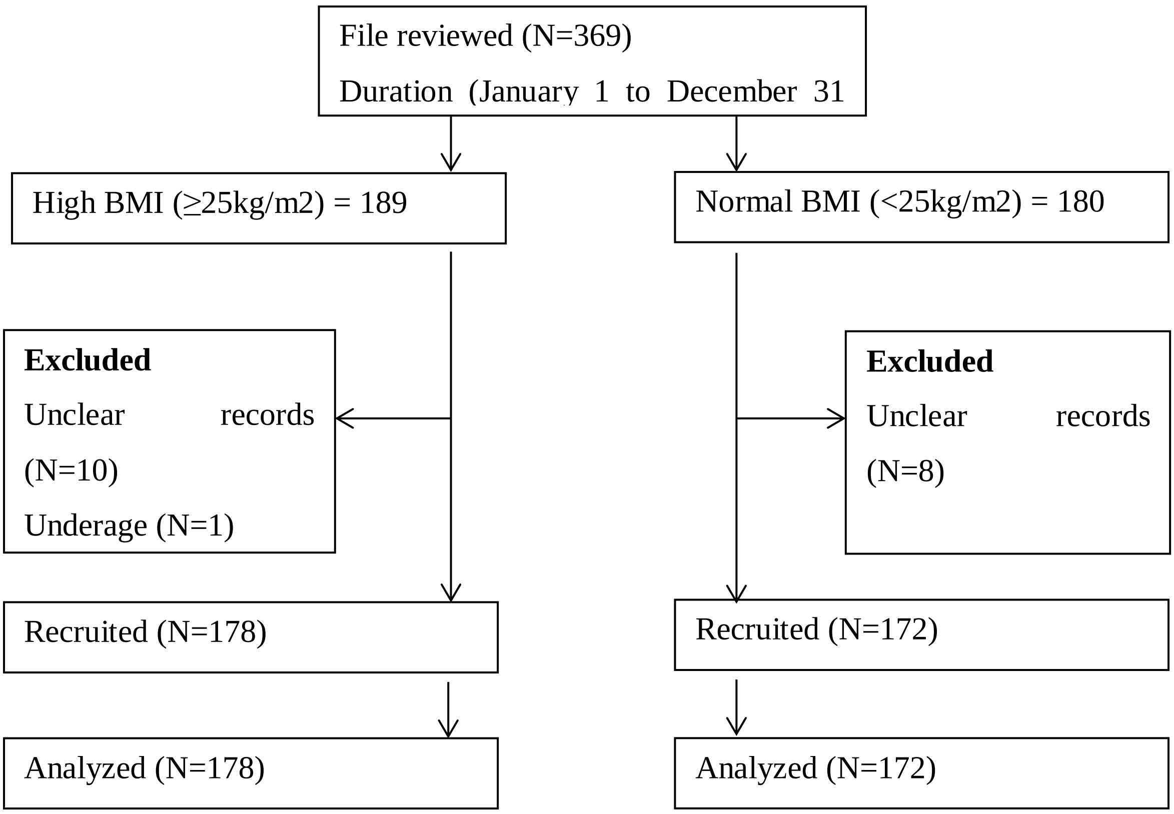

Figure 2.Study Flow Chart

Table 3:Demographic and medical characteristics of women who delivered at Webuye County Hospital with a high and normal BMI

