TO DETERMINE THE CORRELATION BETWEEN MATERNAL MALNUTRITION AND NEONATAL OUTCOMES AT MBAGATHI DISTRICT HOSPITAL

SUBMITTED BY

DR IBUA STEVEN

TEL: 0722656227

Email: smrefu@yahoo.com

PROPOSAL FOR DISSERTATION IN PARTIAL FULFILLMENT OF MASTER OF OBSTETRICS AND GYNECOLOGY OF THE UNIVERSITY OF NAIROBI

DECLARATION

This is to declare that this research is my original work and that it was done with the guidance of my supervisors. It has not been submitted to any other university for the award of a degree.

Signature .....

Date:

Dr Steven Mrefu Ibua

Senior House Officer

Department of Obstetrics and Gynecology

University of Nairobi

H58/64873/2010

CERTIFICATE OF SUPERVISION

This is to certify that this proposal was developed under my guidance.

Prof. Zahida Qureshi,

Chairperson, Department of Obstetrics and Gynecology,

School of Medicine, College of Health Sciences, University of Nairobi

Signature……

Date.....

Prof. Omondi Ogutu,

Associate professor, Department of Obstetrics and Gynecology,

School of Medicine, College of Health Sciences, University of Nairobi

Signature…….

Date.....

DEPARTMENT CERTIFICATE OF AUTHENTICITY

This is to certify that this dissertation is the original work of Dr Steven Mrefu Ibua, M.Med student registration number H58/64873/2010 in Obstetrics and Gynecology department, University of Nairobi (2010-2013). The research was carried out in the department of Obstetrics and Gynecology, School of Medicine, College of Health Sciences under the guidance and supervision of Prof. Zahida Qureshi and Prof. Omondi Ogutu. It has not been presented in any other university for award of a degree.

Sign: .....

Date: .....

Prof. Zahida Qureshi

Associate Professor of Obstetrics and Gynecology,

Consultant Obstetrician and Gynecologist

Chairperson

Department of Obstetrics and Gynecology

University of Nairobi

DEDICATION

To my beloved parents Mr. Elijah Ibua and Dr. Mary Ibua.

Your inspiration and encouragement has been invaluable to me.

ACKNOWLEDGEMENTS

Acknowledgements are well deserved. First to my supervisors, Prof Zahida Qureshi and Prof Omondi Ogutu, for your patience, understanding and guidance without which this study would not have been accomplished.

To Partnership for Innovative Medical Education In Kenya (PRIME-K), for mentorship and funding of the research.

To my fellow residents, for your encouragement during the course of this study.

TABLE OF CONTENT

ABBREVIATIONS AND ACRONYMS

ACC	Administrative Committee on Coordination
ACOG	American College of Obstetrics and Gynaecology
AGA	Appropriate for Gestational Age
ANC	Antenatal Clinic
BMI	Body Mass Index
HBW	High Birth Weight
IUGR	Intrauterine Growth Restriction
KDHS	Kenya Demographic and Health Survey
KNH	Kenyatta National Hospital
LBW	Low Birth Weight
LGA	Large for Gestational Age
NIH	National Institutes of Health
PROM	Premature rupture of membranes
SCN	Sub-Committee on Nutrition
SGA	Small for Gestational Age
WHO	World health organization

ABSTRACT

Background

The nutritional status of a woman before, during pregnancy and after delivery is critical to both her infant's and her own health and survival. Maternal malnutrition and suboptimal weight gain during pregnancy are risk factors for LBW. Neonatal mortality rates are two to three times higher for LBW babies.

Obesity is a worldwide epidemic. Related complications range from infertility, hypertensive disorders, coagulopathies, gestational diabetes, and fetal complications such as LGA, congenital malformations, stillbirth, and shoulder dystocia

Objective: To determine the prevalence of maternal malnutrition and compare neonatal outcomes of underweight, normal weight, overweight and obese mothers.

Study design: This was a cross-sectional study of normal newborn babies delivered at Mbagathi district hospital and their mothers to determine the prevalence of malnutrition and compare the neonatal outcomes of underweight, normal weight, overweight and obese mothers.

Study area: Mbagathi District Hospital, Nairobi, Kenya

Study population: The target population was all women delivering normal singletons and neonates born during the study period.

Methodology: All women delivering normal singletons and neonates born in the study period were recruited sequentially till the sample size of 372 pregnant women was achieved. The measurements taken from the mothers who consented are body weight to the nearest 0.1 kg and body height to the nearest 0.1 cm. The BMI of the mothers was calculated by dividing the weight (Kg) by the square of the height (cm). BMI

Categories: underweight = <18.5 Normal weight = 18.5-24.9 Overweight = 25-29.9 Obesity = BMI of 30 or greater.

The neonates in the study were measured after 6 hours to allow for birth edema to subside and not more than 24 hours after delivery. The following measurements were taken: body weight to the nearest 10 g; recumbent length (crown heel length) to the nearest 0.1 cm.

Data Management and Analysis Statistical package SPSS version 17 was employed in Data analysis.

Results: The mean age of the study participants was 24.9 years (SD 5). The mean BMI was 24.2 (SD 3.7). The prevalence of maternal malnutrition was 38.1%. The mothers with obesity were found to be significantly older with mean age 28.4 (SD 5.0).

The mean weight of the neonates was 3.1 (SD 0.5), while the mean length 47.9 (SD 5.2). The mean birth weight increased from the underweight BMI 2.8 (SD 0.3), normal BMI 3.0 (SD 0.5) and overweight group 3.2 (SD 0.5). The overweight group was comparable to babies born to obese mothers mean weight 3.1 (SD 0.3).

The mean length showed no significance in the four BMI categories.

Conclusion: This study showed that mothers with obesity were significantly older.

The study showed an increase in BMI with increased parity of two or more children.

The study found that there was an increase in birthweight with increase of maternal BMI.

Recommendation: Improving maternal nutrition and encouraging antenatal services facilitating nutrition and care during pregnancy can lead to improved perinatal outcomes in our population.

Chapter 1: Introduction

1.1 Background

Malnutrition is the condition that results from taking an unbalanced diet in which certain nutrients are either lacking, in excess (too high an intake), or in the wrong proportions. This includes both low and high body mass index. (10)

The nutritional status of a woman before, during pregnancy and after delivery is critical to both her infant's and her own health and survival. It determines her wellbeing and that of the foetus and child, and in turn the health and reproductive capacity of the next generations' mothers. (1)

Between 5 to 20 percent of women in various African countries have low body mass index. Pregnant women in industrialized countries gain on average twice as much as pregnant women in Africa. In 12 out of 17 African countries, ten percent or more of babies are born with low birth weight. (4)

On the other end of the spectrum, obesity has become a worldwide epidemic; its prevalence during reproductive age is also increased. Alarming reports state that 41% of women in Kenya are overweight or obese, with half of them in the latter category, and the rate of obese pregnant women is estimated at 18-38%.(6)

Nutrient intake and weight gain during pregnancy are the two main modifiable factors influencing maternal and infant outcomes. Indeed, a low body mass index (BMI) and suboptimal weight gain during pregnancy are long-recognized risk factors for the delivery of infants small for gestational age. (2)

Being born small for gestational age is a major predictor of neonatal mortality and morbidity, (3), failure to grow, slow cognitive development and chronic diseases in

adulthood. Infants large for gestational age also experience higher perinatal and long-term health risks. In addition, both groups of infants are more likely to be delivered by Caesarean section. Thus, reducing the delivery of small or large infants translates into fewer surgical risks for women. Appropriate antenatal management of maternal nutrition, as dictated by scientific evidence, is critical in reducing the delivery of these babies for whom both the intrauterine environment and the birth process can be life-threatening. (*2*)

Low body mass index among women in Africa results in maternal and infant death and illness. Many women in Africa suffer from chronic energy deficiency, inadequate weight gain during pregnancy, and poor micronutrient status. Insufficient food intake, high-energy expenditure, micronutrient-deficient diets, infections, and the demands of pregnancy and lactation contribute to maternal malnutrition. (4)

Three indicators reflect inadequate food intake in women: low weight for height, low pregnancy weight gain, and low birth weight. Many African women consume less than the recommended daily caloric intake. (4)

Maternal malnutrition also has serious consequences on infant health and survival. Intrauterine growth restriction (IUGR), largely the result of maternal low BMI prior to and during pregnancy, causes approximately two thirds of low birth weight in developing countries. Although the etiology of IUGR is complex, a major determinant of IUGR in developing countries is low maternal BMI. Evidence has shown that there is a greater incidence of IUGR births among women who have low BMI or stunted prior to conception, or who fail to gain sufficient weight during pregnancy. (5) Neonatal mortality rates are two to three times higher for low birth weight babies than for normal weight

babies. Low birth weight, thinness, and short body length at birth are associated with increased rates of cardiovascular disease and non-insulin dependent diabetes in adult life. (4)

Obese women are of major concern to women's health providers because they encounter numerous pregnancy related complications. Obesity related reproductive health complications range from infertility to a wide spectrum of diseases such as hypertensive disorders, coagulopathies, gestational diabetes mellitus, respiratory complications, and fetal complications such as large for gestational age infants, congenital malformations, stillbirth, and shoulder dystocia. Recent reports suggest that obesity during pregnancy can be a risk factor for developing obesity, diabetes, and cardiovascular diseases in the newborn later in life. (6)

Maternal anthropometry is a potentially valuable tool in the evaluation of pregnancy status and prediction of birth weight. For the purpose of this study we shall use the *body mass index* (BMI), which is also known as the *Quetelet index* calculated as weight in kilograms divided by height in meters squared (kg/m^2).

