

**RELATIONSHIP BETWEEN MATERNAL ANTHROPOMETRY, SOCIO-
DEMOGRAPHIC FACTORS AND INFANT'S ANTHROPOMETRY AT BIRTH: The
case of the Provincial General Hospital, Nakuru, Kenya**

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**A Thesis Submitted to Graduate School in Partial Fulfillment of the Requirement for
the Degree of Masters of Science in Nutritional Sciences of Egerton University**

EGERTON UNIVERSITY

MARCH, 2011

DECLARATION AND RECOMMENDATION

Declaration

I declare that this thesis is my original work and has not been previously published or presented for the award of a degree in any University.

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DEDICATION

To all that recognize, value and support women in the society to attain their full potential in life and realize their dreams.

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ABSTRACT

An infant's anthropometry (weight and length) at birth are important public health indicators for its survival and later development. Low birth weight (LBW) and stunting at birth are among the major causes of infant mortality which is still a worldwide problem. Despite the government's effort to improve healthcare services, LBW is still a problem at the Provincial General Hospital (PGH) maternity, Nakuru. The main objective of this study was therefore to determine the relationship between maternal anthropometry (delivery weight, Mid Upper-Arm Circumference- MUAC and height), socio-demographic factors and an infant's anthropometry (weight and length) at birth. The information obtained from this study could be helpful in the screening procedure at hospital to identify mothers at a greater risk of delivering low birth weight infants. A cross-sectional study design was adopted and a purposive sample of 200 mothers was used in this study. Anthropometric measurements of both the mothers and the infants were taken. A semi-structured questionnaire was also used in data collection. Maternal haemoglobin (Hb) levels and other health conditions were obtained from their clinic cards and hospital records. The Statistical Package of Social Sciences (SPSS) version 11.5 was used for data analysis. Stated hypotheses were tested using multiple regression, Chi-square, binary logistic regression analysis and t-test statistics. All tests were computed at $\alpha = 0.05$. The study findings showed that low birth weight deliveries are still a problem at the hospital with a rate of 17.3%. Logistic regression analysis revealed that parity, age of the mother, level of education, Hb status, number of ANC clinic visits and a mother's history of a LBW delivery were essential predictors of low birth weight delivery and they were all significant ($p < 0.05$). Maternal delivery weight and MUAC measurements were significantly ($p < 0.05$) associated with the birth weight of an infant after controlling for possible confounding factors and they explained up to 20% ($r^2 = 0.20$, $F = 3.34$, $p = 0.00$) of the variability in the infant's birth weight and 24.8% ($r^2 = 0.248$, $F = 5.91$, $p = 0.00$) variability in infant's birth length. Any intervention aimed at improving birth outcomes therefore should take into consideration parity, maternal age, level of education, Hb status, number of ANC visits, mothers history of LBW delivery, weight and MUAC measurements during its implementation to help curb the high incidences low birth weight deliveries.

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ACRONYMS AND ABBREVIATIONS

ACC	Administrative Committee on Coordination
ANC	Antenatal Care
APG	Appropriate for Gestational Age
CDC	Centre for Disease Control and Prevention
CBS	Central Bureau of Statistics
GoK	Government of Kenya
HIV	Human Immuno-Deficiency Virus
IUGR	Intrauterine Growth Retardation
KNBS	Kenya National Bureau of Statistics
LBL	Low Birth Length
LBW	Low Birth Weight
LGA	Large for Gestational Age
MDGs	Millennium Development Goals
MUAC	Mid-Upper Arm Circumference
NBL	Normal Birth Length
NBW	Normal Birth Weight
PGH	Provincial General Hospital
RR	Relative Risk
SBL	Short Birth Length
SCN	Standing Committee on Nutrition
SGA	Small for Gestational Age
UNICEF	United Nations Children's Fund
WHO	World Health Organization
Hb	Haemoglobin

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

An infant's birth weight has been identified as the best marker of optimal foetal growth and development. Low birth weight (LBW) is defined by World Health Organization (WHO) as a birth weight of less than 2500 g (5.5 pounds) regardless of the gestational period (WHO, 2008). This birth weight has negative implications on neonate survival, later growth, health, development, anthropometric parameters in adulthood and cognitive development (Gross, Spiker and Haynes, 1997; UNICEF/WHO, 2004; WHO, 2005). This is based on epidemiological observations that infants weighing less than 2500 g are approximately 20 times more likely to die than heavier babies. Low birth weight is either as a result of preterm delivery (before 37 weeks) or due to intrauterine growth retardation (IUGR). In developing countries, the problem is majorly due to IUGR. Maternal anthropometry (delivery weight, height and Mid-Upper Arm Circumference), health status (maternal HIV status, hypertension, diabetes and hemoglobin levels) and other related socio-demographic factors (maternal level of education, age, household size, income levels, number of children, attendance to antenatal clinic and sex of the infant) are among factors that have been identified to influence an infant's birth weight and length (Johnson *et al.*, 1994; Eide *et al.*, 2005; Elshibly and Schmalisch, 2008). Delivery weight has been used in most studies as a predictor of an infant's birth weight due to the challenges of keeping track of weight gain among pregnant women (Acharya *et al.*, 2004; Nahar *et al.*, 2006). In these studies mothers who had a delivery weight of < 50 Kg were more likely to give birth to LBW infants compared to heavier mothers. An infant's length at birth has also been found to be an important predictor of both adult height (stature) and weight thus in turn is predictive of pregnancy outcomes hence the intergenerational associations (Melve, Gjessing and Skjaerren, 2000; Morton, 2004; Eide *et al.*, 2005).

Over 20 million infants worldwide are born with Low Birth Weight with more than 95.6% of these infants being born in developing countries (WHO, 2005). Sub-Saharan Africa accounts for around 15% of these LBWs where LBW is a strong determinant of infant mortality. South-

Central Asia accounts for the largest percentage of all LBW infants worldwide where more than 27% of all infants weigh less than 2500 g. In Kenya, 10% of all infants born annually are of LBW (UNICEF, 2008) where infant mortality is still high at 79 per 1000 live births which the government targets to bring down to 25 per 1000 live births by the year 2015. In addition Kenya still lags behind countries such as South Africa, Indonesia and Malaysia where infant mortality rates are 55, 28 and 10 per 1000 live births respectively as stipulated in the Kenya Vision 2030.

In the Kenyan Vision 2030, reducing infant mortality rates is one of the government's commitments towards achieving the main goal in the health sector of improving the overall livelihood of Kenyans. This is through providing an efficient and a high quality health care system with the best standards (GoK, 2007). This is also in line with the millennium development goal (MDG) number four of reducing child mortality rates which are still high. Addressing the problem of LBW and length therefore forms an important basis of solving infant mortality. According to UNICEF (2008), at the current rate of progress, the goal will be achieved 30 years later than the projected time of 2015.

A study by Alderman and Behman (2006) also found that reducing the incidence of LBW has economic benefits estimated primarily from increases in labour productivity (partially through more education) and secondarily from avoiding costs due to infant illness and death as infants born with normal birth weight perform better in school than their LBW counterparts. Therefore addressing the problem of low birth weight is one way of saving resources and increasing productivity. However, this study did not look at this concept. Just like other nutritional indicators for economic growth (nutrition profiles), improving an infant's birth weight can be one of the ways of improving a country's economic growth. This was evident from studies that estimated economic benefits of reducing the incidence of LBW in a low income context (Petrau *et al.*, 2001; Alderman and Behman, 2006).

Investigating other factors associated with an infant's birth weight and length is important to form a basis of improving pregnancy outcomes at the Provincial General Hospital (PGH), Nakuru. High rates of LBW deliveries have continued to be experienced as evidenced in a study conducted by Mbuthia (2006) in the year 2004 and 2005 in the same hospital which found the

rate to be 10.1%. Low birth weight rates for 2007 and 2009 in the same hospital were 10.9% and 13.8% respectively. These rates were calculated from the hospital maternity delivery records by counting the LBW cases recorded in those years and dividing by the total number of deliveries as a percentage. These rates are high compared to the current LBW rate in Kenya which is 10%. This study therefore aimed at investigating the relationship of maternal anthropometry, health status and other socio-demographic factors with an infant's anthropometry at birth. The results of the study may give a new insight of what more needs to be done to reverse the trend of LBW deliveries.

1.2 The statement of the Problem

Infant mortality is a worldwide problem where the highest magnitude is recorded in developing countries such as Kenya. Low Birth Weight (LBW) and stunting are major contributors towards this problem. Over 20 million infants worldwide are born with LBW with more than 95.6% of these infants being born in developing countries (WHO, 2005). In Kenya where infant mortality is still high at 79 per 1000 live births, 10% of all infants born annually are of LBW (UNICEF, 2008) while 35% of all children are stunted with 15% being severely stunted. Nakuru PGH is a government health facility in Kenya where the government is committed to improve health care services especially to avert infant mortality. Despite these efforts by the government, high rates of LBW and stunting have continued to be reported at this facility as evidenced from a study by Mbutia (2006) that recorded 10.1% LBW rate at the hospital and the rates for subsequent years of 10.9% and 13.8% in 2007 and 2009 respectively as determined from the hospital records at the maternity. Factors associated with this problem however had not been explored at the facility. This therefore called for a need to investigate the relationship between maternal anthropometry, socio-demographic factors with infant's anthropometry at birth. These maternal factors have been found in other studies to be associated with an infant's birth weight (Wannous and Arous, 2001; Kramer, 2001; Maruoka *et al.*, 2007). In this studies, maternal height of <150cm, delivery weight of < 50 Kg and MUAC measurements of <22 cm have been found to be associated with LBW infants. Maternal level of education, age, income, parity among other socio-demographic factors have been used as individual and household based indicators for LBW (Spencer *et al.*, 1999).

Thus the findings from this study could be used to give a new insight of other interventions that may be incorporated in the Antenatal Clinic (ANC) in addition to the existing ones to improve the situation at the hospital and even be extended to other hospitals and to the community where this could also be a problem.

1.3 Purpose of the study

The study was designed to determine the relationship between maternal anthropometric characteristics, socio-demographic status, health status and infant's anthropometry at birth.

1.4 Objectives

- i). To determine the birth weight and length of infants born at PGH Maternity Ward, Nakuru.
- ii). To find out the delivery weight, height and mid upper arm circumference (MUAC) of mothers at PGH Maternity Ward, Nakuru.
- iii). To establish the maternal socio-demographic factors associated with an infant's birth weight and length at PGH Maternity Ward, Nakuru.
- iv). To assess the health status of the mothers from their clinic records and cards at PGH Maternity Ward, Nakuru.
- v). To determine the difference between mothers with normal birth weight and length and those with LBW and stunted infants in terms of their anthropometric characteristics and maternal related factors at PGH Maternity Ward, Nakuru.

1.5 Hypothesis

Ho₁. There is no statistically significant correlation between an infant's birth weight and length at PGH Maternity Ward, Nakuru.

Ho₂. There is no statistically significant relationship between maternal anthropometric characteristics and the infant's anthropometry at birth at PGH Maternity Ward, Nakuru.

Ho₃. There is no statistically significant relationship between the health status of the mothers and infant's anthropometry at birth at PGH Maternity Ward, Nakuru.

Ho₄. There is no statistically significant relationship between maternal socio-demographic factors and the infant's anthropometry at birth at PGH Maternity Ward, Nakuru.