		BMI			
		High (178)	Normal (172)	RR (95% CI)	P Value
Age in years	Mean±SD	25.59±5.25	26.88±5.80	-	0.749
Marital status	Single	16 (9.0)	22 (12.8)	0.80 (0.52-1.13)	0.237
	Married	162 (91.0)	148 (86.0)	Reference	
	Separated	0 (0.0)	2 (1.2)	-	
Ethnicity	Luhya	159 (89.3)	136 (79.1)	Reference	
	Kisii	6 (3.4)	4 (2.3)	1.11 (0.57-1.58)	0.703
	Luo	6 (3.4)	10 (5.8)	0.69 (0.34-1.15)	0.200
	Kikuyu	3 (1.7)	9 (5.2)	0.46 (0.16-0.99)	0.050
	Kalenjin	4 (2.2)	6 (3.5)	1.23 (0.55-1.72)	0.534
	Kamba	0 (0.0)	4 (2.3)	-	0.031
	Somali	0 (0.0)	1 (0.6)	-	0.280
	Teso	0 (0.0)	2 (0.6)	-	1.127
Residence	Urban	6 (3.4)	7 (4.1)	Reference	
	Rural	154 (86.5)	151 (87.8)	1.09 (0.69-2.19)	0.759
	Peri-urban	18 (10.1)	14 (8.1)	1.21(0.68- 2.55)	0.538
Type of residence	Rental	21 (11.8)	19 (11.0)	1.03 (0.72-90 to 1.364	0.825
	Own home	157 (88.2)	153 (89.0)	Reference	
Education level	None	2 (1.1)	0 (0.0)	-	
	Primary	55 (30.9)	60 (34.9)	0.78 (0.60-1.05)	0.104
	Secondary	84 (47.2)	88 (51.2)	0.80 (0.63-1.05)	0.112
	Tertiary	37 (20.8)	24 (14.0)	Reference	
Occupation	Unemployed	120 (67.8)	110 (64.0)	1.26 (0.79-2.43)	0.381
	Self employed	43 (24.3)	51 (29.7)	1.11 (0.66-2.18)	0.727
	Salaried	7 (4.0)	10 (5.8)	Reference	
	Casual	7 (4.0)	1 (0.6)	1.21 (0.21-3.30)	0.811
	Not known	1			
Spouse education	None	0 (0.0)	2 (1.3)	-	
	Primary	17 (10.2)	17 (11.3)	0.91 (0.59-1.30)	0.631
	Secondary	104 (62.7)	94 (62.7)	0.95 (0.76-1.229)	0.719
	Tertiary	45 (24.1)	37 (24.7)	Reference	
	Not known	12	22		
Spouse occupation	Unemployed	8 (4.8)	7 (4.7)	0.83 (0.45- 1.33)	0.481
	Self employed	125 (75.3)	116 (78.4)	0.81 (0.63-1.11)	0.177
	Salaried	23 (13.9)	13 (8.8)	Reference	
	Casual	10 (6.0)	12 (8.1)	0.71 (0.40-1.14)	0.169
	Not known	12	24		
Booking gestation	Mean±SD	14.06±3.87	13.69±3.97		0.408
Viable pregnancies	Mean±SD	1.31±1.36	1.44±1.39		0.336
Previous Miscarriages	Mean±SD	0.11±0.38	0.15±0.54		0.983
Gestation	Mean±SD	38.46±2.01	38.90±4.88		0.275
Delivery Systolic BP	Mean±SD	120.24±15.02	120.57±14.16		0.692
Delivery Diastolic BP	Mean±SD	76.26±10.52	74.02±14.11		0.203

4.2 Demographic and Medical Characteristics

The demographic characteristics of women with high BMI compared to normal BMI are presented in Table 2. Women with high BMI compared to women normal BMI were less likely to be single than married but not statistically significantly (RR=0.80, 95% CI= (0.52-1.13, P=0.237). Luhya was the predominant ethnicity among women with high BMI (89.3%) and normal BMI (79.1%), but the 10.2% difference was not statistically significant. Women with a high BMI compared to a normal BMI were 1.21-fold (95% CI=0.68- 2.55) more likely to reside in a peri-urban areas but the difference was not statistically significant (P=0.538).

The education, occupation, booking gestation, viable pregnancies, and blood pressure of women with a high BMI compared to a normal BMI were also comparable on admission. Medical data of patients with a high BMI compared to a normal BMI were similar. The mean booking gestation was higher when BMI was high (14.06±3.87) compared to normal (13.69±3.97) but not statistically significant (P=0.408), while the mean number of viable pregnancies was higher with a normal BMI (1) compared to a high BMI (0) but not statistically significantly (P=0.336). Mean gestation at delivery, systemic blood pressure, and diastolic blood pressure was within a normal range for a majority and similar statistically with a high BMI compared to a normal BMI.