BMI Categories: underweight = <18.5 Normal weight = 20-24.9 Overweight = 25-29.9 Obesity = BMI of 30 or greater. (7)

1.2 Justification

According to Kenya Demographic and Health Survey 2009 (KDHS 2009), a woman's nutritional status has important implications for her health as well as the health of her children. (8) Malnutrition in women results in reduced productivity, an increased susceptibility to infections, slow recovery from illness, and heightened risks of adverse pregnancy outcomes. For example, a woman who has poor nutritional status as indicated by a low body mass index (BMI), short stature, anemia, or other micronutrient deficiencies has a greater risk of obstructed labor, of having a baby with low birth weight, of producing lower quality breast milk, of mortality due to postpartum hemorrhage, and of morbidity of both herself and her baby. (8)

The mean BMI for women aged 15-49 years is 23. A comparison of these outcomes with similar data from the 2003 KDHS indicates no meaningful change during the five year period. Analysis of the BMI shows that at national level, 12 percent of women are considered to be thin (BMI<18.5), also unchanged since 2003. At regional level, the proportion of thin women is highest in North Eastern province (26 percent) and lowest in Nairobi (3 percent). (8)

One quarter of women age 15-49 are overweight or obese. The propensity of being overweight or obese is correlated with increases in age, education level, and wealth quintile. For example, the proportion overweight rises from a low of 9 percent at 15-19 years to a high of 40 percent of women age 40-44 years. At regional level, the proportion of overweight women ranges from a low of 11 percent in North Eastern province to a high of 41 percent in Nairobi. (8)

This study seeks to provide data on maternal malnutrition and neonatal outcomes that could potentially improve will improve pre-conception and antenatal care to correct maternal malnutrition which remains an important causes of maternal and neonatal morbidity and mortality not only in Mbagathi, but also nationally and globally.

1.3 Conceptual Framework

Narrative

Maternal malnutrition has a great impact on the mother and child. A great deal of resources has been utilized to determine the causes and consequences of malnutrition. Causes of low BMI include: insufficient food intake, high energy expenditure, anemia, infections, demands of pregnancy and lactation, inadequate pregnancy weight gain and poor micronutrient status. This leads to low productivity, anemia susceptibility to infections, PROM in the mother. It also affects fetal development leading to SGA, IUGR, LBW, mortality, preterm births, slow cognitive development, compromised immune function, cardiovascular disease and non insulin dependent diabetes.

The causes of obesity include: sedentary lifestyle, excessive food intake, genetic, medications, medical conditions and eating disorders. This leads to coagulopathies, hypertensive conditions and gestational diabetes in the mother. It affects development of the foetus causing LGA, congenital malformations, still births, shoulder dystocia, caesarean section, obesity diabetes and cardiovascular disease.

Diagrammatic representation of conceptual framework

Causes

Low BMI	**Obesity**
- Insufficient food intake - High energy expenditure - Inadequate pregnancy weight gain - Poor micronutrient status - Demands of pregnancy and lactation - Anaemia - infections	- excessive food intake - sedentary lifestyle - genetic - medical conditions - eating disorders - medications

Maternal Consequences

Lower productivity Reduced activity levels Susceptibility to infections Anaemia PROM	Hypertensive disorders Coagulopathies Gestational diabetes mellitus

Fetal development

Fetal/Neonatal consequences

Small for gestational age Intrauterine growth restriction Low birth weight Preterm births Mortality Compromised immune function Slow cognitive development Non insulin dependent diabetes Cardiovascular disease	Large for gestational age Congenital malformations Still birth Shoulder dystocia Caesarean section Obesity Diabetes Cardiovascular disease

1.4 Research Question

What is the prevalence of maternal malnutrition in Mbagathi district hospital and the neonatal outcomes in mothers who have low BMI, normal BMI and high BMI delivering at Mbagathi district hospital?

1.5 Objective of the study

1.5.1 Broad objective

Among mothers attending antenatal clinic and delivering at Mbagathi district hospital to determine the prevalence of maternal malnutrition and the neonatal outcomes.

1.5.2: Specific objectives

1. Determine prevalence of maternal malnutrition among mothers attending antenatal clinic and delivering at Mbagathi district hospital.
2. To compare the neonatal outcomes of low BMI, normal BMI and high BMI among mothers delivering at the Mbagathi district hospital.

Chapter 2: Literature Review

2.1 Malnutrition

The World Health Organization defines malnutrition as "the cellular imbalance between supply of nutrients and energy and the body's demand for them to ensure growth, maintenance, and specific functions." Women and young children are the most adversely affected groups; one quarter to one half of women of child-bearing age in Africa and south Asia are underweight, which contributes to the number of low birth weight infants born annually. (9)

Malnutrition is the condition that results from taking an unbalanced diet in which certain nutrients are lacking, in excess (too high an intake), or in the wrong proportions. (10)

Undernutrition is a type of malnutrition caused by inadequate food intake or the body's inability to make use of needed nutrients. (11)

Overnutrition is a condition of excess nutrient and energy intake over time. It may be regarded as a form of malnutrition when it leads to obesity.

Malnutrition, defined as underweight, is a serious public-health problem that has been linked to a substantial increase in the risk of mortality and morbidity. Women and young children bear the brunt of the disease burden associated with malnutrition. In Africa and south Asia, 27−51% of women of reproductive age are underweight (ACC/SCN, 2000), and it is predicted that about 130 million children will be underweight in 2005 (21% of all children) (12). Many of the 30 million low-birth-weight babies born annually (23.8% of all births) face severe short-term and long-term health consequences (12)

Many factors can cause malnutrition, most of which relate to poor diet or severe and repeated infections, particularly in underprivileged populations. Inadequate diet and disease, in turn, are closely linked to the general standard of living, the environmental conditions, and whether a population is able to meet its basic needs such as food, housing and health care. Malnutrition is thus a health outcome as well as a risk factor for disease and exacerbated malnutrition and it can increase the risk both of morbidity and mortality.

2.2 Maternal Malnutrition

In 1995, WHO published a meta-analysis based on data sets from 25 studies that related maternal anthropometry to pregnancy outcomes (WHO, 1995b). The meta-analysis reported that a pre-pregnancy body−mass index (BMI) below 20 kg/m2 was associated with a significantly greater risk for IUGR, relative to a BMI above 24 kg/m2, with an overall odds ratio of 1.8 (95% confidence interval (CI): 1.7–2.0). In developing countries, it has been estimated that poor nutritional status in pregnancy accounts for 14% of fetuses with IUGR, and maternal stunting may account for a further 18.5% (ACC/SCN, 2000). Estimates of mortality due to perinatal conditions were obtained by calculating the attributable fraction of neonatal mortality due to IUGR, then multiplying this value by the estimated attributable fraction of IUGR due to low maternal pre-pregnancy BMI. The attributable fractions were based on prevalence and risk estimates from published and unpublished sources. The relationship between maternal underweight status and neonatal mortality was estimated by deriving the proportion of IUGR attributable to poor maternal pre-pregnancy anthropometric status and the proportion of neonatal mortality attributed to IUGR. The equation thus has four

components: the proportion of IUGR births among live births; an estimate of infant mortality risk associated with IUGR; prevalence of underweight status among women of reproductive age; and an estimate of the risk of IUGR associated with pre-pregnant underweight status. (12)

2.3 Prevalence of Maternal Malnutrition

Between 5 to 20 percent of women in various African countries are underweight. Pregnant women in industrialized countries gain on average twice as much as pregnant women in Africa. In 12 out of 17 African countries, ten percent or more of babies are born with low birth weight. (4)

2.4 Causes of Maternal Malnutrition

Three indicators reflect inadequate food intake in women: low weight-for-height, low pregnancy weight gain, and low birth weight. Many African women consume less than the recommended daily caloric intake.

Inadequate micronutrient intake—particularly of iron, vitamin A, zinc, folic acid, riboflavin, iodine, and vitamin E—is also common in Africa. Iron deficiency is caused by inadequate dietary intake of bioavailable iron, increased iron requirements during pregnancy, and blood loss from parasitic infections. Anaemia is the most commonly measured indicator to screen for iron deficiency. In 12 African countries surveyed, anaemia rates among pregnant women ranged from 43 to 80 percent.