Ho₅. There is no statistically significant difference between mothers with stunted and LBW infants and those with normal birth weight and length in terms for some characteristics at PGH Maternity Ward, Nakuru.

1.6 Significance of the study

Reducing infant mortality rates is one of the millennium development goals which the government is committed to achieve by the year 2015. The government through the Ministry of Health has put in place interventions to ensure improved pregnancy outcomes such as introducing refocused ANC which recommends a minimum of four ANC visits by pregnant women. However, LBW is still a problem at the hospital. The results of this study therefore will inform the government and other stakeholders in the health sector on other factors that need to be incorporated in the health care service delivery in order to realize improved birth outcomes in terms of infant's birth weight and length at birth. If this information is known, then it can be used in the screening process of the mothers at the antenatal clinic to identify those at a greater risk so that early interventions can be institutionalized to improve on the birth outcomes in terms of birth weight and even length. Thus this will be cost effective to the government than what it would have otherwise spent on medication for frequently sick children later. If this information is known, it can be used in making critical health decisions that would enable mothers to take full charge of their health and the health of their unborn children. Also mothers will be able to seek timely advice concerning their health and know the risk factors for poor pregnancy outcomes and take precaution to improve the outcomes.

Hence the aim of the study was to investigate the relationship between maternal anthropometry (delivery weight, height and MUAC), maternal health status (Hb levels, diabetes and hypertension) and other socio-demographic factors (maternal age, number of children, maternal level of education, family size, household income, sex of the infant, attendance to the ANC and history of LBW deliveries among others) with infant's anthropometry at birth (birth weight and length). The results of the study therefore may provide the understanding on the association

between these factors and the infant's anthropometry at birth at the hospital and the way forward. The results of the study will also provide baseline information upon which further research can be built up on.

1.7 Scope of the study

The study was confined in a hospital setting at the Provincial General Hospital, Nakuru which was selected due to its location in a highly cosmopolitan region of Nakuru. Study subjects were selected from the hospital delivery records and this was guided by the number of LBW infants in the delivery records. The study sample included only mothers who came to deliver at the hospital and it comprised both mothers who had LBW infants and those who had normal weight infants.

1.8 Limitations of the study

- i). There were problems determining the correct gestational period as it was dependent on the truthfulness, ability to recall and the literacy level of the mother about her last menstrual period. To control for this, supplementary information on the mothers' clinic cards i.e. EDD as indicated by the health care providers was used as a better source for this information.
- ii). Infants birth weights were taken and recorded by the nurses at the hospital and not by the researcher, however, to ensure accuracy of the weights, the researcher frequently validated the scales using known weights
- iii). Since this was a cross-sectional study, it was a limitation as the effects of IUGR on infant's birth weight could not be detected therefore making it impossible to tell whether the LBW was due to preterm delivery or due to effects of IUGR however the researcher considered infants born at term but with LBW to be as a result of IUGR.
- iv). The study was carried out in a hospital setting, thus the results will only be representative of the hospital and not the whole population as some deliveries occur at home. However, since the study was carried out at PGH, Nakuru that is situated in a highly cosmopolitan

region, the probability of ethnic diversity is high hence the results could be representative of all the provincial hospitals in the country.

- v). The study only covered a few variables known to be associated with an infant's anthropometry at birth (maternal anthropometry, health status and a few socio-demographic factors) and therefore has given an indication for further research to investigate other factors that affect an infant's anthropometry at birth.

1.9 Assumption of the study

Mothers were able to recall a number of exposures such as years in formal education, ANC attendance, age among others in their near past and that they would be cooperative.

The difference in infant length within 24 hours after delivery is insignificant

1.10 Operational definitions of terms

This section provides the meaning of some of the words and phrases as used in this study.

Anaemia in pregnancy: Haemoglobin levels of < 11 g/dl according to WHO

Appropriate for Gestational Age: An infant birth weight of equal to or greater than 10th percentile but less than 90th percentile

Extremely low birth weight: birth weight <1,000 g

Family size: All the members living in the same house with the mother and sharing from a common pot including relative

HIV status: Whether the mother is HIV positive or negative as indicated on their clinic cards or in the hospital records

Infant's anthropometry: Weight and length at birth

Intrauterine growth retardation: Born at term (after 37 weeks) but with LBW due to restricted foetal growth in the uterine

Large for Gestational Age: An infant birth weight greater than 90th percentile

Length of the infant at birth: The crown-heel length of the infant in cms at birth measured within 24 hours after delivery using a tape measure

Low Birth Weight: birth weight < 2,500 g regardless of the gestation period

Maternal anthropometric characteristics: Height, MUAC and delivery weight

Maternal delivery weight: The weight of the pregnant mother just before delivery

Maternal health status: Diabetes, hypertension, HIV status and Hb levels

Maternal related factors: Age, parity, education level, occupation, number of antenatal care visits, supplementation, income, time when mother started ANC clinic, marital status, previous LBW delivery and birth spacing

Normal Birth Length: A birth length of 46 cm and above

Normal Birth Weight: A birth weight of 2.5 Kg and above

Preterm: born before 37 completed weeks of pregnancy as determined by the health care providers (Expected Date of Delivery- EDD)

Refocused ANC: A minimum of four ANC clinic visits during which critical examination of the mother is conducted

Short Birth Length: A birth length of less than 46 cm

Small for Gestational Age: An infant weighing less than 10th percentile

Stunting (short length) at birth: An infant length of less than 46 cm

Term infants: Those born after 37 completed weeks

Very low birth weight: birth weight < 2,000 g

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter will review relevant literature on low birth weight in line with the study topic. Maternal risk factors associated with low birth weight will be discussed in depth and the implications of low birth weight on the overall development of a country will also be discussed in this chapter.

2.2 Low birth weight

Low birth weight is defined by the World Health Organization (2008) as birth weight less than 2500 g. According to Norton (2000), low birth weight is governed by two major processes: a short gestational period, i.e. the infant is born too soon and is qualified as premature (birth weight < 2500 g and gestational age < 37 weeks), or retarded intrauterine growth, i.e. the infant is small for gestational age (birth weight < 2500 g and gestation age > 37 weeks). In developing countries, intrauterine growth retardation accounts for the majority of low birth weights whereas in developed countries most LBW babies are premature as opposed to growth retardation. Low birth weight is associated with increased risk of morbidity and mortality during infancy. There is also growing evidence from studies Melve *et al.*, 2000; Morton, 2004; Eide *et al.*, 2005) that the adverse consequences of LBW may continue throughout the life cycle. Increased LBW rates have been noted in many parts of the world. Low birth weight is thus a worldwide concern (Li and Sung, 2008). Worldwide, 20 million infants are born with LBW with developing countries accounting for the largest percentage of 95.6% LBW cases. Sub-Saharan Africa accounts for 15% while in Kenya, 10% of all infants born annually are of LBW (UNICEF, 2008).

In the Kenyan Vision 2030, reducing infant and maternal mortality rates is among the government's commitments to attain the main goal in the health sector of improving the overall livelihood of Kenyans. This is through providing an efficient and a high quality health care system with the best standards (GoK, 2007). This will also make it possible to attain the millennium development goals (MDGs) on the reduction of infant and maternal mortality (MDG

4 and 5). Currently, infant mortality rate is 79 per 1000 while maternal mortality rate is 410 per 100,000 live births. Kenya still lags behind countries such as South Africa, Indonesia and Malaysia where infant mortality rates are 55, 28 and 10 per 1000 live births and maternal mortality rates are 150, 307 and 30 respectively as stipulated in the Kenya Vision 2030. The current trend of infant mortality is as shown in Figure 2.1.

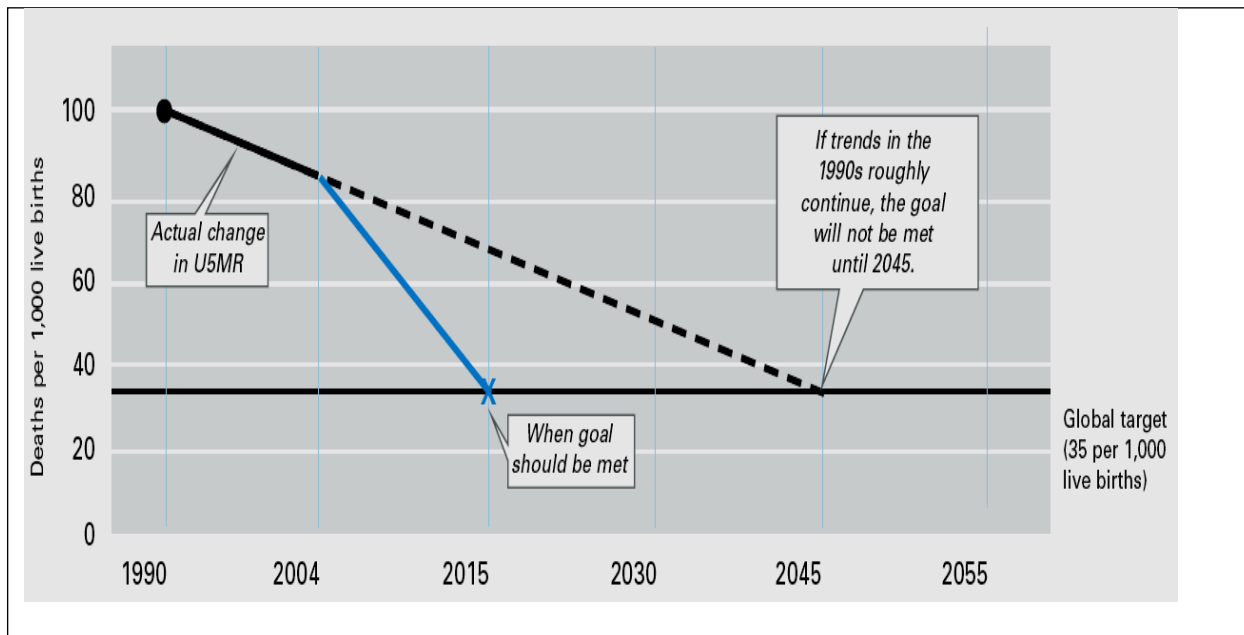


Figure 2.1: Global progress towards reducing under-five mortality rates by two thirds
Source: UNICEF (2008)

According to UNICEF (2008), at the current rate of progress, the goal will be achieved 30 years late contrary to the projected time 2015. Since LBW is a major determinant of infant mortality, it could be one of the reasons for the poor progress, addressing the problem would significantly help in improving the trend hence timely achievement of the goal.

According to the current KDHS report, the probability of infant mortality is high 70 per 1000 live births in LBW infants as compared to 50 per 1000 live births in normal weight infants (KNBS, 2010). A longitudinal study conducted in Bangladesh by Yasmin *et al.* (2001) found an increased mortality rate of 133 per 1000 live births among LBW infants compared to 52 per 1000 live births among normal weight infants. Similar findings were found in another study in Iran by Golestan *et al.* (2008) where LBW accounted for two-thirds of neonatal deaths. According to the study findings, mortality rate was 23 times more in LBW infants compared to normal weight

infants. Furthermore, LBW infants especially the extremely LBW cases often face severe short and long term health consequences. According to Barker's concept, some chronic conditions such as coronary heart disease have foetal origin thus the explanation of long term consequences of LBW (Rasmussen, 2001). In addition, LBW is a major determinant of mortality and morbidity in infancy and childhood. Low birth weight also results in substantial costs to the health care system and imposes a significant burden on society as a whole (WHO, 2005 and Elshibly and Schmalisch, 2008).