Table 4: Maternal outcomes of women who delivered with a high and normal BMI

		BMI		Bivariate		Multivariable	
		High (178)	Normal (172)	RR (95% CI)	P value	ARR (95% CI)	P value
HDP	Yes	23 (13.1)	16 (9.4)	1.18 (0.85-1.52)	0.274	1.14 (0.45-2.89)	0.768
	No	152 (86.9)	154 (90.6)	Reference			
	Not known	3	2				
Labor onset	Spontaneous	163 (97.0)	163 (96.4)	Reference			
	Induced	5 (3.0)	6 (3.6)	0.90 (0.42-1.46)	0.766	0.82 (0.04-15.89)	0.898
	Not known	10	3				
Labor duration (1st)	Mean±SD	8.02±3.75	8.45±3.21	-	0.138	-	0.485
Labor duration (2nd)	Mean±SD	17.30±9.90	17.63±10.14	-	0.982	-	0.372
Mode of delivery	SVD	143 (80.8)	148 (86.0)	Reference			
	Caesarian section	34 (19.2)	24 (14.0)	1.19 (0.91-1.49)	0.187	1.54 (0.80-2.95)	0.190
Type of CS	Elective	3 (8.8)	2 (8.3)	Reference	0.948		
	Emergency	31 (91.2)	22 (91.7)	1.02 (0.38-1.68)	0.947	0.97 (0.38-2.48)	0.956
Blood loss in mls	Mean±SD	254.72±163.70	231.77±163.70		0.510		
Post-Partum Hemorrhage	Yes	4 (2.3)	2 (1.2)	1.31 (0.58-1.84)	0.435	3.51 (0.145-84.4)	0.431
	No	173 (97.7)	169 (98.8)	Reference			
	Not known	2	1				
Length of hospital stay	Mean±SD	2.29±1.20	2.33±1.55	-	0.512	-	0.344

4.3 Maternal Outcomes

High BMI compared to normal was not associated with adverse pregnancy outcomes. The risk of HDP was 1.18 fold (95% CI=0.85-1.52) higher among women with a high BMI compared to normal BMI but the difference was not statistically significant (P=0.274). Labor induction was 0.90 fold (95% CI=0.42-1.46) lower among women with high BMI compared to normal BMI but not statistically significantly (P=0.766), while the duration of first stage of labor (8.02±3.75 versus 8.45±3.21 hours) and second stage of labor (17.30±9.90 versus17.63±10.14 minutes) were statistically similar between women with a high BMI compared to normal BMI. The risk of caesarian delivery was 1.19 fold (95% CI=0.91-1.49) higher among women with a high BMI compared to normal BMI but not statistically significantly (P=0.190) with a higher risk of emergency caesarian delivery among high BMI versus normal BMI 1.02 (95% CI =0.38-1.68).The mean blood loss during delivery was higher in high BMI versus normal BMI although not statistically significant (254.72±163.70 versus 231.77±163.70). The risk of PPH was 1.31 fold (95% CI=0.58-1.84) higher among women with a high BMI compared to normal BMI but not statistically significantly (P=0.435), while the length of hospital stay was statistically similar (2.29±1.202.33±1.55days, respectively), P=0.512.

Table 5:Perinatal outcomes of women who delivered with a high and normal BMI

		High (178)	Normal (172)	RR (95% CI)	P value	ARR (95% CI)	P value
Gestation at birth	Preterm	32 (18.2)	32 (18.7)	0.97 (0.72-1.25)	0.873	0.93 (0.45-1.91)	0.850
	Post term	5 (2.8)	6 (3.5)	0.88 (0.41-1.44)	0.713	0.73 (0.00-904.7)	0.930
	Term	139 (79.0)	133 (77.8)	Reference			
	Unknown	2	1				
Birth outcome	Live	171 (96.6)	163 (94.8)	Reference			
	Still	6 (3.4)	9 (5.2)	0.78 (0.38-1.27)	0.396	0.37 (0.06-2.15)	0.273
	Unknown	1					
Birth weight (grams)		3052.62±520.94	3099.88±511.04		0.558		0.462
SGA	Yes	31 (17.4)	26 (15.3)	1.07 (0.80-1.36)	0.593	1.33 (0.62-2.83)	0.454
	No	147 (82.6)	144 (84.7)	Reference			
	Unknown		2				
LGA	Yes	2 (1.1)	4 (2.3)	0.65 (0.18-1.38)	0.386	2.13 (0.05-84.4)	0.687
	No	175 (98.9)	167 (97.7)	Reference			
	Unknown	1	1				
NBU admission	Yes	3 (1.7)	3 (1.7)	0.98 (0.36-1.63)	0.972	1.00 (0.08-12.47)	1.000
	No	174 (98.3)	169 (98.3)	Reference			
	Unknown	1					
Apgar at 5 minutes	<7	4 (2.3)	0 (0.0)	-	**0.048**		0.985
	7+	173 (97.7)	171 (100)	Reference			
	Unknown	2	1				
Early neonatal death	No	175 (100)	169 (100)	-	-	-	-
	Unknown	3	3	-	-	-	-