Hookworm and malaria contribute significantly to high anaemia rates. The prevalence of hookworm infection among African women 15 to 45 years is estimated at 32 percent. Hookworms attach to and feed upon the intestinal epithelium. This causes bleeding and results in faecal loss of blood and iron. Women in Africa often have low iron stores,

making them especially vulnerable to developing iron deficiency anaemia from chronic blood loss due to hookworm infection.

Malaria, which destroys red blood cells, is the primary cause of anaemia in many endemic areas. In malaria endemic areas, pregnant women develop malaria more frequently and have more severe infections than non-pregnant women, particularly in their first or second pregnancies. More than 90 percent of the world's malaria cases are in sub-Saharan Africa.

HIV infection also heightens women's energy and nutrient needs. Nutrient malabsorption accompanies frequent bouts of diarrhoea commonly experienced by people with HIV/AIDS. Approximately 12.9 million African women between 15 to 49 years of age were living with HIV/AIDS in 2000.

Other factors affecting women's nutritional status are energy expenditures and the demands of pregnancy and lactation. African women frequently maintain high levels of physical activity throughout pregnancy without compensating for the increased energy demands. If a woman's energy intake is not sufficient to meet the requirements of pregnancy, her energy stores are depleted to make up the deficit. If energy intake is not adequate after delivery, fat stores are used for lactation. A short interval between births may not provide women with enough time to replenish lost energy stores before another reproductive cycle begins. A Demographic and Health Survey review of birth intervals found that in most African countries analyzed, more than half of birth intervals were less than 36 months and approximately a quarter were less than 24 months.

2.5 Consequences of Maternal Malnutrition

The combination of infections, chronic energy deficiency, poor weight gain in pregnancy, short birth intervals, increased reproductive risks, anemia, and other micronutrient deficiencies contribute to maternal and infant deaths and illness. Anemia is responsible for an estimated 20 percent of maternal deaths. (13) In addition to being at greater risk of hemorrhage, anemic women are more likely to experience prolonged labor, which predisposes them to sepsis. Sepsis is one of the major causes of maternal mortality. (14) Direct consequences of chronic energy deficiency include increased susceptibility to infection, reduced activity levels, and lower productivity. (15) Infections, especially those associated with fever, can decrease appetite while increasing energy and nutrient needs. Deficiencies in several micronutrients, such as vitamin A (16) and zinc, increase the incidence or severity of infections. (17)

Maternal malnutrition also has serious consequences on infant health and survival. Intrauterine growth retardation—largely the result of maternal malnutrition prior to and during pregnancy—causes approximately two-thirds of low birth weight in developing countries. (18) Neonatal mortality rates are two to three times higher for low birth weight babies than for normal weight babies. (19) Low birth weight has additional consequences during adulthood. Low birth weight, thinness, and short body length at birth are associated with increased rates of cardiovascular disease and non-insulin dependent diabetes in adult life. (20)

Micronutrient deficiencies in zinc, iron, iodine, vitamin A, folic acid, vitamin B6, vitamin

D, calcium, and magnesium can increase the risk of low birth weight, preterm births, premature rupture of membranes, and fetal death. Micronutrient deficiencies can result in birth defects, lower cognition, and compromised immune functions. (21)

2.6 Maternal Obesity

A number of systems have been used to define and classify obesity. The *body mass index* (BMI), which is also known as the *Quetelet index,* is currently in use. The BMI is calculated as weight in kilograms divided by height in meters squared (kg/m^2).

Calculated BMI values are available in various chart and graphic forms, such as the one shown in Figure 43–1. According to the National Heart, Lung, and Blood Institute (1998), a *normal* BMI is 18.5 to 24.9 kg/m^2; *overweight* is a BMI of 25 to 29.9 kg/m^2; and *obesity* is a BMI of 30 kg/m^2 or greater. According to Freedman and colleagues (2002), obesity is further categorized as class I (BMI: 30 to 34.9 kg/m^2), class II (BMI: 35 to 39.9 kg/m^2), and class III (BMI: 40-plus kg/m^2). (22)

2.7 Causes of Maternal Obesity

Weight gain occurs when you eat more calories than your body uses up. If the food you eat provides more calories than your body needs, the excess is converted to fat. Initially, fat cells increase in size. When they can no longer expand, they increase in number. If you lose weight, the size of the fat cells decreases, but the number of cells does not.

Obesity, however, has many causes. The reasons for the imbalance between calorie intake and consumption vary by individual. Your age, gender, genes, psychological makeup, and environmental factors all may contribute.

Genes: Obesity tends to run in families. This is caused both by genes and by shared diet and lifestyle habits. Having obese relatives does not guarantee that you will be obese.

Emotions: Some people overeat because of depression, hopelessness, anger, boredom, and many other reasons that have nothing to do with hunger. This doesn't mean that overweight and obese people have more emotional problems than other people. It just means that their feelings influence their eating habits, causing them to overeat.

Environmental factors: The most important environmental factor is lifestyle. Your eating habits and activity level are partly learned from the people around you. Overeating and sedentary habits (inactivity) are the most important risk factors for obesity.

Age: People tend to lose muscle and gain fat as they age. Their metabolism also slows somewhat. Both of these lower their calorie requirements. (23)

Pregnancy: Women tend to weigh an average of 4-6 pounds more after a pregnancy than they did before the pregnancy. This can compound with each pregnancy.

Certain medical conditions and medications can cause or promote obesity, although these are much less common causes of obesity than overeating and inactivity. Some examples of these are as follows; Cushing syndrome, Depression, Certain medications (examples are steroids, antidepressants, birth control pills), Prader-Willi syndrome, Polycystic ovarian syndrome

Obesity can be associated with other eating disorders, such as binge eating or bulimia.

The distribution of your body fat also plays a role in determining your risk of obesity-related health problems. There are at least two different kinds of body fat. Studies

conducted in Scandinavia have shown that excess body fat distributed around the waist ("apple"-shaped figure, intra-abdominal fat) carries more risk than fat distributed on the hips and thighs ("pear"-shaped figure, fat under the skin). (23)

2.8 Prevalence of Maternal Obesity

One-quarter of women age 15-49 are overweight or obese. The propensity of being overweight or obese is correlated with increases in age, education level, and wealth quintile. For example, the proportion overweight rises from a low of 9 percent at 15-19 years to a high of 40 percent of women age 40-44 years. At provincial level, the proportion of overweight women ranges from a low of 11 percent in North Eastern province to a high of 41 percent in Nairobi. (8)

2.9 Consequences of Maternal Obesity

Increased maternal morbidity results from obesity, defined variably as more than 150 percent of ideal body weight, BMI greater than 35 kg/m^2, BMI greater than 40 kg/m^2, and 150 pounds or more greater than ideal body weight (24). These investigators chronicled significantly increased incidences of a number of disorders including chronic hypertension, gestational diabetes, preeclampsia, fetal macrosomia, as well as higher rates of cesarean delivery and postpartum complications.

In a nurse–midwife practice, women whose BMI exceeded 29 kg/m^2 had a two- to fourfold increased caesarean delivery rate (25). Similarly, in a physician private practice, the caesarean delivery rate for dystocia was increased sixfold in obese nulliparas (26). In another study, only 15 percent of obese women with a previous caesarean delivery succeeded in having a subsequent vaginal delivery (27).

In addition, there are reports of increased adverse pregnancy outcomes in overweight women with a BMI of 25 to 29.9 kg/m^2. A study reported that obesity (weight greater than 200 pounds) and hypertension were common co-factors in causing peripartum heart failure. (28) Another study found that obesity was an independent risk factor for post cesarean infection morbidity. (29) Finally obese women were less likely to initiate breast-feeding than were women with a normal BMI before pregnancy who also gained the recommended weight during pregnancy. (30).

2.10 Neonatal Birth Weight

The prevalence of low birth weight is estimated to be 15% worldwide with a range of 3.3-38% and occurs mostly in developing countries. It is a multifaceted public health problem. (31)

Low birth weight is a major determinant of mortality, morbidity and disability in neonates, infancy and child hood and has long term impact on health outcomes in adult life. Low birth weight results in substantial costs to the health sector and imposes a significant burden on the society as a whole. Maternal size and lifestyle also determine the size of the baby at birth. (31)

The relationship between gestational age and birthweight should be used to identify neonates at risk for complications (McIntire and colleagues, 1999). For example, neonates who are either small- or large-for-gestational age are at increased risk for hypoglycemia and polycythemia, and measurements of blood glucose and hematocrit are indicated (32).