A study by Petrau *et al.* (2001) further indicates that reducing LBW incidences bears economic benefits especially in resource poor countries. The study showed that, reducing LBW in the U.S. had high and visible economic returns because it averts extensive resources used for neonatal emergency care as well as subsequent resources used for special education. These findings were also given emphasis in another study by Alderman and Behman (2006) who estimated the economic benefits from preventing a LBW birth in a low income context. These benefits include those derived from reduced infant mortality, reduced incidence of neonatal care and infant/child illnesses and reductions in the costs of chronic diseases as well as productivity gains associated with reduced stunting and increased cognitive ability. A study by Gross *et al.* (1997) found that low birth weight infants are also at a greater risk of reduced mental capabilities later in life.

Given all these possible benefits of reduced incidence of LBW, investigating factors associated with LBW at the hospital could help in addressing the problem. According to Kramer (2001), the maternal determinants of LBW include: poverty which impacts on maternal nutrition, unemployment and the level of education of the mothers. Since these factors have shown to have a major influence on an infant's birth weight in other studies (Kramer, 2001, Wannous and Arous, 2001, Vahdaninia *et al.*, 2008), this study will investigate these factors among mothers at the Rift Valley hospital maternity.

2.3 Infant's birth length

There is growing evidence that birth length of an infant is also a strong determinant of adult height. Though the genetic makeup plays a role in this, nutritional status (stunting) is said to enhance its effect. A good nutritional status therefore can suppress these negative effects of

genetics. Strong associations have been identified between an infant's birth length and adult height especially among term infants born at gestation age of between 39-41 weeks in comparison to preterm infants. Mean adult height has been seen to increase linearly by increasing birth lengths from 46 cm. Birth lengths below 46 cm only show weak associations with height as these short lengths represent preterm births. With this research evidence, infant's birth length has been identified as a predictor of adult height (Eide *et al.*, 2005). Short mothers due to stunting are more likely to give birth to short infants who then remain stunted in their childhood. They also grow up into short mothers in adulthood who again are more likely to give birth to short infants. This forms intergenerational associations of poor pregnancy outcomes that have negative implications to an infant's survival. However, this intergenerational cycle can be broken at one point if others factors such nutritional status can be improved (Morton, 2004).

2.4 Factors influencing infant's anthropometric measurements at birth

Low birth weight and length are considered to be indicators not only of the health and nutrition status of pregnant women but also of the social development of a population. A number of factors have been identified to be associated with LBW and length of infants in various studies but a baby's low weight at birth is dependent on two major factors: a premature birth or intrauterine growth retardation (IUGR). The latter implies that the foetus growth has been inhibited and thus the foetus has not attained the potential growth (Vahdaninia *et al.*, 2008). These two factors are in turn influenced by other factors as evidenced from a study conducted in Tehran, Iran in 15 university hospitals (Melve *et al.*, 2000). Maternal age, maternal education level, history of low birth weight deliveries, number of parities and chronic diseases are some of the factors found to influence an infant's birth weight. The relationship between these variables and LBW were examined and were found to be highly significant in predicting the birth weight of an infant.

A study by Wannous and Arous (2001) conducted in the Syrian Arab Republic to identify determinants of LBW in government hospitals and in the community also showed that more than half of the LBW babies were born premature and more female babies were of LBW. In addition, maternal factors were very important determinants of LBW and these factors include low delivery weight of < 50 Kg, maternal height, poor maternal nutritional status, short birth intervals

and parity. Previous delivery of a LBW baby had significant association with LBW. The study also showed that maternal anaemia and a history of hypertension were associated with a high proportion of LBW cases. Another study among the Japanese infants by Maruoka *et al.* (2007) also yielded the similar results. In the light of these findings, this study will seek to investigate whether this is the case at the PGH, Nakuru hence give an indication of other interventions that could be put in place to improve the situation at the hospital

According to Kramer (2001), LBW is caused by a number of factors which interact among themselves hence resulting in LBW infants. These factors are summarized in Table 2.2.

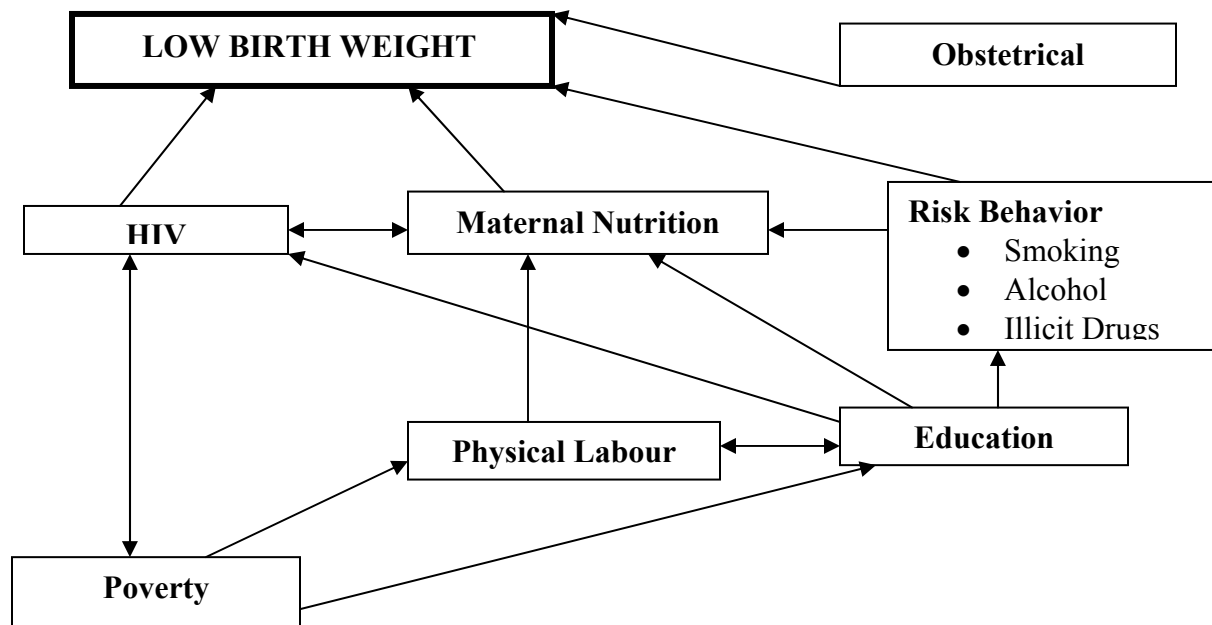


Figure 2.2: Low birth weight risk factors
Source: Kramer (2001)

In developing countries, the major determinants of growth retardation are nutritional: inadequate maternal nutritional status before conception, short maternal stature (principally due to under nutrition and infection during childhood) and poor maternal nutrition during pregnancy (low gestational weight gain, primarily due to inadequate dietary intake). Maternal nutrition during pregnancy is especially important. Inadequate intake of some nutrients can lead to adverse infant effects such as preterm births, intrauterine growth retardation and low birth weight (Black, 2001;

Christian, 2003). Low pregnancy weight gain may account for more than 14% of growth retardation, further, in populations with a high prevalence of short stature, low maternal height accounts for about 18.5%. In addition, diarrhoeal diseases, intestinal parasitosis and respiratory infections are common in developing countries and may also have an important impact on IUGR. These illnesses may be associated with an impaired foetal growth of, on average, 45 g per birth. Again, where it is endemic, malaria is a major determinant of IUGR. Infants born to women with placental malaria have a mean deficit in birth weight of about 170 g (ACC/SCN, 2000). Furthermore, according to this report, the immediate causes of IUGR often operate simultaneously with more deeply rooted underlying and basic causes which include care of women, access to and quality of health services, environmental hygiene and sanitation, household food security, educational status and poverty. This study therefore will confine itself to only a few factors in relation to low birth weight among mothers at the maternity. It will not cover all the factors and hence will give an indication for further research. Thus the factors of interest will be given more emphasis in this section.

2.4.1 Maternal anthropometric characteristics

Maternal nutrition is a fundamental determinant of foetal growth, birth weight and infant morbidity as well as women's health, productivity and caring capacity. Anthropometry provides a simple, reliable and low cost method of assessing maternal nutrition status which can be universally applied at the primary care level (Kelly *et al.*, 1996). According to the researchers, the potential for maternal anthropometry to indicate the risk of intrauterine growth retardation, LBW, pre-eclampsia and obstructed labour has been explored based on known physiological principles. Low maternal weight and weight gain are greatly associated with IUGR. This was shown in a study by Nahar *et al.* (2006) in which maternal weight, height and pregnancy weight gain were identified as significant predictors of an infant's birth weight. However, according to the researchers, there are differences between developed and developing countries in determining the most appropriate cut off points for anthropometric measurements. The results of this study will therefore provide information that can be used in screening mothers who are at a greater risk of poor birth outcomes with reference to LBW infants based on their anthropometric measurements. From their study, Nahar *et al.* (2006) recommended that screening using

measurements that require only one contact with a woman such as height and MUAC are useful given the limitations of poor antenatal attendance by women in developing countries.

In an earlier study conducted in Dhaka by Jonson *et al.* (1994), maternal anthropometric measurements which are significantly correlated with pregnancy outcomes included delivery weight, pregnancy weight gain, weekly weight gain, pregnancy weight, net weight gain, height, pre-pregnancy BMI and percent ideal pre-pregnancy body weight at $p < 0.05$ using stepwise selection procedure in multiple regression analysis. In this study, delivery weight of the mothers, percent ideal pre-pregnancy body weight and pre-pregnancy BMI were predictive of infant's birth weight. They thus concluded that anthropometric measurements were better nutritional predictors of pregnancy outcomes than dietary intake. Since in their study, delivery weight of the mothers was found to be highly significant hence an important predictor of infant's birth weight, they suggested a need to pay greater attention to this variable in future studies. It is in this light that my study will endeavor to investigate the association of delivery weight with the infant's birth weight among the mothers at the hospital. MUAC on the other hand is another variable that has found its application in predicting an infant's birth weight. A study by Mohanty *et al.* (2006) revealed that a MUAC measurement of < 22 cm in the first trimester was predictive of LBW. Consequently, maternal MUAC at delivery of < 22 cm is said to increase the relative risk of LBW (Elshibly and Schmalisch, 2008). This anthropometric measurement is a good indicator of chronic malnutrition and therefore in this study, it will be predictive of maternal nutritional status before and during pregnancy.

Maternal height and weight

Besides biological factors such as gestational age (GA), maternal weight and height can greatly influence an infant's birth weight. Maternal height is an important predictor of an infant's birth weight as proved in a number of studies conducted among pregnant mothers (Elshibly and Schmalisch, 2008 and Baqui *et al.*, 1994). Both studies found that maternal height of below 155 cm was a risk factor of LBW and that mothers with a short stature had an increased risk of child death. This confirmed the value of maternal height as a predictor of child morbidity and mortality. The interpretation behind this phenomena is that there is slower foetal growth in mothers with a short stature and this appears to be physiologic as put across by Zhang *et al.*

(2007). Other similar studies have found maternal weight gain and height to be good predictors of an infant's birth weight too. Nahar *et al.* (2006) for instance in their study conducted in Dhaka, found out that maternal weight gain in pregnancy and height had a great influence on an infant's birth weight. In their study, it was evident that each 1 Kg increase in weight was associated with an increase in birth weight of about 260 g and that women who weighed 43 Kg at any point in the course of pregnancy delivered babies with the lowest birth weight and therefore concluded that a weight at pregnancy of 43 Kg or less was a good predictor of low birth weight. In addition, their study revealed that a combination of weight (45 Kg or less) and height (150 cm or less) gave the highest sensitivity of 50% hence the best predictors of low birth weight. Figures 2.3, 2.4 and 2.5 give a summary of how weight at 9 months, weight gain in the third trimester and height are sensitive predictors of LBW as per their study.