4.4 Perinatal Outcomes

High BMI compared to normal was not associated with adverse perinatal outcomes (Table 5). Low Apgar at 5 minutes was higher among women with a high BMI compared to normalnot significantly after adjusting for confounding factors (P=0.985). The risk of preterm birth was 0.97 fold (95% -+CI=0.72-1.25) lower among women with a high BMI compared to a normal BMI but the difference was not statistically significant (P=0.873). Risk of stillbirth was 0.78 fold (95% CI 0.38-1.27) lower among women with a high BMI compared to a normal but the difference was not statistically significant (P=0.396). Birth weight of babies of women with a high BMI (3052.62±520.94) was similar to women with a normal BMI (3099.88±511.04), while small for gestation age was 1.07 fold (95% CI=0.80-1.36) higher among women with a high BMI compared to a normal BMI but the difference was not statistically significant (P=0.593).The rate of NBU admission was similar among high versus normal BMI with no statistical difference (3 versus 3 P=1.00).There were no early neonatal deaths recorded in both BMI classes of interest.

5.0 CHAPTER FIVE: DISCUSSION, CONCLUSION, AND RECOMMENDATIONS

5.1 Discussion

The primary aim of the study was to evaluate the association between BMI and adverse pregnancy outcomes in WCH. The data of 350 mothers with a high BMI (178) and normal BMI (172) was reviewed and analyzed using statistical techniques. From the findings, high BMI was not associated with adverse maternal outcomes such as PPH, caesarian section births, hypertensive disorders of pregnancy and length of hospital stay, but was associated with a marginal increase in the odds of adverse perinatal outcomes.

While Apgar scores at 5 minutes were mostly normal for a majority of neonates, babies born to women with a high BMI were more likely to have poor Apgar scores at five minutes compared to those born to women with a normal BMI. Birth outcomes (still or live), the need for NBU admission, and the incidence of small for gestation age and large for gestation age were comparable between women with a high BMI and normal BMI, but the extremes of the BMI such as obesity and morbid obesity were not evaluated separately.

HDPs were higher among women with a high BMI1.18 fold (95% CI=0.85-1.52) compared to a normal BMI but not significantly statistically, contradicting published data. Scott-Pillai et al. in a retrospective study in a tertiary unit in Northern Ireland in 2004 to 2011(88) found a high incidence of HDP among obese compared to normal women. In both studies, obese and morbidly obese patients were evaluated as separate groups and had the highest burden for HDP compared to women with a normal BMI. In this study, overweight, obese, and morbidly obese mothers were analyzed as a single group.

Women with a high BMI had a 1.19-fold (95% CI 0.91-1.49) increased risk of caesarian section delivery compared those with a normal BMI, although the difference was not statistically significant. Some of the risks associated with a higher BMI include preterm and post term deliveries and higher infant birth weight. Emergency caesarian sections were the commonest irrespective of the level of BMI but the prevalence rate was comparable. Our data complemented the findings of Chu et al. (2007) (97) where a meta-analysis of the current literature from Pub med and review articles published between 2000 and 2005found no evidence that caesarian deliveries might be correlated with the BMI of mothers.

From our findings, BMI does not seem to be a significant predictor for caesarian deliveries when labor progression is normal and adjustment for obesity related pregnancy complications such as HDPs was done. A majority of obesity-induced CS are predominantly due to failure of labor to progress (100,101).Labor progression however according to our findings was mostly normal.

With regard to post-partum hemorrhage (PPH), women with a high BMI had an increased risk of developing PPH1.31 fold (95% CI=0.58-1.84) compared to normal BMI but not statistically significant. Overall, 1% more women who had a higher BMI had PPH, but this difference was negligible. Our findings were in line with the findings of Fyfe et al. (2012) in a study population at National Women's Hospital, Auckland New Zealand(102) ,where obesity was not associated with a higher risk for PPH (≥1000mls), especially when women deliver vaginally at term. Postpartum hemorrhage risk is known to vary according to mode of delivery with the lowest risk in vaginal delivery. In our study population, over three quarter of women with a high BMI and a normal BMI delivered vaginally. Our findings suggest that a high BMI is not a significant risk factor for postpartum hemorrhage.