Newborns that are small for gestational age (SGA), historically defined as less than the 10th percentile on the growth curve, may warrant evaluation for congenital infections,

chromosomal syndromes or other causes if there is no identifiable cause for the growth retardation, such as multiple pregnancy or preeclampsia or other evidence of placental insufficiency. Infants that are SGA or large for gestational age (LGA) should be treated similarly to the infants of diabetic mothers, and should be monitored for hypoglycemia in the first few hours of life. (33)

According to ACOG, in the past, the period from 3 weeks before until 2 weeks after the estimated date of delivery was considered “term,” with the expectation that neonatal outcomes from deliveries in this interval were uniform and good. Increasingly, however, research has shown that neonatal outcomes, especially respiratory morbidity, vary depending on the timing of delivery within this 5-week gestational age range. To address this lack of uniformity, a work group was convened in late 2012, which recommended that the label “term” be replaced with the designations *early term* (37 0/7 weeks of gestation through 38 6/7 weeks of gestation), *full term* (39 0/7 weeks of gestation through 40 6/7 weeks of gestation), *late term* (41 0/7 weeks of gestation through 41 6/7 weeks of gestation), and *postterm* (42 0/7 weeks of gestation and beyond) to more accurately describe deliveries occurring at or beyond 37 0/7 weeks of gestation. (34)

In each grouping, infants are then identified according to growth as AGA if birth weight falls between the 10th to 90th percentile, SGA if birth weight is below the 10th percentile, and LGA if birth weight is above the 90th percentile. Knowledge of a baby's birth weight in relation to gestational age is helpful in anticipating neonatal problems.

2.11 Classification on Neonatal Birth weight

The average birth weight of a full-term newborn is approximately 7 ½ lbs. (3.2 kg), and is typically in the range of 5.5–10 pounds (2.7–4.6 kg). The average total body length is 14–20 inches (35.6–50.8 cm), although premature newborns may be much smaller. (35) Most full-term babies (born between 37 and 40 weeks) weigh somewhere between 5 pounds 8 ounces (2,500 grams) and 8 pounds, 13 ounces (4,000 grams). (36)

2.12 Low Birth weight

The term "low birthweight" is used to describe infants who are born at the lower extreme of the birth-weight distribution. In 1948 the World Health Assembly recommended that a single definition of low birthweight (LBW) be established for consistent vital statistics and other public policy purposes. The current definition, a weight of less than 2,500 grams (approximately 5 pounds, 8 ounces), was derived from earlier recommendations by Ethel Dunham and Arvo Ylppo. Marked advances in medical technology and practice have occurred since the 2,500-gram criteria for LBW was established, resulting in vastly improved survival rates for LBW infants. The improvements in survival led to the need for further classifications of LBW to better identify high risk infants. Very small infants are now further categorized as very low birthweight (VLBW; less than 1,500 grams (3 pounds, 5 ounces)) and extremely low birthweight (ELBW; less than 1,000 grams (2 pounds, 3 ounces)).

Low birthweight includes both preterm delivery and fetal growth restriction, but these two categories have very different determinants.

Despite extensive research, current knowledge is limited about the causes of preterm delivery. Risk factors associated with preterm birth include cigarette smoking during

pregnancy, prior preterm birth, low prepregnancy weight, and maternal chronic diseases; but known risk factors account for less than one-fourth of preterm births. The factors associated with fetal growth restriction are more readily understood than those of preterm delivery. Cigarette smoking during pregnancy, low maternal weight gain, and low prepregnancy weight account for nearly two-thirds of all fetal growth restriction and seem to be the most promising areas for possible interventions. Other associated factors include multiple births (e.g., twins), infant gender, and several factors relating to the mother, including: birthweight, racial or ethnic origin, age, height, infections, and history of prior low birthweight delivery, work/physical activity, substance use/abuse, cigarette smoking, alcohol consumption, and socioeconomic status. (37)

2.13 High Birth weight

High birthweight (HBW), or macrosomia (large body), in an infant also increases the risk to the infant and mother. A widely agreed upon definition of macrosomia has yet to be established but often-used definitions include a birthweight equal to or exceeding 4,000 grams (8 pounds, 12 ounces), 4,250 grams (9 pounds, 4 ounces), or 4,500 grams (9 pounds, 14 ounces), as well as a birth weighing at or above the ninetieth percentile of birthweights for the infant's gestational age. While one-third of macrosomic births are still unexplained, several factors are known to contribute to excessive fetal size, including large size of parents (especially the mother), multiparity diabetes in the mother, and prolonged gestation. Older maternal age, male infants, and previous delivery of a high birthweight infant also seem to be indicative of macrosomic births. Babies of diabetic women are usually large at birth, but they behave clinically as if they are immature. These infants are not longer in average length but have increased fetal

weight. Because glucose, a substance necessary for fetal growth, is elevated in both diabetic and obese women, these mothers are more likely to have macrosomic births. (38)

2.14 Consequences of Birth weight

When compared to normal birth-weight children, LBW children have higher rates of mental retardation, cerebral palsy, blindness, deafness, psychomotor problems, school failure, subnormal growth, and health problems, which are compounded by poverty and related adverse socioeconomic factors.

Studies using linked birth/infant death files have reported that infants weighing <2,500 g at birth are at a considerably increased risk of neonatal mortality. Neonatal death is 40 times more likely among LBW infants and 200 times greater among very-lowbirth-weight infants (infants weighing <1,500 g at birth) than it is among infants of normal birth weight. Infant and childhood morbidity are also associated with low birth weight. LBW infants are at an increased risk of neurological problems such as cerebral palsy and seizure disorders, severe mental retardation, lower respiratory tract conditions, and general morbidity. (39)

Risks for birth injuries rise rapidly for heavier babies, with vaginal deliveries being related to higher morbidity and mortality for both the infant and the mother. Lacerations of the birth canal and haemorrhaging may occur to the mother, fetal death may occur due to asphyxia (lack of oxygen), and infants may suffer broken clavicles and neurological damage. While caesarean delivery has been prescribed as the best delivery method to prevent fetal death or injury, others suggest that vaginal birth is still possible for some macrosomic infants.

Chapter 3: Methodology and Materials

3.1 Study Design

The study was a comparative cross sectional design among pregnant mothers delivering at Mbagathi district hospital.

3.2 Study area

The study was conducted at Mbagathi District Hospital which is located within Nairobi City. It is a level 4 government hospital that caters for both in and out patient. This hospital serves, among others, residents of the Kibera slums, one of the largest informal settlements in Africa where most residents live below the poverty line. It is one of the designated sentinel centers for community based management for uncomplicated severe acute malnutrition in Kenya. It has a 45 bed paediatric ward which is managed by 2 paediatricians. In 2010 it catered for 2289 antenatal mothers and 2432 deliveries. The catchment area for the hospital is Golf Course within Dagoretti division with population of under-5 years of 4960 and a total population of 39061. Women of childbearing age are 12,266.

The maternity unit has 1 antenatal ward with 20 beds, 1 delivery room with 2 beds and 2 theatres dedicated to both elective and emergency caesarean section. The hospital has 1 post delivery room with 7 beds. The unit is covered by 2 obstetricians, 2 medical officers and 2 medical officers intern providing 24hour coverage.

3.3 Study population

The study population was compromised of 372 pregnant women with term pregnanacy that didn’t have any antenatal complications coming to deliver at Mbagathi district hospital during the study period.

All neonates delivered during the study period and their mothers were recruited.

The selected babies were singletons, full term, of gestational age range between 37 and 41 weeks (expressed as completed weeks since the first day of the last menstrual period), or documented by ultrasound. The infants' weights were taken after 6 hours to allow for birth edema to subside and not more than 24 hours after delivery.

The sample was a mother and baby pair. The mothers were be recruited at start of labor and had their BMI recorded.

Inclusion criteria

- Pregnant women with singletons, full term, of gestational age range between 37 and 41 weeks (expressed as completed weeks since the first day of the last menstrual period), or documented by ultrasound.
- Mothers who give informed consent.
- Mothers with clear antenatal records with measures of interest.
- Mothers who had antenatal booking before 20 weeks gestation

Exclusion criteria

- Preterm neonates
- Multiple gestation mothers
- Mothers with medical conditions such as diabetes, chronic hypertension, cardiac disease.
- Mothers who had antenatal booking at > 20 weeks gestation

3.4 Sample size

Sample size was determined using the single population formula for proportions

$$n = \frac{Z^2 [P (1-P)]}{}$$

d^2

n is the required sample size

z, critical value associated with significance level of 95%, is 1.96

p, the expected prevalence (if the expected prevalence is 3% of low BMI in Nairobi, then P=0.03, prevalence of high BMI in Nairobi is 41%, then P=0.41)

d, the margin of error accepted for this study was 5%.

The required sample size was, using the above information, 372 pregnant women.

3.5 Data Collection

Primary data was collected using pre-coded, structured questionnaire administered to pregnant women coming for delivery. Secondary data was collected by retrieving information from the ANC cards.

The mothers were recruited to the study in first stage of labor. They had their weight and height taken and recorded. They were then interviewed and labor allowed to progress. After delivery the weight and length of the neonates was measured and recorded plus any adverse outcomes of mother and neonate.