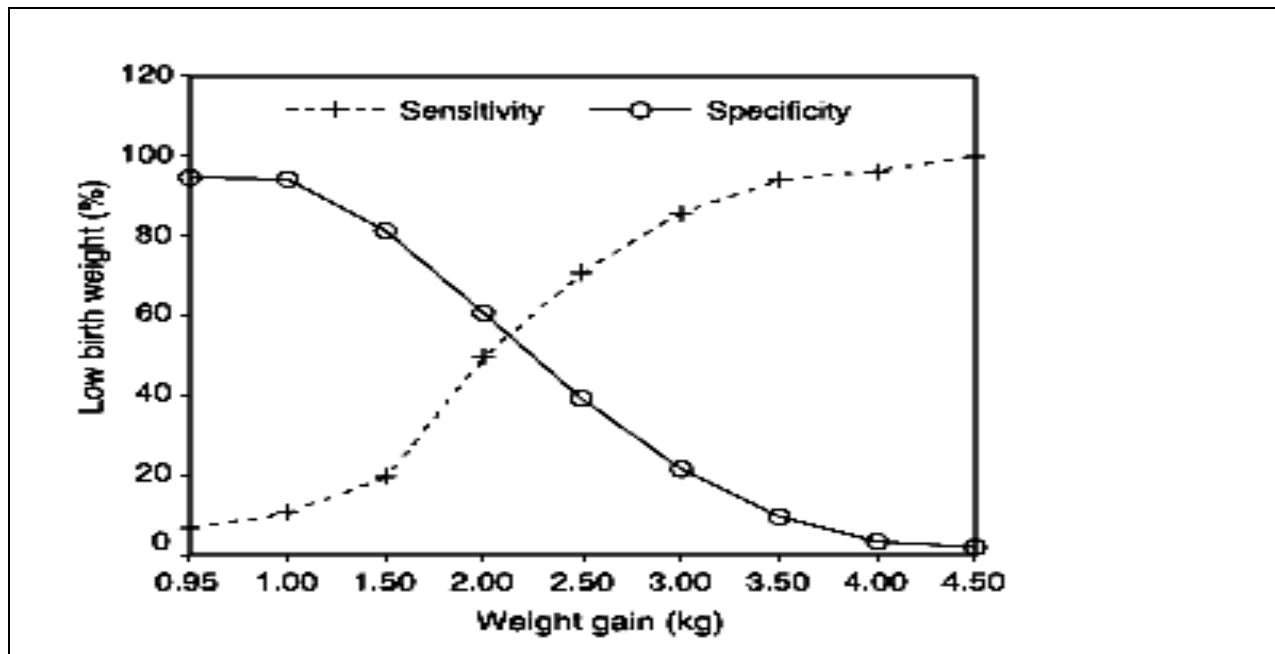


Figure 2.3: Sensitivity and specificity for weight in third trimester
Source: Nahar *et al.* (2006)

Though much emphasis has always been directed towards weight gain in pregnancy as a determinant of an infant's birth weight, delivery weight too has proven to be an important predictor of weight at birth of an infant suggesting a need to pay greater attention to this variable (Johnson *et al.*, 1994). From their study, it was evident that anthropometric measurements are better predictors of pregnancy outcome than prenatal dietary intake. According to the

researchers, prenatal diet affects maternal weight and birth weight most in women who are starving or are acutely hungry. These findings are also supported by findings from another study by Kelly *et al.* (1996) which showed maternal anthropometry to be a better predictor of pregnancy outcome than maternal nutrition and that maternal nutrition is associated with only a limited range of reproductive risk and that its relative contribution to the successful outcome of pregnancy varies in relation to prevailing health conditions. Though this is the case, nutrition adequacy is a vital factor during pregnancy and therefore this should not be taken for granted. Pregnant women should be encouraged to eat enough and rest.

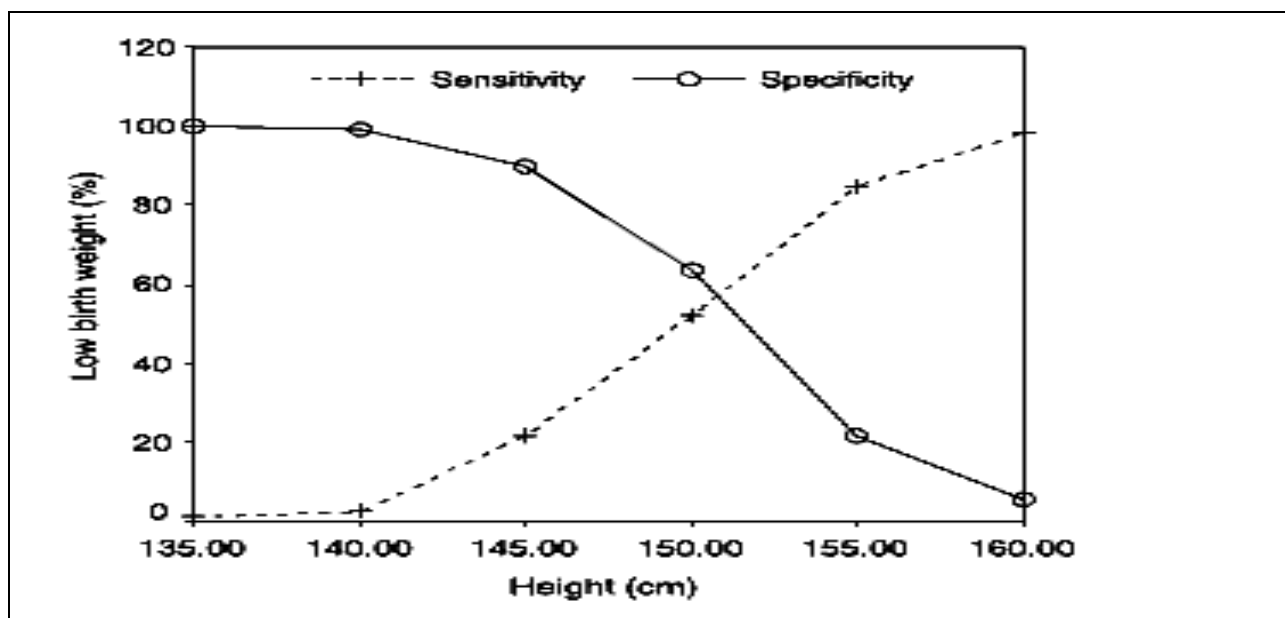


Figure 2.4: Sensitivity and specificity for height
Source: Nahar *et al.* (2006)

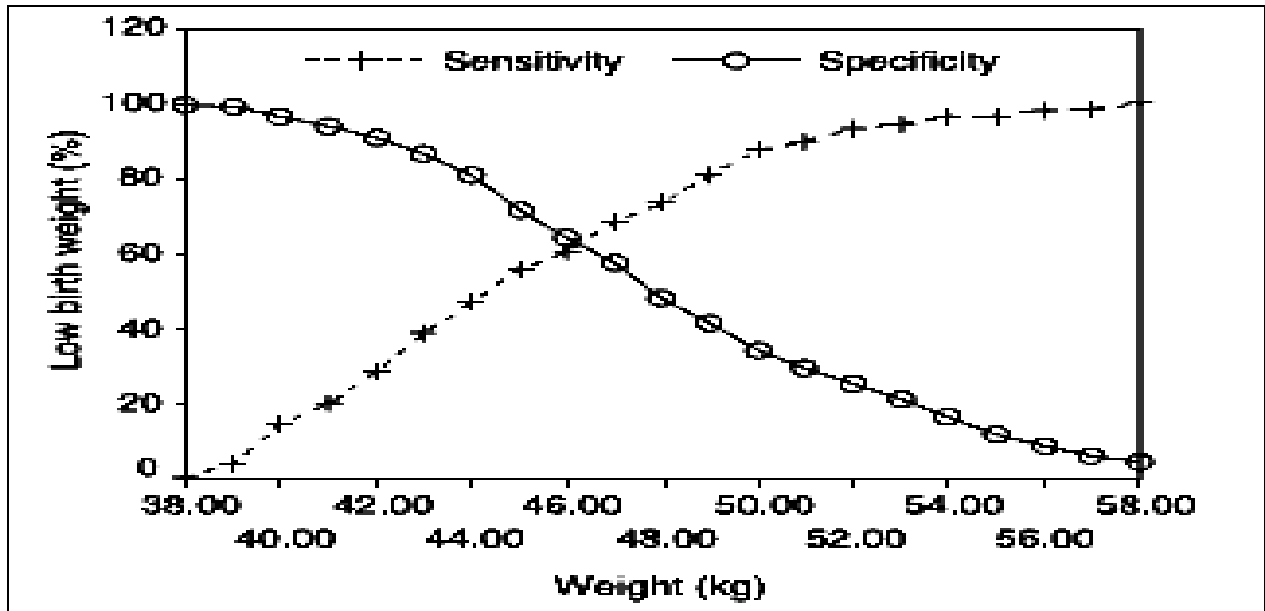


Figure 2.5: Sensitivity and specificity for weight at 9 months
Source: Nahar *et al.* (2006)

Apart from maternal height (stature) being a good predictor of an infant’s birth weight, it has also been shown to be a strong determinant of an infant’s length at birth which is also an important health indicator. There has been growing evidence that birth length too especially in a compromised nutritional status is also a determinant of perinatal mortality beyond the effects of birth weight (Melve *et al.*, 2000 and Eide *et al.*, 2005). According to a study by Eide *et al.* (2005), birth length of an infant is associated with maternal stature and in turn, it is again associated with adult height. Length and weight at birth each contribute independently to the final stature and body weight at 18 years of age with long and heavy infants becoming heavy adults. The study showed that birth length predicts, childhood height, adult stature and in turn, adult stature is associated with short length of infants thus heritability of stature is high (80%). Based on this, birth length can be a better predictor of adult health than birth weight. This is because adult weight is affected by environmental factors to a greater degree and appears to have a weaker hereditary component than does height (Pietilainen *et al.*, 2001).

Complex associations have been mentioned to exist between size at birth and maternal anthropometry across generations especially between birth length and adult height. Thus this has raised the need of proper timing of interventions to improve growth in an attempt to improve

health status. If this is achieved, the intergenerational cycle of poor health outcomes will be broken hence good health will be enhanced (Morton, 2004). According to Kirchengast and Hartmann (2007), a short maternal stature is associated with poor pregnancy outcomes and obstetric complications. A height of < 150 cm as evidenced from their findings was associated with adverse pregnancy outcomes such as high rates of LBW newborns and short infants at birth. On the contrary, however, socioeconomic factors have been highly linked with maternal stature. Some of these factors that affect maternal stature include age, nutritional status and family income (Irvin *et al.*, 2004). Thus the changing socioeconomic status of a population can lead to both increases and decreases in adult stature which in turn affects an infant's birth weight and length.