From the data, the birth outcomes of babies did not seem to differ statistically among mothers with a high BMI compared to a normal BMI. The gestation at birth was mostly at term for both mothers with a high and normal BMI which could explain the findings. In an 'Early CHARITÉ (EaCH)' study by Ott et al. that included 205 mother-child dyads, recruited between 2007 and 2010, from women with treated GDM and delivery at the Clinic of Obstetrics, Charité – Universitätsmedizin Berlin, Germany(106) had similar findings.

The finding that a high BMI compared to a normal BMI was associated with a higher incidence of poor Apgar scores at five minutes (<7) supports the body of literature published prior in the developed and developing countries. Zhu et al. conducted a systematic review of eleven cohort studies with a total of 2,586,265 participants(107) reported a 1.13 fold increase in the odds of poor Apgar scores at 5 minutes among overweight women compared to normal weight women in a systematic analysis of offspring Apgar and maternal obesity in Sichuan China, increasing exponentially with increasing BMI. Chen et al. (2010) reviewed data obtained from Maine State Birth Records Database, USA and analyzed information on 58,089 white women and their newborns(108) reported a 1.4-2.0 fold increase in the odds of poor Apgar at 5 minutes in obese and morbidly obese mothers compared to others with a normal weight, while obese compared to normal weight mothers were 31% more likely to deliver low Apgar babies. In a Belgian registry study by Minsart et al. (2013) (109) and SB L et al , in an institutional review on medical information abstracted from all deliveries at

University of Florida Health in December 2013(110) reported similar findings respectively. Additionally, a high BMI is associated with endothelial dysfunction, altered lipid metabolism(111) and exaggerated inflammatory responses even in the absence of clinical disease. Decreased placental perfusion, placental thrombosis leading to abruption and placental infarction is caused by hyperlipidemia that leads to decreased prostacyclin secretion and increases thromboxane production(113) in later pregnancy (114)which can all lead to poor Apgar scores. From these finding, maternal obesity seemed to have an adverse effect on neonates, necessitating robust/ routine post-delivery care to improve outcomes.

From the data, BMI did not seem to influence the development of babies adversely in utero. While birth weight was lower when BMI was high compared to normal, the difference was by chance. Moreover, SGA deliveries were higher when BMI was high compared to normal but not statistically significantly. This contradicted the findings of Papazian et al. in a retrospective cross sectional observational study in Lebanon through the National Collaborative Perinatal Neonatal Network, in Lebanon (2017) (119) on 1000 term deliveries that identified obesity as an adverse prognostic factor for fetal development. Like other authors (91,115) Papazian et al. (2017) categorized BMI in four levels (underweight, normal, overweight, and obese), with a significant association reported at higher BMI levels. This might explain the difference in findings, as we categorized BMI in two levels (normal/ high). From these findings, obese women seem to bear the greatest risk for SGA. Overweight women might have a comparable risk to normal women but more studies are needed.

5.2 Conclusion

- Findings from this study suggest that individuals classified as overweight with respect to their BMI, by and large, had the same or in some instances better health profile outcomes as compared to those who had a normal BMI.
- Critical post-delivery care of neonates should be anticipated, as the risk of a poor Apgar score is higher with a high BMI. However, controlling for sociodemographic and reproductive characteristics, the association is non-existent.
- Preconception care to optimize BMI of women entering pregnancy.

5.3 Recommendations

- A follow up study to evaluate the maternal and perinatal outcomes of different classes of obesity is warranted as the higher BMI groups were underrepresented in our high BMI category.
- Is there a need to revise the international cut offs upwards to suit our population as there were no adverse pregnancy outcomes demonstrated? Follow up studies to thoroughly assess the effect of overweight on pregnancy outcomes among diverse populations is warranted.
- This study has identified a new area of research looking into the intrinsic limitations of BMI in differentiating lean body mass from adipose tissue or alternatively using other measures of adiposity with stronger associations to adverse health outcomes like waist circumference and waist-to-hip ratio. Other studies should use these alternate measurements and not BMI.

5.4 Funding

This was a self-sponsored study

5.5 Strengths and Limitations

The study was the first of its kind at Webuye County Hospital and a pacesetter for future studies outside Nairobi and its environs which has been the focus of most local studies. We have also added evidence from a diverse rural based population with varied SES and ethnicity to the pregnancy-related research and practice. The impact of BMI on adverse pregnancy outcomes was evaluated, which will guide policy formulation in future with a shift from treatment based polices to preventative policies aimed at ensuring women enter pregnancy in ideal weight categories to prevent further wastage of vital resources dealing with preventable conditions that cause adverse pregnancy outcomes such as obesity. The low rate of missing data and a large set of covariates analyses were other strengths.