Data was collected by the principle researcher and two trained assistants. A structured questionnaire was used to collect data. The questionnaire comprised of open and closed ended questions. The inpatient numbers were obtained from the admission registers in labor ward, maternity wards and maternity theatre

The mothers were interviewed and the information obtained entered into the questionnaire. The patient's admission, delivery, operation and neonatal notes were scrutinized and data obtained entered into the questionnaire.

3.6 Definition of Terms

Stadiometer	a device for measuring height that typically consists of a vertical ruler with a sliding horizontal rod or paddles which is adjusted to rest on the top of the head.
Infantometer	a device for measuring height of infants
Anthropometry	refers to the measurement of the human individual; it has been used for identification, for the purposes of understanding human physical variation.
Malnutrition	is the condition that results from taking an unbalanced diet in which certain nutrients are lacking, in excess (too high an intake), or in the wrong proportions.
Undernutrition	a type of malnutrition caused by inadequate food intake or the body's inability to make use of needed nutrients.
Overnutrition	a condition of excess nutrient and energy intake over time. Over nutrition may be regarded as a form of malnutrition when it leads to obesity.
Obesity	Obesity has been more precisely defined by the National Institutes of Health (the NIH) as a BMI of 30 and above. (A BMI of 30 is about 30 pounds overweight.)

3.7 Data Storage

Data was collected by the principal investigator and the study assistants. The questionnaires were checked for completeness and filed in a lockable cabinet.

3.8 Data Management

During data collection the participant's files were in a locked cabinet in the investigator's office. During data entry the files were placed in a lockable cabinet in the statistician's office. Participant files had serial numbers instead of the names of the participants.

The data was entered into a password protected Microsoft Access database and once entry was complete, the principal investigator compared the contents of the database with the hard copy files of the participants to identify any data entry errors.

3.9 Data Processing and Analysis

Data cleaning and management was be done by employing the statistical package SPSS version 17. Data was summarised using graphs and tables, chi-square test of association used to link maternal body mass index to neonatal outcomes.

Categorical variables were compared using the chi-squared tests for nominal variables whereas continuous variables were compared using t-tests for comparing means.

Independent correlates of neonatal outcome were identified using logistic regression.

3.10 Ethical Considerations

Approval was sought from the KNH/UON Ethics and Research committee at Kenyatta National Hospital. Informed consent was obtained from all recruited mothers, records were coded and patients' names were not used. All the information collected remained confidential and would be used for purposes of the study only. Participation was voluntary and no incentives were given. At any stage the participants were free to withdraw from the study or not answer some questions without penalty.

3.11 Study Limitations

1. This study was carried out in postnatal ward in Mbagathi district hospital. However, the postnatal mothers may be different from those who deliver elsewhere, making generalization of results to the entire population of pregnant women in Kenya inappropriate.
2. Data was collected from the antenatal card and the mothers start clinic at different gestations. The ideal time to measure the weight and height would have been in the pre pregnancy period which was not possible.
3. The weighing scale used at first antenatal visit was different from the one used at delivery affecting the observation of interest.

Minimization of Errors and Biases

The two study assistants were trained on interviewing, information retrieval and filling the questionnaire. Recording of data was done after thorough scrutiny.

In order to avoid double participant recruitment, the participants' admission (in-patient) numbers was entered into a register upon recruitment for serialization. This register was counter-checked on a daily basis for any double entries and if it is so discovered, one of the questionnaires was withdrawn and discarded and the serialization rectified before recruitment was continued.

Chapter 4: RESULTS

A total of 372 mothers were recruited into the study.

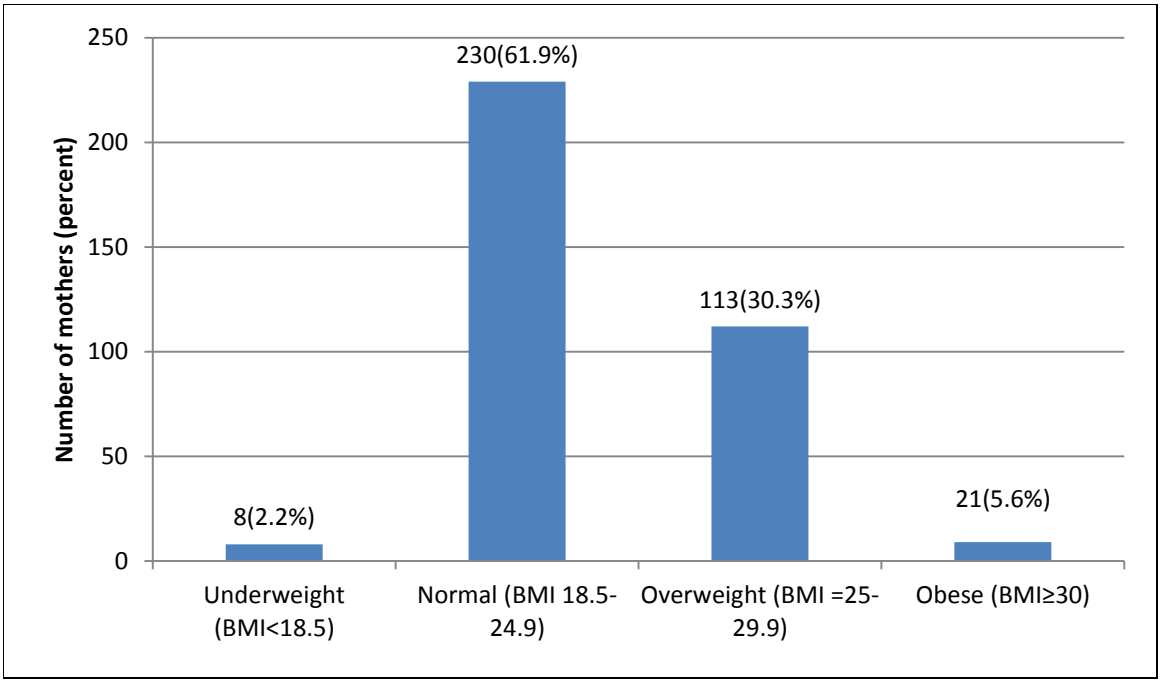
Table 1: Socio-demographic characteristics of mothers delivering at Mbagathi district hospital

Characteristic	Frequency
Mean age in years (SD)	24.9 (5.0)
Marital status, n (%)	
Single	54(14.5)
Married	317(85.2)
Separated/ divorced	1(0.3)
Widowed	0(0.0)
Education, n (%)	
Informalp[	0(0.0)
Primary	179(48.1)
Secondary	166(44.6)
College/ University	27(7.3)
Occupation, n (%)	
Unemployed	196(52.7)
Self employed	90(24.2)
Salaried employment	52(14.0)
Casual employment	34(9.1)

The mean age of the study participants was 24.9 years with a standard deviation of 5. Three hundred and seventeen mothers (85.2%) were married. One hundred and seventy nine (48.1%) had attained primary level education and one hundred and sixty six (44.6%) secondary education respectively. One hundred and ninety six (52.7%) mothers were unemployed. The socio-demographic characteristics are tabulated below.

Objective 1: Determine prevalence of maternal malnutrition in Mbagathi district hospital

Figure 1: Nutritional status of mothers delivering at Mbagathi District Hospital



The mean BMI was 24.2 (SD 3.7), ranging from 15.0 to 45.3. The majority were within normal two hundred and thirty mothers (61.9%). The prevalence of maternal malnutrition was 38.1%. One hundred and thirteen (30.3%) were overweight, twenty one (5.6%) were in the obese category and eight (2.2%) were underweight with BMI under 18.5 as presented in figure 1above.

Table 2: Socio-demographic characteristics versus body mass index of mothers delivering at Mbagathi district hospital

Characteristic	Underweight (BMI <18.5)	Normal (BMI 18.5-24.9)	Overweight (BMI 24.9-29.9)	Obese (BMI ≥ 30)	P value
Mean age in years (SD)	24.5 (5.0)	24.2(4.9)	25.6(5.4)	28.4(5.0)	<0.001
Marital status					
Single	1(12.5)	36(15.7)	13(11.5)	4(19.1)	0.50
Married	7(87.5)	194(84.3)	99(87.6)	17(80.9)	0.76
Separated/ divorced			1(0.9)		-
Widowed					-
Education					
Informal		1(0.4)			
Primary	5(62.5)	123(53.5)	41(36.3)	10(47.6)	0.029
Secondary	3(37.5)	98(42.6)	54(47.8)	10(47.6)	0.72
College University		8(3.5)	18(15.9)	1(4.8)	0.002
Occupation					
Unemployed	6(75.0)	139(60.4)	45(39.8)	7(33.3)	0.001
Self employed	1(12.5)	46(20.0)	33(29.2)	10(47.6)	0.014
Salaried employment	1(12.5)	19(8.3)	29(25.7)	3(14.3)	0.001
Casual	0	26(11.3)	6(5.3)	1(4.8)	0.242

The mothers with obesity were found to be significantly older with mean age 28.4 (SD 5.0) while the mean ages of mothers in the underweight, normal and overweight BMI groups were comparable at 24.5 (SD 5.0), 24.2 (SD 4.9) and 25.6 (SD 5.4) respectively. There were more women who were married delivering during the study than single women in all the BMI categories. 317(85%) of the mothers were married as compared to 54 (14.5%) who were single.