2.4.2 Socio-demographic factors and infant's anthropometry

Maternal age, level of education, social class, and income have been used as individual and household based socioeconomic indicators in the studies of low birth weight (Spencer *et al.*, 1999). According to the authors, these factors have a significant influence on an infant's birth weight and therefore are important predictors of LBW.

(i). Maternal Age

Age is identified as a protective factor for LBW. A one year age increase leads to a 4% risk reduction as was evident in a study conducted in Iran by Vahdaninia *et al.* (2008). These observations were also echoed in an earlier study by Karim and Taylor (1997). The authors found out that LBW was common in younger (<20 years) and older (31 years and above) mothers. In their study, age was an important predictor of LBW deliveries. According to Negi *et al.* (2006), the risk of delivering LBW babies is almost twice among mothers aged <20 (19 years and below) years and those who are over 30 years. Villamor *et al.* (2002) argue that below 20 years of age, growth and development are still ongoing and so these mothers have not attained their optimal height. Competition for nutrients between the growing teenager and the developing foetus is also high therefore inadequacies which result in poor foetal growth hence poor pregnancy outcomes.

(ii). Maternal level of education

Evidence from studies show that the birth weight of an infant increases with higher maternal education. For instance a study in Germany by Karim and Mascie-Taylor (1997) revealed that the risk of LBW deliveries is significantly higher in women with no education or low education compared to those with higher education. Raun *et al.* (2001) too obtained similar findings where by women with the lowest education had significantly elevated risk for small for gestational age newborns (SGA). The explanation behind these findings could be women with higher education are able to make wiser decisions concerning their health compared to those who are not educated. Ignorance rates are also higher in women with no education hence the poor birth outcomes. The similar scenario also applies to women married to educated spouses as they can help them make informed decisions concerning their health (Villamor *et al.*, 2002). In Africa, poverty, low education and poor nutritional status among women are some of the risk factors associated with adverse reproductive outcomes including LBW and preterm deliveries (Elshibly and Schmalisch, 2008).

(iii). Maternal health status

Anemia in pregnancy

Maternal health status is another most important determinant of infant survival. According to the Kenyan profiles of nutritional indicators for economic growth, prevalence of anemia is high in both the pregnant and the non pregnant women. In pregnant women, the prevalence is 60% while in non pregnant women it is 45% as indicated in Figure 2.6.

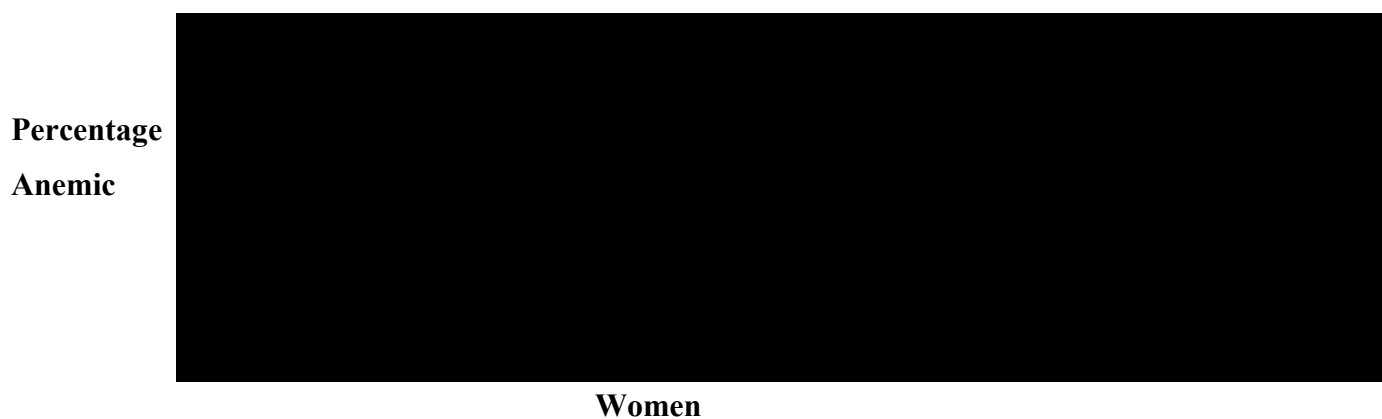


Figure 2.6: Prevalence of anemia among women in Kenya
Source: 2003 KDHS Report (CBS, 2004)

Anemia as one of the health condition associated with poor pregnancy outcomes is mentioned to result in LBW deliveries. According to the current KDHS report of 2008-09 (KNBS, 2010), haemoglobin levels of < 12 g/dl of blood are an indication of anemia. World Health Organization (WHO, 2001) however accepts up to 11 g/dl in pregnancy. This cut-off level of 11 g/dl of blood was adopted for this study since it is acceptable internationally as per the recommendations by the World Health Organization. Iron deficiency interferes with the duration of pregnancy or intrauterine growth resulting in LBW and preterm deliveries (Wannous and Arous, 2001). To improve on the iron status of women in pregnancy, the government has a policy on iron-folic acid supplementation in the antenatal clinics. Most mothers, however, visit the clinics too late and some do not visit them at all hence they do not benefit from this policy. Their iron status therefore remain poor throughout pregnancy hence the poor pregnancy outcomes. It is in this light that this study will endeavor to determine the Hb levels of women at the maternity and determine its influence on the birth weight of an infant. Women attendance to the antenatal clinics will also be assessed to determine the number of times women visit the clinic and when they start the visits.

HIV and low birth weight deliveries

The prevalence rates of HIV have been found to be high in Sub-Saharan Africa. An estimated 12.2 million women of child bearing age in Sub-Saharan African countries are infected with HIV. Pregnant women infected with HIV have been found to have a higher risk of delivering LBW infants, preterm deliveries and intrauterine growth retardation in comparison with HIV uninfected women (Dreyfuss *et al.*, 2001). According to their study in Tanzania, HIV infected women had a lower weight gain in pregnancy compared to that of uninfected women. This was attributed to reduced food intake, mal-absorption of nutrients and metabolic alterations early in the infection that are associated with HIV infection. Another study in Kenya on the effect of dual infection with HIV and malaria on pregnancy outcomes, found that maternal HIV status in absence of malaria reduces mean birth weight of an infant by 145 g (Ayisi *et al.*, 2003). Other studies too have come to the conclusion that HIV infected women have an increased risk of bearing LBW infants even after adjusting for different confounding factors (Osman *et al.*, 2001 and Coley *et al.*, 2001). However, not all studies have found similar findings. Other studies for

instance Bobat *et al.* (2001) in South Africa and Watts (2002) did not find significant differences between birth weight of HIV infected and non-infected women.

Hypertension, Diabetes and infants birth weight

Hypertension is the most common medical problem encountered during pregnancy, complicating 2-3% of pregnancies. It is associated with an increased risk for placental abruption and foetal growth restriction (IUGR). This in turn results into LBW of an infant (Gipson and Carson, 2007). Diabetes on the other hand occurs in 3-10% of pregnancies, contrary to effects hypertension, approximately 30% of babies born to diabetic mothers are said to be large for gestational age. In pre-existing diabetes mellitus, this incidence is slightly higher, about 38% (Moore, 2009). Furthermore, maternal history of chronic diseases such as hypertension and other chronic conditions increase the risk of giving birth to low birth weight infants. This has been confirmed in a number of studies (Schwartz and Sacks, 2002; Jamal and Khan, 2006). Findings from these studies indicate that mothers with these chronic conditions; hypertension and other chronic diseases have a 3.70 and 2.04 folds risk respectively.

(iv). Other socio-demographic factors

Other socio-demographic factors that have been studied and found to have a relationship with an infant's size at birth include: family income, birth spacing, sex of the infant, previous LBW delivery, attendance to the ANC, maternal occupation, parity and family size (Wannous and Arous, 2001). According to their study, mothers from households which had some income had a reduced rate of LBW deliveries compared to those which did not have any source of income. From their study, these households were able to afford nutritious foods and also medical care during pregnancy hence the reduced incidences of LBW among the women. Similarly, their study findings revealed that mothers who had a birth spacing of less than 12 months had an increased risk of LBW deliveries. According to Elshibly and Schmalisch (2008), mothers with a reasonable birth spacing of 2 years and above are able to regain their health and replenish their nutrient stores before another pregnancy hence better birth outcomes. This study also revealed that history of previous LBW delivery was a predictor of LBW among women as factors that might have led to the previous LBW delivery may still be present hence the risk of giving birth to

another LBW infant. This study therefore will also explore these factors among the mothers and determine their relationship with infant's anthropometry at birth.

2.5 Short and long term consequences of low birth weight

Low birth weight infants are considered to be at a greater risk of suffering later developmental difficulties compared to normal weight infants. They are likely to suffer from brain dysfunction or neuro-sensory impairment among other impairments (Parlman, 2001 and Hack *et al.*, 2002). On the other hand, Almond *et al.* (2005) found out that higher infant mortality rates and higher hospital costs were further consequences of low birth weight. These are short term consequences of LBW. But long term effects of low birth weight include children with low IQs, health and behavioral problems (McCormic *et al.*, 1992 and Hack *et al.*, 2002). Further, Conley and Bennette (2000) found a negative association between low birth weight and timely high school graduation. Low test scores were also found to be associated with low birth weight as it was evident in these studies. If these are some of the poor outcomes of low birth weight, then it is important to address the problem as this is also associated indirectly with the MDGs. Addressing the problem may therefore contribute towards the attainment of the goals. Furthermore, other studies have found out that low birth weight increases the risk of myocardial infarction in women later in life. Intrauterine malnutrition as reflected by birth weight and abnormal thinness at birth has been associated with an increased incidence of risk factors for arterial diseases i.e. hypertension, impaired glucose tolerance, diabetes and to a lesser extent hyperlipidemia and body fat distribution in adulthood according to Barker concept. A case control study by Tanis *et al.* (2005) confirmed that women born with low birth weight < 2000 g had a 2.4 fold higher risk of myocardial infarction before they attain the age of 50 as compared with a birth weight of 2000 g or higher. These findings confirmed the 'barker concept' on 'foetal origins of adult diseases' which suggests that several of the major diseases in later life including coronary heart diseases, stroke and cardiovascular death originate from impaired intrauterine growth and development.

According to WHO report (2005), poor foetal growth during pregnancy is said to trigger development of diabetes, high blood pressure and cardiovascular disease, consequences that become apparent only at a much later age. From all these, it is more clear that low birth weight

has adverse effects that have a negative impact on the development of a nation. Addressing this problem therefore could confer developmental benefits to developing countries such as Kenya.

2.6 Economic implications of low birth weight

The economic growth (development) of the developing countries is summarized in the 8 MDG. The attainment of these goals translates into a country's development. In the vision 2030, health plays an important role in the economy of any country. Poor health imposes a heavy burden on society and slows down economic growth. Illness is one of the major causes in the reduction of incomes and assets of poor Kenyans (GoK, 2007). In the light of this, LBW is one of the causes of ill health and future developmental problems in addition to the existing burden of early infant mortality as discussed earlier. All these lead to extra costs that leave Kenyans poor and undeveloped. Improving the birth weight of infants therefore could significantly contribute to a country's economy. This has therefore led to a number of studies that have tried to estimate the economic benefits of reducing the incidence of LBW (Alderman and Behman, 2006 and Alderman *et al.*, 2007).