Although the ideal gestational age to best reflect the effect of conception high BMI on pregnancy outcomes would have been BMI (up to 13 weeks) we chose 20 weeks as the closest co-relatable entry gestational age point because according to KDHS 2014 only 20 % of women had their first ANC visit in the hence if we limited to 13 weeks the desired sample size would not be achievable given the timelines indicated for this study. Most of the studies in this area have also used 20 weeks as the entry point. Some of the eligible patients had incomplete data filled into their medical files leaving out information critical to the study hence disqualifying them, Moreover, because obese patients (class I, II, and III) were underrepresented in the study population, association between high BMI and adverse maternal and perinatal outcomes might have been underestimated. Future studies that evaluate obese women in their different class categories and pregnancy outcomes are warranted.

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APPENDICES

Appendix I: Data Extraction Tool

Baseline socio-demographic characteristics of women delivering in WCH between Jan 2019 and Dec 2019 in a retrospective cohort study to determine association between high BMI and adverse pregnancy outcomes

OBSTETRIC VARIABLES	NORMAL BMI n=	HIGH BMI (>25) n=	RR	P Value
Maternal age in years(SD)				
Marital status ○ Single ○ Married/Cohabiting ○ Separated/Divorced				
Area of Residence • Urban • Rural • Peri-urban				
Type of Residence ○ Rental ○ Own Home				
Educational Level ○ None ○ Primary ○ Secondary ○ Tertiary				
Occupation Unemployed Self employed Salaried Casual				
Spouse Educational level None Primary Secondary Tertiary				
Occupation ○ Unemployed ○ Self employed ○ Salaried ○ Casual				

Baseline anthropometric characteristics of women delivering in WCH between Jan 2019 and Dec 2019 in a retrospective cohort study to determine association between high BMI and adverse pregnancy outcomes

Variable	**Booking Week**	**Booking Weight**	**Booking Height**	**Booking BMI**
Non-Exposed Normal BMI N=172				
Exposed High BMI(>25) N=172				

Maternal outcomes of women delivering at WCH in 2019 in a retrospective cohort study to determine association between high BMI and adverse pregnancy outcomes

Maternal outcomes	NORMAL BMI n=	HIGH BMI >25) n=	RR	P Value
1. **Parity** **0** **1-2** **3 and above**				
2. **Last menstrual Period**				
3. **Current Gestation** 4. **Adverse Maternal Outcomes**				
5. **BP-** **Hypertensive Disorders in Pregnancy** ○ **Yes** ○ **No**				
6. **Random Blood Sugar** **Gestational Diabetes** ○ **Yes** ○ **No**				
7. **Preterm delivery** ○ **Yes** ○ **No**				
8. **Post term delivery** ○ **Yes** ○ **No**				
9. **Term Delivery** ○ **Yes** ○ **No**				
10. Onset of labor: Spontaneous ○ **Spontaneous** ○ **Induced**				
11. **Labor Duration: Prolonged** ○ **Yes** ○ **No**				
Duration of Labor in Hours of **1st stage** **2nd stage**				
12. **PPH AS PER HOSPITAL PROTOCOLS** ○ **YES** ○ **NO**				
Amount of Blood loss in mls				
Mode of Delivery				
Type of Delivery**:** SVD ○ **Yes**				

○ **No** AVD ○ **Yes** ○ **No** BREECH ○ **Yes** ○ **No** CS ○ **Yes** ○ **No**				
○ IF Caesarian Section Elective ○ **Yes** ○ **No** Emergency ○ **Yes** ○ **No**				
1. Attempted Tolac: Successful TOLAC ○ **Yes** ○ **No**				

Perinatal outcomes of women delivering at WCH in 2019 in a retrospective cohort study to determine association between high BMI and adverse pregnancy outcomes

Perinatal outcomes	**NORMAL BMI n=**	**HIGH BMI (>25) n=**	**RR**	**P Value**
Perinatal outcome Neonatal Outcome **LIVE BIRTH/STILL BIRTH** ○ **YES** ○ **NO**				
1. Severe Respiratory distress necessitating NBU admission ○ **Yes** ○ **No**				
2. . Apgar scores less than 7 in 5 Minutes ○ **Yes** ○ **No**				
3. Early Neonatal Death ○ **Yes** ○ **No** **If Yes: occurred within 24hrs** ○ **Yes** ○ **No**				
4. Birth Weight in gms				
SGA ○ **YES** ○ **NO**				
LGA ○ **YES** ○ **NO**				
5. Length of Hospital stay in Days**: more than 7 days** ○ **Yes** ○ **No**				
Actual duration of hospital stay in days				