Mothers in the underweight category had primary level education 5 (62.5%) compared to 3 (37.5%) with secondary education. There were more overweight mothers with secondary education 54(47.8%). In the obese category the numbers of primary and secondary educated mothers was the same 10(47.6%).

There was a significant number of overweight women who were salaried 29(25.7%) with p value 0.001 compared to underweight 1(12.5%), normal 19(8.3%) and overweight 3(14.3%).

The mothers in the underweight category were mostly unemployed 6 (75.0%) compared to 1(12.5) self employed and 1(12.5) salaried in the same category. This was significant with p value 0.001.

The mothers in obese group, majority were self employed 10(47.6%) compared to 1(12.5) underweight, 46(20%) normal and 33(29.2%) overweight.

A comparison of socio-demographic characteristics of the mothers in the four BMI groups was done and represented in table 2.

Table 3: The parity, gestational age and mode of delivery for mothers at Mbagathi district hospital

	Frequency (%)
Delivery mode	
SVD	279(75.0)
Caesarean	90(24.2)
Breech	3(0.8)
Type of C/S	
Elective	26(28.9)
Emergency	64(71.1)
Parity	
0+0	153(41.1)
1+0	111(29.9)
≥2+0	95(25.5)
Other parity(0+1, 0+2)	13(3.5)
Gestational age	
37 weeks	52(14.0)
38 weeks	87(23.4)
39 weeks	64(17.2)
40 weeks +	169(45.4)

There were 372 deliveries during the study period. Majority were spontaneous vertex deliveries (SVD) at 279 (75.0%), also had 90 (24.2%) caesarean sections (C/S) and 3 (1.1%) breech deliveries. Of the C/S 26 (28.9%) were elective and 64 (71.1%) were emergency cases.

The majority of the mothers had first time pregnancies 153 (41.1%) compared to those with one or two previous deliveries 111 (29.9%) and 95 (25.5%) respectively.

Delivery of the babies was mostly at forty completed weeks 169(45.4%) followed by 38 completed weeks 87(23.4%).

Table 4: Comparing gestational age and Parity in each BMI group

Characteristic	Underweight	Normal	Overweight	Obese	
Gestational age					
37 weeks	1(12.5)	33(14.3)	16(14.2)	3(14.3)	0.999
38 weeks	1(12.5)	45(19.6)	34(30.0)	7(33.3)	0.099
39 weeks	2(25)	46(20.0)	14(12.4)	3(14.3)	0.27
40 weeks +	4(50)	106(46.1)	49(43.4)	8(38.1)	0.793
Parity					
0+0	5(62.5)	106(46.1)	38(33.6)	4(19.1)	0.014
1+0	2(25)	72(31.3)	29(25.7)	5(23.8)	0.68
≥2+0	0	44(19.1)	39(34.5)	12(57.1)	<0.001
Other parity (0+1, 0+2)	1(12.5)	8(3.5)	7(6.2)	0	0.31

Most of the deliveries in each BMI category were at forty completed weeks, underweight 4(50%), normal 106(46.1%), overweight 49(43.4%) and obese 8(38.1%). In the obese category it was comparable with deliveries ay 38 completed weeks 7(33.3%) but not statistically significant.

The highest number of underweight mothers were primiparas i.e. 5(62.5%) compared to those with previous deliveries 2 (25%).

There was a statistical significant increase in the BMI with increased parity with a p value <0.001. In mothers with more than two previous deliveries there was no underweight, normal BMI 44(19.1%), overweight 39(34.5%) and obese category 12(57.1%) showing that there is increased maternal BMI with parity of 2 or more that is statistically significant.

Table 5: Comparing the mode of delivery in each BMI group

Characteristic	Underweight	Normal	Overweight	Obese	P value
Normal vaginal delivery, n (%)	5(62.5)	182(79.1)	76(67.3)	16(76.2)	0.23
Caesarean section, n (%)	3(37.5)	48(20.9)	34(30.1)	5(23.8)	0.22
	0	16	9	1	0.82
Elective	3	32	25	4	0.11
Emergency					
Breech delivery	0	0	3(2.6)	0	-
Type of labor, n (%)					
Spontaneous	0	35(15.2)	21(18.6)	4(19.1)	0.36
Induced	5(62.5)	147(63.9)	55(48.7)	12(57.1)	0.07

Normal vaginal delivery was the commonest mode of delivery in all the four BMI categories with 5(62.5%) underweight, 182(79.1%) normal, 76(67.3%) overweight and obese 16(76.2%).

The caesarean deliveries were mostly emergency 64 (71.1%). The caesarean deliveries in each BMI category were 3(37.5%) underweight, 48 (53.3%) normal, 34 (30.1%) overweight and 5 (23.8%) obese. There were also 3 (2.6%) breech deliveries all to mothers in the overweight category.

For the mothers with normal vaginal deliveries 60(21.5%) went into spontaneous labor while 219(78.5) were induced. Mothers with underweight BMI were all induced 5(62.5%).

Table 7: Newborn characteristics of neonates delivered at Mbagathi district hospital

Characteristic	Frequency
Sex, n (%)	
Male	211(56.7)
Female	161(43.3)
Mean birth weight (SD)	3.1 (0.5)
Mean length (SD)	47.9(5.2)
Status, n (%)	
Live birth	366(98.4)
Still birth	6(1.6)
New born unit admission, n (%)	25(6.7)

The characteristics of 372 babies were recorded from the mothers of similar number recruited.

There were more male babies born 211 (56.7%) than females 161 (43.3%). The mean weight of the neonates was 3.1 (SD 0.5), while the mean length 47.9 (SD 5.2). Live births were highest at 366 (98.4%) compared to only 6 (1.6%) still births. There were a total of 25 (6.7%) admissions to the new born unit.

Objective 2: Compare neonatal outcomes of underweight, normal weight and obese mothers

TABLE 8: Comparison of neonatal outcomes in each BMI group

Characteristic	Underweight	Normal	Overweight	Obese	P value
Sex, n (%)					
Male	6(75)	134(58.3)	57(50.4)	14(66.7)	0.29
Female	2(25)	96(41.7)	56(49.6)	7(33.3)	
Mean birth weight (SD)	2.8 (0.3)	3.0 (0.5)	3.2 (0.5)	3.1 (0.3)	0.014
Mean length (SD)	47.5(1.1)	48.1(6.6)	47.8(1.1)	47.6(0.9)	0.95
Status, n (%)					
Live birth	7(87.5)	227(98.7)	111(98.2)	21(100)	0.09
Still birth	1(12.5)	3(1.3)	2(1.8)	0	
New born unit admission	1(12.5)	16(7.0)	7(6.2)	1(4.8)	0.89

There were more male babies born in each BMI category compared to females. The mean birth weight increased from the underweight BMI 2.8 (SD 0.3), normal BMI 3.0 (SD 0.5) and overweight group 3.2 (SD 0.5). The overweight group was comparable to babies born to obese mothers mean weight 3.1 (SD 0.3).

The mean length showed no significance in the four BMI categories. There were only 6 still births 1 in the underweight category, 3 in normal BMI mothers and 2 in Overweight BMI. New born admissions were 6.8% of the total live births with majority from normal BMI as shown in table 8.

Chapter 6: DISCUSSION

Malnutrition is a serious public-health problem that has been linked to a substantial increase in the risk of mortality and morbidity. (12) Women and young children bear the brunt of the disease burden associated with malnutrition. Malnutrition in women results in reduced productivity, an increased susceptibility to infections, slow recovery from illness, and heightened risks of adverse pregnancy outcomes.(4)

According to Kenya Demographic and Health Survey 2009 (KDHS 2009) the mean BMI for women aged 15-49 years is 23. A comparison of these outcomes with similar data from the 2003 KDHS indicates no meaningful change during the five year period. This study found that the mean BMI of mothers delivering in Mbagathi district hospital was 24.2 which is a representative of the urban population.

Analysis of the BMI shows that at national level, 12 percent of women are considered to be thin (BMI<18.5), also unchanged since 2003. At regional level, the proportion of thin women is highest in North Eastern province (26 percent) and lowest in Nairobi (3 percent). The study at Mbagathi district hospital shows prevalence of Undernutrition at 2.2% which is slightly lower than the Nairobi average.