Reducing the incidence of LBW not only lowers infant mortality rates but also has multiple benefits over the life cycle. A study by Alderman and Behman (2006) that was aimed at estimating the economic benefits of reducing the incidence of LBW in low income countries proved that this lowers the mortality rates and medical costs and also increases learning and productivity. The study found out that the estimated economic benefits under plausible assumptions are fairly substantial at about \$ 510 per infant moved from a low birth weight status. The estimated gains are primarily from increases in labour productivity (partially through more education) and secondarily from avoiding costs due to infant illness and death. Therefore any intervention aimed at reducing the incidence of LBW will substantially result in saving resources or increasing productivity.

In a different but a rather similar study by Alderman *et al.* (2007) on economic benefits of improving nutrition in poor communities, there are economic benefits of preventing LBW in a low-income setting. These benefits include those derived from reduced infant mortality, reduced cost for neonatal care and infant/child illnesses, and reductions in the cost of chronic diseases as

well as productivity gains associated with reduced stunting and increased cognitive ability. In both the studies, the results were similar, this gives a clear indication that reducing the incidence of LBW has greater economic benefits to any country especially the developing countries Kenya being one of them.

2.7 The conceptual framework

2.7.1 The theoretical framework

Based on the epidemiological concepts of risk, susceptibility and causality, the study will adopt the Web of Causation Model as the theoretical framework (Clark, 1999). Causal theory is the key example of epidemiologic science and it recognizes that different biological and social phenomena can be studied and preventive interventions be applied at many different levels of explanation hence improvement of public health. According to the model, risk is the probability that an individual will develop a specific condition and is affected by a variety of influences including physical, emotional, environmental and lifestyle factors. The basis for risk lies in susceptibility, the ability to be affected by factors contributing to a particular health condition. In this model, factors are explored in terms of their interplay, and both direct and indirect causes of a problem like low birth weight are identified (Freidman, 1994).

The web encompasses the interrelationships between a multitude of factors, some known and some unknown, but all with an ultimate bearing on risk (Valanis, 1992). The Web of Causation Model allows the mapping of interrelationships among contributing factors and assists in determining areas where control efforts can be most feasible and effective. Low infant birth weight is viewed as the result of multiple interacting factors. Understanding these factors will lead to earlier identification of mothers at risk of giving birth to low birth weight infants. This model can assist with exploring whether or not, some factors affecting infant birth weight e.g. the nutritional and health status of the mother can be modified to facilitate positive birth outcomes.

The conceptual framework depicts how variables in the study interact. Based on the Web of Causation Theory, maternal anthropometric and socio-demographic factors and maternal Hb and HIV status are the risk factors associated with low birth weight deliveries. These factors vary among individuals as influenced by genetics and even socio-cultural practices. These factors will

be studied among mothers at the maternity and their relationship with the birth weight length of an infant determined hence this will provide an indication of the interventions to be undertaken to improve the birth outcomes. The interrelationship between these factors will also be studied to assist in determining what control efforts can be most feasible and effective to arrest the problem of low birth weight infants.

2.7.2 Variables of the study

Table 2.1 gives a summary of the study variables in terms of independent, extraneous and dependent variables.

Table 2.1: Variables of the study

Independent variables	Extraneous variables	Dependent variable
<ul style="list-style-type: none"> • Socio-demographic factors • Maternal health status • Maternal anthropometric characteristics 	<ul style="list-style-type: none"> • Genetic factors • Socio-cultural practices 	<ul style="list-style-type: none"> • Infant's anthropometry at birth

The conceptual framework for the study therefore is as given in figure 2.7 as follows:

INDEPENDENT VARIABLES

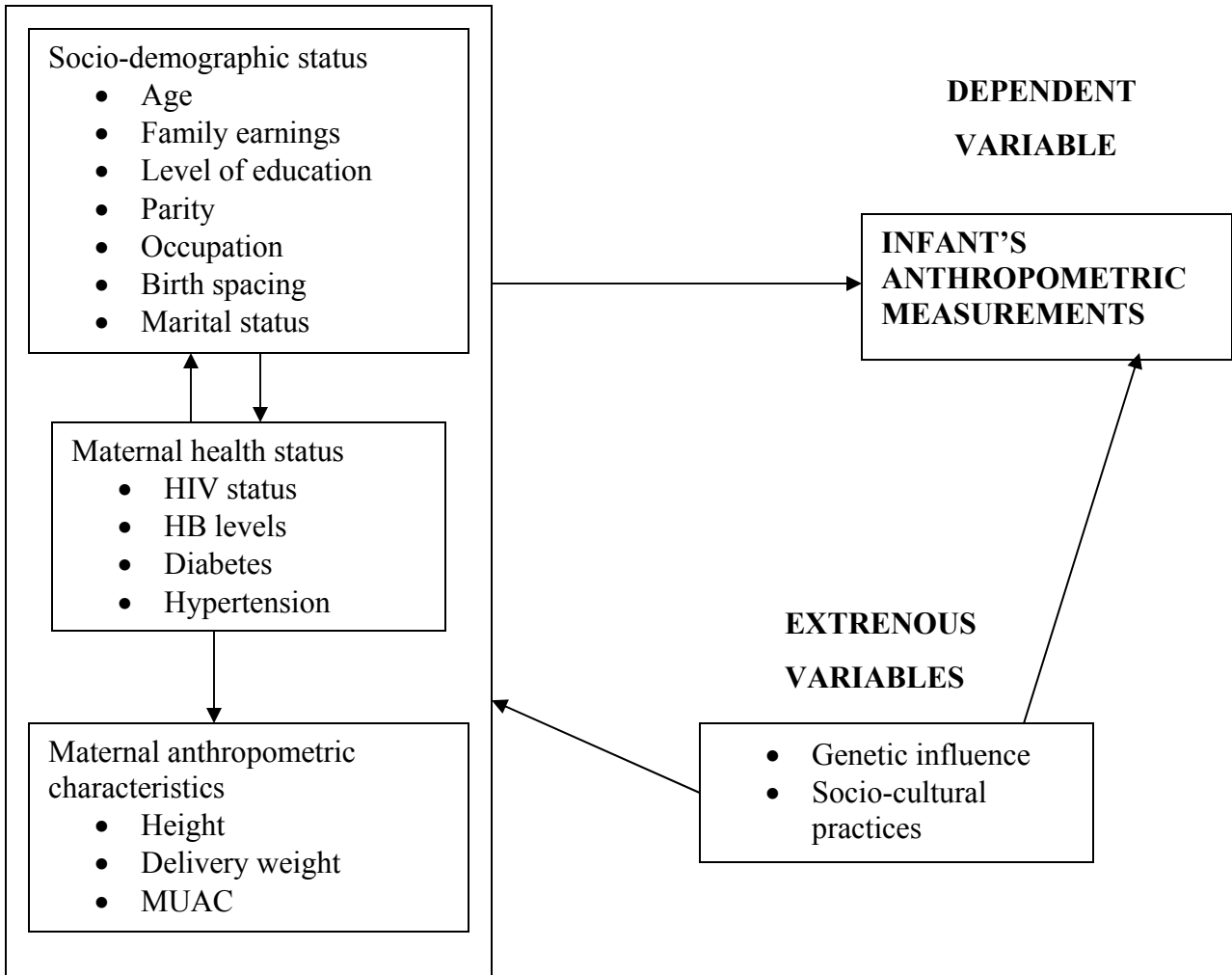


Figure 2.7: The conceptual framework on effects of maternal health status, anthropometric characteristics and socio-demographic factors on infant's birth weight and length; Web of Causation theory (Clark, 1999)

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides the methodology of attaining the objectives of the study. It presents the research design, location of the study, the population of the study, sampling, instrumentation, validity and reliability of the instruments, data collection and analysis.

3.2 Research design

The study adapted a cross-sectional study design. In this study design, both the exposure (maternal associated factors) and the outcome (infant's birth weight and length) were assessed at the same time. Maternal anthropometric characteristics, socio-demographic factors (exposures) and infant's anthropometry at birth (outcome) were assessed at one point in time. An ex-post facto approach was utilized in this particular design as the study was carried out in an already existing situation where mothers were already exposed and possessing the independent variables of interest (health status, anthropometric characteristics and socio-demographic status) that have a relationship with the birth outcome which was the infant's anthropometric measurements at birth. The advantage of this research design is that the independent variables cannot be manipulated through pure experimentation but can only be studied the way they are (Kerlinger, 2000). This therefore allows room for hypothesis testing without necessarily controlling for the independent variables.

3.3 Location of the study

The study was conducted at PGH situated in Nakuru town, the fourth largest town in Kenya after Nairobi, Mombasa and Kisumu. It is 160 km North-West from Nairobi with an altitude of 1840m above sea level and it is within the Great Rift Valley region. It lies between latitudes 0° 10' and 0° 20' and longitudes 36° and 36° 10' (See Appendix 6 for the map). The hospital was selected due to its high rates of LBW that have been evident from a study by Mbuthia (2006) that was

conducted in 2004-05, rate 10.1% and also from the delivery records for the years 2007 and 2009 at the maternity with 10.9% and 13.8% rate respectively.

3.4 Population

The target population consisted of all women within the reproductive age in Nakuru municipality who came for the ANC at the hospital and even those who did not visit clinic but had plans to deliver at the facility. All referral cases at the time of the study were also part of the target population. Out of this population, only mothers who delivered at the hospital within the study period formed the sampling frame.

3.5 Sampling and sample size

The sampling frame consisted of pregnant mothers awaiting delivery at the ward within the study period. The target population comprised of all mothers within the reproductive age within Nakuru. The sample size therefore was estimated using the formula by Mugenda and Mugenda (1999) as follows:

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

Where:

n = the desired sample size (if the target population is greater than 10,000).

z = the standard normal deviate at the required confidence level.

p = the proportion in the target population estimated to have characteristics being measured which 13.7% (prevalence of LBW in a similar study in Sudan (Elshibly and Schmalisch, 2008)

q = 1-p (1-0.137 = 0.863)

d = the level of statistical significance set.

$$\text{Therefore } n = \frac{(1.96^2)(0.137)(0.863)}{(0.05)^2}$$

$$= 182$$

Final sample size = 182 + (10% of 182) = 182 + 18

$$= \mathbf{200 \text{ subjects}}$$

An extra 18(10%) subjects were added to give a sample size of 200 subjects. The 10% was to cater for any loss of information resulting from incomplete questionnaires. Also to cater for loss of subjects due to extreme circumstances such as death after delivery. This sample was deemed appropriate given that in any social study, the minimum recommended sample size is 100 (Borg and Gall, 1983). The prevalence rate of 13.7% from Sudan was used because there was no available LBW prevalence for Nakuru. Purposive sampling was used to obtain the subjects. In this case, for every LBW case identified, two normal birth weight infants after the case were recruited for the study from the hospital delivery records. This sampling procedure derived strength from a study conducted in India on LBW by Negi *et al.* (2006). According to their findings, for every three infants born, one was likely to be of LBW hence the justification of using the sampling procedure. This process which lasted from February to April, 2010 was repeated over until the required sample size of 200 mothers was achieved. Within this sample therefore, a third of the infants were of LBW while two-thirds were of normal birth weight.

3.6 Inclusion and exclusion criteria

The researcher explained the purpose of the research to the mothers and they were also assured of strict confidentiality of information obtained from them before signing the consent form to participate in the study. Only mothers who accepted to participate in the study by signing the consent form were included in the study. Referral cases were also included in the study once they accepted to sign the consent form. However, mothers with complications such as those who went through cesarean delivery, those who went into a coma after delivery and those who were at their last stages of labour were not part of the study. This is because it was not possible to take their delivery weights. Furthermore, mothers who had delivered twins were not also part of the study as studies have shown that twins are more likely to be born with LBW than single infants (Wannous and Arous, 2001) hence including these cases would have biased the study results.