Appendix II: Questionnaire

Unique Study Number …………………….   Date…………………………

A. SOCIODEMOGRAPHIC CHARACTERISTICS

1. Marital status
   - Single
   - Married/Cohabiting
   - Separated/Divorced
2. Ethnicity
3. Area of Residence
   - Urban
   - Rural
   - Peri-urban
4. Type of Residence
   - Rental
   - Own Home
5. Educational Level
   - None
   - Primary
   - Secondary
   - Tertiary
6. Occupation
   - Unemployed
   - Self employed
   - Salaried
   - Casual
7. **Spouse** Educational level
   - None
   - Primary
   - Secondary
   - Tertiary

8. **Spouse** Occupation
    - Unemployed
    - Self employed
    - Salaried
    - Casual
9. Booking Week(gestation by LMP or Ultrasound)
10. Weight at booking(kg)
11. Height at booking(cm)
12. BMI AT BOOKING

B. <u>OBSTETRICS AND GYNAECOLOGY HISTORY</u>

13. Parity-
14. Last menstrual Period
15. Current Gestation

C. <u>OUTCOMES</u>

16. BP-
17. Hypertensive Disorders in Pregnancy
    - Yes
    - No
18. Random Blood Sugar
19. Gestational Diabetes
    - Yes
    - No
20. Gestation at Delivery
21. Preterm delivery
    - Yes
    - No
22. Post term delivery
    - Yes
    - No

23. Term Delivery
    - Yes
    - No

24. Type of Delivery:
    - SVD
    - AVD
    - BREECH
    - CS

25. IF Caesarian Section

    Elective
    - Yes
    - No

26. Emergency CS
    - Yes
    - No

27. Previous Scar Attempted Tolac: Successful TOLAC
    - Yes
    - No

28. Onset of labor: Spontaneous
    - Spontaneous
    - Induced

29. Labor Duration: Prolonged
    - Yes
    - No

30. Duration of Labor in Hours of

    1st stage

31. Duration of Labor in Hours of

    1st stage

32. Amount of Blood loss in mls

33. PPH AS PER HOSPITAL PROTOCOLS

- YES
- NO

34. Neonatal Outcome: LIVE BIRTH/STILL BIRTH

- YES
- NO

35. Severe Respiratory distress necessitating NBU admission

- Yes
- No

36. Apgar scores less than 7 in 5 Minutes

- Yes
- No

37. Early Neonatal Death

- Yes
- No

38. If Yes: occurred within 24hrs

- Yes
- No

39. Birth Weight in grammes

40. SGA-<2700gm

- YES
- NO

41. LGA->4000gm

- YES
- NO

42. Length of Hospital stay in Days: more than 7 days

- Yes
- No

43. Actual length of Hospital stay in Days

Appendix III: Approval Letter From KNH/UON-ERC

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3rd September 2020

Dr. Kelvin Arnola Mukui
Reg. No.H58/7070/2017
Dept.of Obstetrics and Gynaecology
School of Medicine
College of Health Sciences
University of Nairobi

Dear Dr. Mukui

RESEARCH PROPOSAL – THE ASSOCIATION BETWEEN BMI AND PREGNANCY OUTCOMES AT WEBUYE COUNTY HOSPITAL IN 2019: A RETROSPECTIVE COHORT STUDY (P243/04/2020)

This is to inform you that the KNH- UoN Ethics & Research Committee (KNH- UoN ERC) has reviewed and **approved** your above research proposal. The approval period is 3rd September 2020 – 2nd September 2021.

This approval is subject to compliance with the following requirements:

a. Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b. All changes (amendments, deviations, violations etc.) are submitted for review and approval by KNH-UoN ERC before implementation.
c. Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
d. Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH- UoN ERC within 72 hours.
e. Clearance for export of biological specimens must be obtained from KNH- UoN ERC for each batch of shipment.
f. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal*).
g. Submission of an *executive summary* report within 90 days upon completion of the study.
This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/ or plagiarism.

Protect to discover