One-quarter of women age 15-49 are overweight or obese in the Western world. The propensity of being overweight or obese is correlated with increases in age, education level, and wealth quintile. At regional level, the proportion of overweight women ranges from a low of 11 percent in North Eastern province to a high of 41 percent in Nairobi. This study found the prevalence of overweight mothers to be 30.3% and 5.7% to be obese. Mothers with obesity were also found to be significantly older with mean age

28.4 (SD 5.0) and with increased parity. A study by Ritho (2012, Kenyatta National Hospital) showed obese women to be significantly older with average age of 29.6 years (SD 4.3) (40)

The influence of nutritional status on the degradation of health has been the subject of many studies. BMI, which is derived from weight and height measurements, is a good marker of nutritional status and is used to classify people from underweight to obese. The impact of low or increased BMI in the general population has been the focus of many studies, but studies pertaining to pregnant women are few. Whatever studies we have, they are from the Western countries; there are very few Kenyan studies. It was therefore important to conduct the present study, since the findings of Western studies may not apply to the Kenyan population. In the USA the incidence of obesity among pregnant women ranges from 18.5% to 38.3%, while in the present study 5.7% of pregnant women were obese and 30.3% were overweight. (41)

There is a significant relationship between maternal BMI and the neonatal birthweight. The study found that there was an increase in birthweight with increase of maternal BMI.

The mean birth weight increased from the underweight BMI 2.8 (SD 0.3), normal BMI 3.0 (SD 0.5) and overweight group 3.2 (SD 0.5). The overweight group was comparable to babies born to obese mothers mean weight 3.1 (SD 0.3). This study supports that there is a correlation between maternal BMI and neonatal outcome. With increasing BMI

there is increasing fetal weight except for the obese category where the finding did not correlate.

Previous reports showed an increased obstetric risk for low maternal BMI perinatal outcome. These complications included maternal anemia, preterm labor, IUGR and low birthweight. (42) In the present study the occurrence of IUGR and low birth weight had no specific relation to any BMI group.

A study by Nutrition Collaborative Research Support Program (CRSP) between 1981 and 1992 examined the relationship between maternal body mass index (BMI) and pregnancy outcome in Egypt, Mexico and Kenya. The findings were low birth weight infants in Kenya were born to women with a BMI <21(43). This finding was not replicated in this study.

Several studies investigating the relationship of maternal obesity with fetal growth have shown that obese women have an 18 – 26% increased chance of delivering large for date infants, even after controlling for maternal diabetes. (44, 45)

In the present study the occurrence of Large for gestational age and neonatal macrosomia was not demonstrated in any BMI group.

CONCLUSION

This study showed that mothers with obesity were significantly older than mothers who were underweight, normal or overweight.

It also showed that most of the underweight women were unemployed while most of those who were overweight were salaried. This shows that socioeconomic status has an influence on the BMI of the women.

The study showed an increase in BMI with increased parity of two or more children.

There was no adverse outcome associated with the maternal BMI in this study.

The study found that there was an increase in birthweight with increase of maternal BMI increasing from underweight, normal and overweight but no correlation with the obese category.

RECOMMENDATION

Improving maternal nutrition and encouraging antenatal services facilitating nutrition and care during pregnancy can lead to improved perinatal outcomes in our population.

A nationwide prospective study should be conducted to provide knowledge about impact of BMI on neonatal outcomes among different socio-demographic and ethnic groups.

Policy makers need to recognize that malnutrition is a serious public health matter and formulate guidelines on its management to optimize maternal and neonatal health.

REFERENCES

1. World Health Organization. Maternal Anthropometry and Pregnancy Outcomes. Supplement to volume 73 of the bulletin, 1995, p185.
2. World Health Organization. Maternal body mass index and gestational weight gain and their association with perinatal outcomes in Viet Nam. Bulletin of WHO, 2011;89:127-136
3. Kramer MS. Determinants of low birth weight: methodological assessment and meta-analysis. *Bull World Health Organ* 1987; 65: 663-737 pmid: 3322602
4. Sandra L. Huffman, Elizabeth R. Zehner et al: Essential Health Sector Actions to Improve Maternal Nutrition in Africa May 2001, Chapter 1 and 2
5. World Health Organization. Global and regional Burden of Disease attributable to selected major risk factor, 2004, volume 1, chapter 2, page 84.
6. Aviram A, Hod M, Yogev Y. Maternal Obesity: Implications of pregnancy outcome and long-term risks-a link to maternal nutrition. Int J Gynaecol Obstet. 2011 Nov; 115 Suppl 1: S 6-10
7. World Health Organization. Global database on Body mass index, BMI Classification, 2004
8. Kenya National Bureau of Statistics (KNBS) and ICF Macro. 2010. Kenya demographic and health survey 2008-09. Carlveton, Maryland: KNBS and ICF Macro. Chapter 11, page 157-158.
9. Harohalli R Shashidhar, Jatinder Bhatia. Malnutrition, medscape, 2011. Available from: http://emedicine.medscape.com/article/985140-overview

10. Malnutrition definition from Wikipedia. Available from: http://en.wikipedia.org/wiki/Malnutrition
11. Malnutrition definition from the free dictionary by Farflex. Available from: http://medical-dictionary.thefreedictionary.com
12. Blössner, Monika, de Onis, Mercedes. Malnutrition: quantifying the health impact at national and local levels. Geneva, World Health Organization, 2005. (WHO Environmental Burden of Disease Series, No. 12).
13. Ross J, Thomas EL. Iron deficiency anemia and maternal mortality. Profiles Working Notes Series No. 3. Washington: Academy for Educational; 1996.
14. Gillespie S. Major issues in iron. Ottawa: Micro-nutrient Initiative; 1998
15. Shetty PS, James WPT. Body mass index: a measure of chronic energy deficiency in adults. FAO Food and Nutrition Paper 56. Rome: Food and Agriculture Organization; 1994
16. Christian P et al. Vitamin A or B-carotene supplementation reduces symptoms of illness in pregnant and lactating women. J Nutr 2000;130:2675–82.
17. Caulfield L, et al. Potential contribution of maternal zinc supplementation during pregnancy to maternal and child survival. Am J Clin Nutr 1998 Aug;68 Suppl 2:499S–508S.
18. Black R. Reducing perinatal and neonatal mortality. In: Child Health Research Project Special Report 3(1). Report of a meeting. Baltimore, MD. 1999 May 10–12. Baltimore: Johns Hopkins University; Oct 1999
19. Prentice AM. Presentation made at ICDDRB. Meeting on Prevention of Low Birthweight. Dhaka, Bangladesh. Aug 1999.

20. Barker DJP. Fetal origins of coronary heart disease. BMJ 1995 Jul 15;311:171–4.
21. Ramakrishnan U, Manjrekar R, Rivera J, Gonzalez T, Martorell R. 1999b. Micronutrients and pregnancy outcome. Nutr Res 1999;19:103–59.
22. Williams text book of Obstetrics: Medical and Surgical complications, Obesity 22nd Edition, Mc Graw Hill publishers. 2005. Chapter 43.
23. Jerry R. Balentine: Obesity Causes. Emedicinehealth, 2012, p2. Available from: http://www.emedicinehealth.com/obesity/page2_em.htm
24. Wanjiku K, Denise BR. Obstetric outcomes associated with increased BMI category during pregnancy. American Journal of Obstetrics and Gynecology 2004; 191:928-932
25. Kaiser and Kirby, 2001; Kaiser PS, Kirby RS. Obesity as a risk factor for cesarean in a low-risk population, Obstet Gynecol 2001;97:39-43.
26. Young TK, Woodmansee B. Factors that are associated with cesarean delivery in a large private practice: the importance of prepregnancy body mass index and weight gain. Am J Obstet Gynecol 2002;187:312-8.
27. Chauhan SP, Magann EF, Carroll CS, et al: Mode of delivery for the morbidly obese with prior cesarean delivery: Vaginal versus repeat caesarean section. Am J Obstet Gynecol 185:349, 2001
28. Cunningham FG, Pritchard JA: Peripartum heart failure: idiopathic cardiomyopathy or compounding cardiovascular events? Obstet Gynecol. 1986 Feb; 67(2):157-68.

29. Myles TD, Gooch J, Santolaya J: Obesity as an independent risk factor for infectious morbidity in patients who undergo cesarean delivery. Obstet Gynecol. 2002 Nov;100(5 Pt 1):959-64.
30. Li R, Jewell S, Grummer-Strawn L. Maternal obesity and breastfeeding practices. Am J Clin Nutr. 2003;77:931–936.
31. World Health Organization. Development of a Strategy Towards Promoting Optimal Fetal Growth. Low birth weight strategy, 2003, p1.
32. Williams text book of Obstetrics: The Newborn Infant, Routine Newborn Care the Estimation of Gestational Age. 22nd Edition, Mc Graw Hill publishers. 2005, Chapter 28.
33. Currents diagnosis and treatment in Obstetrics and Diagnosis: Essentials of Normal Newborn Assessment and Care. 10th edition, Mc Graw Hill publishers 2007, chapter 11.
34. The American College of Obstetricians and Gynecologists Committee on Obstetric Practice Society for Maternal-Fetal Medicine. Number 579, November 2013.
35. Simkin, Penny; et al. Pregnancy, Childbirth and the Newborn: The Complete Guide. Meadowbook Press, 1992, ISBN 0-88166-177-5.
36. The Nemours foundation. Growth and your Newborn, What Newborns weigh by kidshealth.org, 2012.
Available from: http://kidshealth.org/parent/growth/growth/grownewborn.html
37. Alexander, Greg. Birthweight – Low Birthweight – Lbw, Infants, Factors and Weight. Social issues reference, Child development reference volume 2, JRank Articles, 2012, p100.