3.7 Instrumentation

Data was collected using a semi-structured questionnaire that was researcher administered to the mothers. The questionnaire was developed with the advice from the University supervisors and its items were developed based on the objectives of the study. The questionnaire comprised of

three parts: part A consisted of the mother's anthropometry i.e. delivery weight, MUAC and height. Part B consisted of the infant's anthropometry i.e. infant's birth weight and length at birth then part C sought information regarding the respondent's socio-demographic status together with her health status. The mothers HIV status and Hb levels were determined from their clinic cards together with other health conditions which included hypertension and diabetes. A data sheet was used for recording maternal anthropometric measurements prior to delivery (delivery weight) and also MUAC and height after delivery. The delivery weight of the mothers was taken and recorded by the researcher just before delivery at the admission point. The infant's birth weight was filled in the questionnaires as it was recorded in the hospital record book by the nurses. The infants' weights could not be taken by the researcher because there were deliveries which occurred at night in the absence of the researcher. However, to ensure the correctness of the weights, the researcher constantly validated the scale using known weights. The infants' birth lengths was taken by the researcher using a non-stretchable well calibrated tape measure within 24 hours after delivery and recorded. Mothers were interviewed within 24 hours after delivery. The questionnaires were researcher administered to the subjects.

3.8 Validity of the instrument

Validity is the accuracy, soundness or the effectiveness with which an instrument measures what it is intended to measure (Wiersma, 1995). In this study, validation of the instrument (questionnaire) was done to ensure that the content and the format of the questionnaire were consistent with the study variables. In this case face validation, content and construct of the questionnaire were assessed by experts from the department of Foods, Nutrition and Dietetics and also from the Faculty of Health Sciences of Egerton University. Comments from the experts were incorporated into the instruments before being used in the field. Pre-testing of the questionnaire was also done to confirm the validity of the questionnaire in terms of its content and effectiveness in obtaining the intended information on various aspects of the study.

3.9 Reliability of the instrument

Pilot testing was done using 10% of the sample size (20 mothers) at Njoro dispensary and this comprised of mothers delivering at the dispensary. Pilot testing of the research instrument was done at this dispensary as it has an ANC care system similar to the one at PGH hospital where the actual study was carried out. It also has a provision for a maternity ward where mothers come for delivery. Therefore, the subjects who were included in the pre-testing sample had similar characteristics as those in the actual study. Pilot testing of the instrument ensured that there were no deficiencies and ambiguities in the final instrument. After the pilot testing, the reliability of the instrument was tested using the Cronbach's coefficient test. Reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials. According to Fraenkel and Wallen (2000), a reliability of 0.70 or higher is preferable for research purposes. In this study, the research instrument yielded a reliability of 0.80 hence the use of the research instruments.

3.10 Ethical issues and data collection

Ethical considerations

The researcher obtained an introductory letter from the University's graduate school before carrying out the study. This facilitated the acquisition of a research permit from the National Council of Science and Technology authorizing the carrying out of the research among mothers at Nakuru PGH. The researcher also sought for permission from the hospital management to be allowed to carry out the study in the hospital. With the hospital's permission, a survey was conducted to obtain the required data. Mothers' informed consent was obtained before interviewing them and this was after explaining to them the purpose of the study and how the results from the study will be used. They were also assured of strict confidentiality of all the information collected in the study. This was done by ensuring that their names were not included in the questionnaires but instead their clinic card numbers were used. One enumerator assisted only in the taking of the delivery weights of the mothers. She was first trained by the researcher on the nature of information to be collected and the objectives of the study generally and how to

take accurate weight measurements. This was important to ensure consistency in the weight measurements recorded.

Actual data collection

The birth weights of the infants were taken using Seca pan weight scales for the infants and recorded by the nurses as it is a routine procedure at the hospital. Therefore to ensure the accuracy of the weights recorded, the researcher validated the scales periodically using known weights. The nurses were also informed on the importance of the information that was to be collected and hence the need to take the measurements accurately. These measurements were then used by the researcher the following day. Maternal delivery weight was then taken prior to delivery and recorded. Hb status of the mothers and other health conditions were determined from their clinic cards. The hospital uses a hemoCue system in the assessment of anaemia and up to 10 g/dl of Hb levels are acceptable at the hospital. This study, however, used Hb cut-off points of 11 g/dl of blood which are internationally acceptable standards as recommended by WHO (2001). A calibrated and non-stretchable MUAC tape was used by the researcher for taking MUAC measurements to the nearest 0.1 cm while Seca scales for weight were used by the researcher to take the delivery weights of the mothers with minimal clothing to the nearest 100 g. Delivery weights of the mothers were taken and recorded in the data sheet as they came in until the required sample size was achieved.

Mothers were then followed up the following morning after delivery to be interviewed by the researcher and this was after recording the infant's birth weights from the hospital records. At this point, the mothers' heights and MUAC measurements were also taken using a well calibrated stadiometer and MUAC tapes respectively and recorded to the nearest 0.5 cm and 0.1 cm respectively. Both the height and MUAC measurements of the mothers were taken after delivery. Mothers were asked to stand straight with their heels close together and their backs and the behind of the head touching the vertical piece with the hands hanging loosely by the sides and looking straight ahead. The head piece was then moved to touch the head then the reading was made without the influence of parallax and recorded in the questionnaire to the nearest 0.1 cm. The questionnaires were in English but were researcher administered to the respondents in

Kiswahili which was well understood by the respondents to ensure the accuracy of the information obtained.

The crown-heel length of all infants was taken using a well calibrated tape measure made from non-stretchable material. This was found appropriate compared to the infantometer as it was not possible to completely straighten the infant's limbs. The nurses at the hospital also used a tape measure to take an infant's length. To take the length, the infant was made to lie on the side without clothes. Then the tape measure was placed at the crown behind the ear, this was then moved along the infant's body all the way to the heel. The reading on the tape measure was then recorded to the nearest 0.1 cm. The mothers' HIV status (whether positive or negative), Hb levels and other health conditions were determined from their clinic cards as indicated by the health care providers. Hospital records were also used to supplement the information on the clinic cards. Gestation period (expected date of delivery) was also obtained from the maternity record book.

3.11 Data analysis

Means and standard deviations (SD) were calculated for all maternal anthropometric parameters and infants' anthropometry at birth. Mean age of the mothers and mean birth weight and length of the infants was determined. Frequencies of infants in different birth weight categories and also mothers in different delivery weight categories were also determined. This formed part of descriptive statistics for the study. Correlation analysis to determine the relationship between the variables was also computed. The degree of association between maternal anthropometric parameters, and birth weight and length was investigated by multiple linear regression analysis while Chi-square test was used to determine the association between the maternal socio-demographic factors and infant's anthropometry at birth. The Odds Ratio (OR) for having LBW infants was also computed based on the independent variables of the study. This was computed to measure the likelihood of a mother delivering a LBW infant. T-test statistic was also used to compare means of anthropometric measurements and some of the socio-demographic factors between mothers with normal birth weight and those with LBW infants. The hypothesis of the study were tested at $\alpha = 0.05$. The Statistical Package for Social Science (SPSS) version 11.5 was

used to compute the data collected. Table 3.1 gives a summary of statistical procedures that were used in the data analysis.

Table 3.1: Summary of data analysis

Objectives	Null hypothesis	Independent variable	Dependent variable	Statistical test
i). To determine the birth weight and length of infants born at PGH maternity, Nakuru	Ho1 There is no statistically significant correlation between an infant's birth weight and length at PGH maternity, Nakuru	Infant's birth weight	Infant's birth length	Pearson's Product Moment (Correlation) Descriptive statistics
ii). To determine the delivery weight, height and mid upper arm circumference (MUAC) of mothers at PGH maternity, Nakuru	Ho2 There is no statistically significant relationship between the mother's anthropometry and the birth weight and length of the infant at PGH maternity, Nakuru	Maternal anthropometry: <ul style="list-style-type: none"> • Delivery weight • MUAC • Height 	Infant's birth weight and length	Descriptive statistics and Multiple linear regression
iii). To assess the maternal socio-demographic factors at PGH maternity, Nakuru	Ho3 There is no statistically significant relationship between maternal socio-demographic factors with the infant's anthropometry at PGH maternity, Nakuru	Maternal factors: <ul style="list-style-type: none"> • Education • Occupation • Parity • Income • Birth spacing • Family size • Age 	Infant's birth weight and length	Descriptive statistics Binary logistic regression, Chi-square,
iv). To assess the health status of the mothers from their clinic records and cards at PGH maternity Nakuru	Ho4 There is no statistically significant relationship between mothers health status and infant's anthropometry at PGH maternity, Nakuru	Maternal health status (HIV/Hb status)	Infant's birth weight and length	Descriptive statistics, Chi-square
v). To determine the difference between mothers with stunted and LBW infants and those with normal infants at PGH maternity, Nakuru	Ho5 There is no statistically significant difference between mothers with normal weight and length infants and those with stunted and LBW infants at PGH maternity, Nakuru	Maternal anthropometric measurements and socio-demographic factors	Infant's birth weight and length	Descriptive statistics, t-test

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter provides the results of data analyses and discussion with reference to research objectives and hypothesis as stated in Chapter One. The aspects analyzed and discussed include: relationship between mothers' anthropometry and that of an infant at birth, association between maternal socio-demographic factors and infant's anthropometry at birth and mean birth weights of infants born at the hospital. Statistical tests were done using Statistical Package for Social Sciences (SPSS) for windows version 11.5 at a significance level of $P=0.05$

4.2 A general overview of the deliveries at PGH, Nakuru

The hospital records up to approximately 600-700 deliveries every month with 20-30 deliveries occurring per day. During the study period from February to April, 2010, the hospital recorded 655 deliveries out of which 113 (17.3%) infants were of LBW out of which 29(25.7%) were preterm and 84(74.3%) were term infants. Figure 4.1 gives a summary of all the deliveries at the hospital that occurred during the study period.