Available from: http://social.jrank.org/pages/100/Birthweight.html

38. Alexander, Greg. Birthweight. High Birthweight. Social issues reference, Child development reference, Jrank articles, volume 2, 2012, p99. Available from: http://social.jrank.org/pages/99/Birthweight-High-Birthweight.html
39. John L. Kiely, Stella Yu, Kate M. Brett, Diane M. Rowley. Low Birth Weight and Intrauterine Growth Retardation, p185.
40. Ritho, University of Nairobi, Obstetrics and Gynecology Department, 2012.Effect of body mass index on pregnancy outcomes at Kenyatta national hospital.
41. Galtier-Dareure F, Boegner C, Bringer J. Obesity and pregnancy: Complication and cost. *Am J Clin Nutr* 2000; 71: 1242S–1248S.
42. Ehrenberg HM, Dierker LRN, Milluzzi C, Mercer BM. Low maternal weight failure to thrive in pregnancy and adverse prenatal outcomes. *Am J Obstet Gynecol* 2003; 189: 1726–1730.
43. L. H. Allen, M. S. Lung'aho, M. Shaheen, G. G. Harrison, C. Neumann and A. Kirksey: Maternal body mass index and pregnancy outcome in the nutrition collaborative research support program. 1981-1992. Available from: http://archive.unu.edu/unupress/food2/UID10E/UID10E0I.HTM
44. N J Sebire, M Jolly and J P Harris; Maternal obesity and pregnancy outcome: a study of 287 213 pregnancies in London; International Journal of Obesity (2001) 25, 11751182.
45. Bianco AT, Smilen SW, Davis Y, Lopez S, Lapinski R, Lockwood CJ: Pregnancy outcome and weight gain recommendations for the morbidly obese woman. Obstet Gynecol 1998, 91:97-102.

APPENDIX 1

Certificate of Informed Consent

University of Nairobi- Department of Obstetrics and Gynaecology

CONSENT TO PARTICIPATE IN A STUDY TO ASSESS RELATIONSHIP BETWEEN MATERNAL MALNUTRITION AND PREGNANCY OUTCOMES AT MBAGATHI DISTRICT HOSPITAL

Principal Investigator: Dr. Steven Mrefu Ibua

Introduction

I am a doctor who is studying to specialize in the field of Obstetrics and Gynecology conducting research that is titled **"**A STUDY TO ASSESS RELATIONSHIP BETWEEN MATERNAL MALNUTRITION AND PREGNANCY OUTCOMES AT MBAGATHI DISTRICT HOSPITAL". I'm conducting a study to understand how maternal nutrition affects the outcome of pregnancy.

I am conducting the above-stated study at Mbagathi District Hospital. You are being requested to participate in the study because you meet the inclusion criteria.

I am going to give you information and invite you to be part of this research. Before you decide, you can talk to anyone you feel comfortable with about the research.

There may be some terminologies not clear to you. Please feel free to interrupt me as we go through the information and I will take time to explain. If you have questions later, you can ask them of me, the doctor attending to you or the nursing staff.

Objectives of the study

The study aims to find out the prevalence of maternal malnutrition and compare fetal outcomes to underweight, normal weight and obese mothers.

Benefits of participating in the study:

The results of the study will help us get important information that may help in formulating policy at National level on maternal malnutrition and its effects on pregnancy outcomes.

You will be informed about your BMI and its effect on your health. If any complications or health issues are detected you will be referred appropriately. Your participation will be very helpful in improving the way we manage pregnant women.

Risks

There are no risks in participating in this study.

.Compensation

There is no compensation for study participants. Participation is voluntary

Voluntary Participation

Your participation in this research is entirely voluntary. It is your choice whether to participate or not. Whether you choose to participate or not, all the services you receive at this hospital will continue and nothing will change. If you choose not to participate in this research project, you will be offered the treatment that is routinely offered in this hospital. You may change your mind later and stop participating even if you agreed earlier.

Type of Research

In this study we will invite women who come to labor ward. Information from the women who accept to join this research will be collected by interviewing them and filling a questionnaire. The total number of participants will be 372 mothers.

This will require that I administer to you a questionnaire at the labor ward when we make contact. The weight, height of the mother and weight, length of the neonate will be taken.

Confidentiality

The information that we collect from this research project will be kept confidential. Information about you that will be collected during the research will be put away and no-one but the researchers will be able to see it. Any information about you will have a number on it instead of your name. Only the researchers will know what your number is and we will lock that information up. It will not be shared with or given to anyone. We will not be sharing the identity of those participating in the research.

Sharing the Results

The knowledge that we get from doing this research will be shared with the policy makers in this hospital and Ministry of Medical Services. And other doctors through publication and conferences. Confidential information will not be shared.

Right to Refuse or Withdraw

*Y*ou do not have to take part in this research if you do not wish to do so and refusing to participate will not affect your treatment at this hospital in any way. You will still have all the benefits that you would otherwise have at this hospital. You may stop participating in the research at any time that you wish without losing any of your rights as a patient here. Your treatment at this clinic will not be affected in any way.

Who to Contact

If you have any questions you may ask them now or later, even after the study has started. If you wish to ask questions later, you may contact any of the following:

This proposal has been reviewed and approved by Kenyatta National Hospital Ethics Committee, which is a committee whose task it is to make sure that research participants are protected from harm.

You can ask me any more questions about any part of the research study, if you wish to. Do you have any questions?

Contact information

For further information or clarification, please contact Dr. Steven Ibua, Department of Obstetrics and Gynaecology, University of Nairobi. Tel: 0722 656227.

In case you need to contact Research and Ethics committee, the contact is Tel: 7263009(020). Now, I will request you to sign below if you have agreed to take part in the study. Thank you.

1. **Consent form - English**

Code Number

I Mr. / Mrs. / Miss. _____, agree to the above and give consent for myself / daughter / sister/ wife to be included in this study as explained to me by _____.

I understand the purpose of the study and conditions of participation.

Signature _____ Date_____

Witness

Signature _____ Date_____

2. Consent form - Kiswahili

Code Number

Mimi _____, nimekubali kushiriki katika utafiti huu kama nilivyo elezwa na _____.

Nimelewa umuhimu wa utafiti huu na masharti yanayoandamana nayo.

Sahihi _____ Tarehe _____

Shahidi

Sahihi _____ Tarehe _____

If Non –literate

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print name of witness_____ AND Thumb print of participant

Signature of witness _____

Date _____

Statement by the researcher/person taking consent

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands that an interview will be conducted to collect information.

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

Print Name of Researcher/person taking the consent_____

Signature of Researcher /person taking the consent_____

Date _____

APPENDIX 2
Questionnaire

Date ☐ Code Number ☐

SECTION A: BIO-DATA / SOCIO-ECONOMIC STATUS

1. Age ☐

2. Marital Status (Tick Appropriate)

   a. Single ☐
   b. Married ☐
   c. Separated / Divorced ☐
   d. Widowed ☐
   e. Other (Specify) ☐

3. Highest level of Education level Attained (Tick one)

   a. Informal ☐
   b. Primary ☐
   c. Secondary ☐
   d. College ☐
   e. University ☐

4. Main type of Occupation (Tick one)

   a. Unemployed ☐
   b. Self employed ☐
   c. Salaried employment ☐
   d. Casual employment ☐

SECTION B: OBSTETRIC HISTORY (At first Antenatal visit)

5. Last Normal Menstrual Period ☐

6. Gestational Age (Weeks from LNMP or Ultra sound) ☐

7. Parity ☐ + ☐

8. Height ☐

9. Weight ☐

10. BMI ☐

SECTION C: DELIVERY

11. Date of delivery ☐

12. Gestation ☐

13. Weight ☐

14. BMI

15. Mode of delivery

    a. Normal vaginal delivery ☐

    b. Caesarean section

        i. Elective ☐ indication_____

        ii. Emergency ☐ indication_____

    c. Vacuum delivery ☐

    d. Breech delivery ☐

16. Type of labor

    a. Spontaneous ☐

    b. Induced ☐

SECTION D: MATERNAL OUTCOME

17. Preeclampsia ☐
18. Eclampsia ☐
19. Gestational Diabetes ☐
20. Antepartum haemorrhage ☐
21. Postpartum haemorrhage ☐

SECTION E: NEONATAL OUTCOMES

22. Sex
    a. Male ☐
    b. female ☐
23. Birth Weight ☐
24. Length ☐
25. Status
    a. Live birth ☐
    b. Still birth ☐
26. New born unit admission ☐

Indication _____