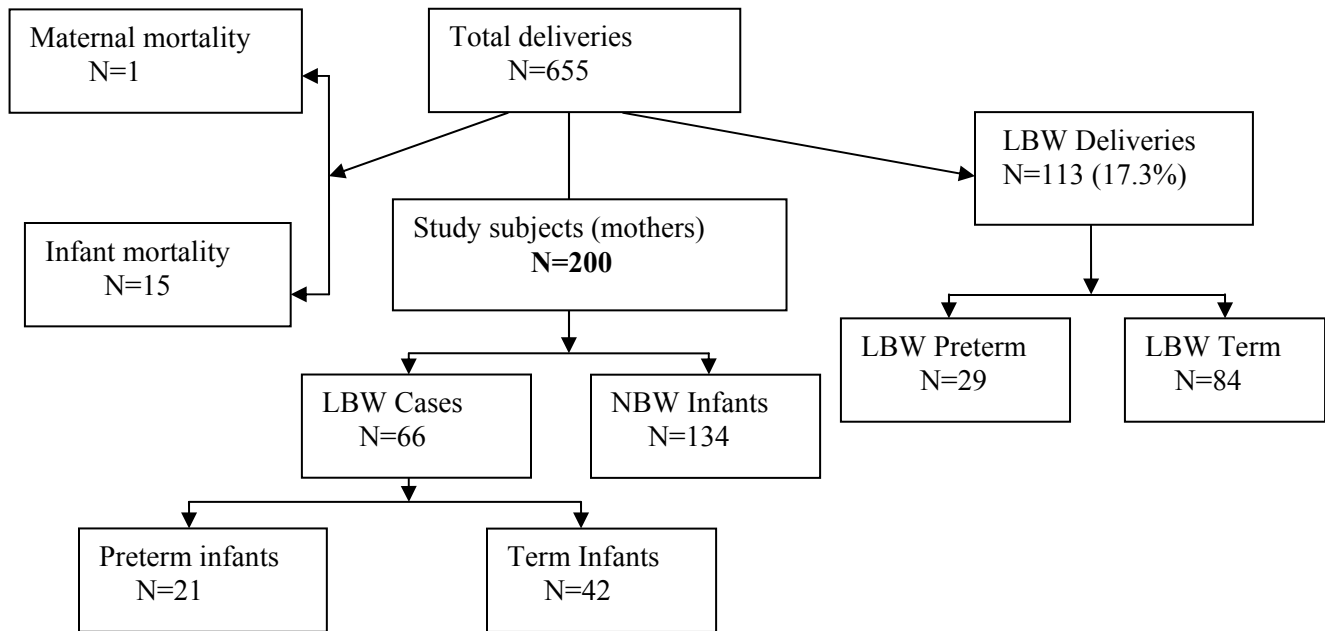


Figure 4.1: A general overview of deliveries at PGH, Nakuru during the study period
Source: Delivery record book at the hospital (February-April, 2010)

The hospital recorded a LBW rate of 17.3% during the study period. This was calculated from the information obtained from the hospital delivery records and summarized in Figure 4.1. This information was recorded by the health care workers at the maternity. This rate was slightly higher than 13.8% which was recorded earlier in the year 2009 in the same hospital. With the current LBW rate of 10% in Kenya (UNICEF, 2008), these LBW rates at the hospital contribute significantly towards this problem. During the study period, 15 cases of infant mortality with one case of maternal death were recorded. Currently, no progress has been realized by Kenya as far as MDG 4 on reducing infant mortality is concerned. Infant mortality rate has in fact increased from 79 per 1000 live births in 2003 to 81 per 1000 live births currently (WHO/UNICEF, 2010). With this poor trend, Kenya might not achieve its target of reducing this rate to 25 per 1000 live births in 2015 as stipulated in the Kenyan Vision 2030. The infant mortality cases that are still being recorded in the hospital will only worsen the progress towards reducing infant mortality in Kenya.

4.3 Descriptive statistics and test of study hypotheses

Data was analyzed using both descriptive and inferential statistics. Descriptive analysis was performed to display the overall distribution of the variables under the study among mothers at PGH Maternity Nakuru. Distribution of infants based on their birth weights and lengths was also displayed using descriptive statistics. Frequencies, means and standard deviations of the variables were also part of the descriptive statistics. Inferential statistics on the other hand was performed for hypothesis testing. The entire section was guided by the study objectives.

4.3.1: Infants anthropometry (birth weight and length) at PGH Maternity Ward, Nakuru.

This objective aimed at describing and distributing the infants anthropometry (birth weight and length) at the hospital. Infants were classified into normal and LBW cases and also stunted and normal length.

i). Infant's birth weight

Infants at the hospital were weighed and their birth weight recorded. Out of all the infants weighed (n=200), 66(33%) had birth weight of less than 2.5 Kg and they were considered LBW infants (Figure 4.2) regardless of their gestational period.

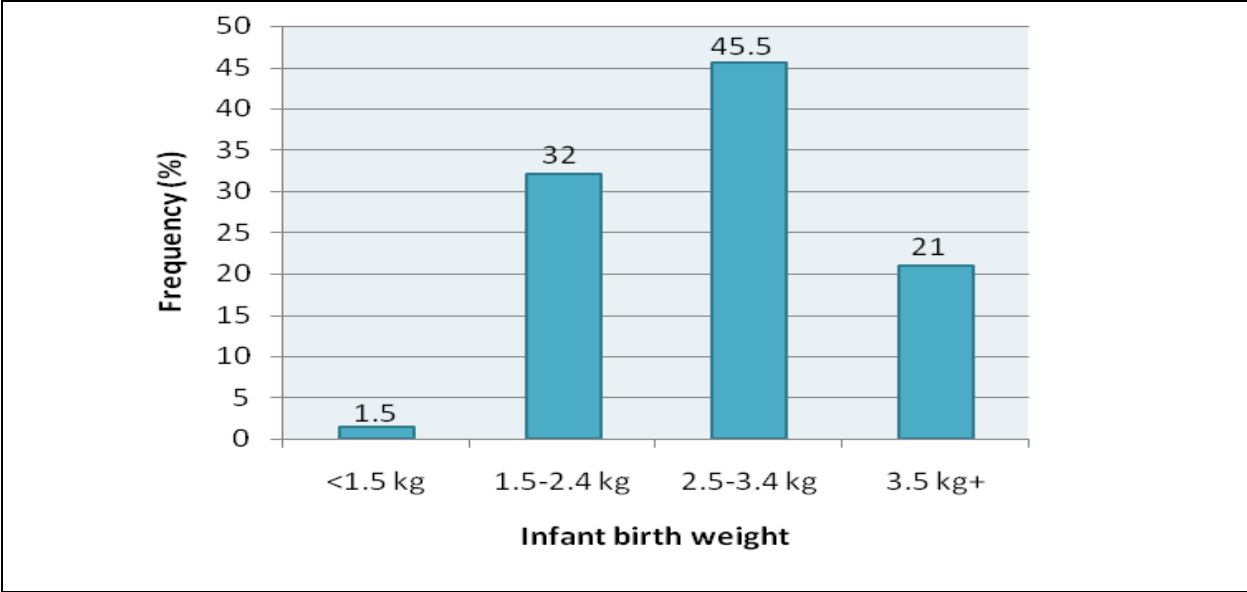


Figure 4.2: Infants birth weight distribution at the PGH Maternity Ward, Nakuru

According to WHO (2008), LBW infants are those born with a birth weight of less than 2.5 Kg regardless of the gestational period and it is a major contributor to infant mortality. This birth weight also has been found through studies to have negative implications on neonate survival, later growth, health, development, anthropometric parameters in adulthood and cognitive development (Gross, Spiker and Haynes, 1997; UNICEF/WHO, 2004; WHO, 2005). With the hospital still recording LBW deliveries, then it can be anticipated that these poor developmental outcomes will still be experienced within the Kenyan societies. In addition, these LBW deliveries at the hospital pose a challenge towards the attainment of the MDG of reducing infant mortality in Kenya. A t-test was computed to determine the differences in birth weights of the infants based on their gender. This is due to the fact that sex has been found in other studies to influence and infant’s birth weight (Elshibly and Schmalisch, 2008). From their study in Sudan, Khartoum, male infants were found to weigh heavier than their female counterparts. The study results from PGH maternity Ward, Nakuru found similar results as displayed in Table 4.1. From the results, male and female infants were significantly different in terms of their birth weights. Boys were heavier with a mean birth weight of 3.01 compared to girls with a mean birth weight of 2.75 and this mean differences were significant ($p < 0.05$).

Table 4.1: Mean birth weight for the infants by gender

Sex of the infant	N	Mean (SD)	t	P-Value	95% CI
Male	111	3.01(0.60)	2.75	0.007*	0.07 - 0.43
Female	89	2.75(0.68)			
Total	200	2.89(0.65)			

($t=2.75$, $p=0.007<0.05$)

The interpretation behind these results is that gender or sex of an infant has a significant influence on an infant's birth weight. Other studies by Storms and Van Howe (2004) and Karim and Mascie-Taylor (1997) have found similar results that male infants are heavier than their female counterparts at birth.

ii). Infants birth length

The birth lengths of the infants were taken and recorded. Out of 200 infants measured, about $n=60(30\%)$ of the infants had a birth length of less than 46 cm (Figure 4.3). A birth length of 46 cm is the cut-off length at birth according to WHO growth standards (Appendix 4 and 5). The mean birth length of the infants was 47.05 cm with a standard deviation of 3.85 cm. Male infants had a mean birth length of 47.48 ± 0.36 cm while female infants had a mean birth length of 46.51 ± 0.42 cm however these differences were not statistically significant ($t=1.793$, $p=0.074$).

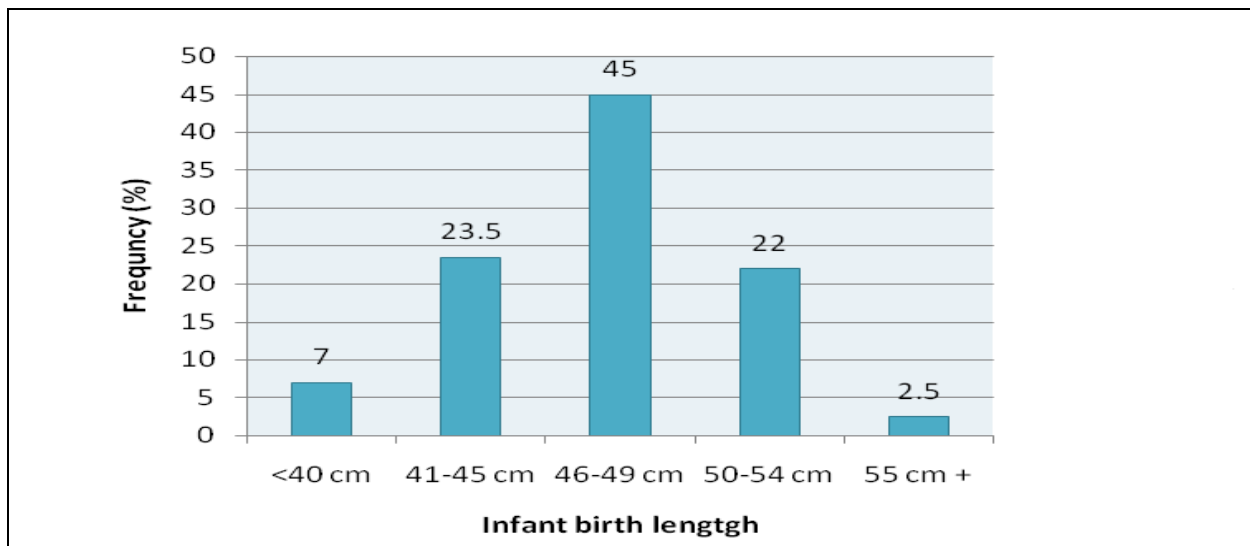


Figure 4.3: Infants length at birth at PGH Maternity Ward Nakuru

An infant's birth length just like birth weight is an important predictor of an infant's survival and later development. In this study, infant's birth length was taken and recorded to the nearest 0.1 cm. A study by Eide *et al.*, (2005) on size at birth and gestation age as predictors of adult height and weight found a strong association between the birth length of an infant and the adult height especially for the infants born at term. In their study, mean adult height increased linearly with increasing birth length from 46 cm. According to WHO growth standards, a birth length of 46 cm onwards for both male and female infants is appropriate (Appendix 4 and 5). In Kenya, 35% of children under the age of five years are stunted according to statistics by UNICEF and the current KDHS report for 2008-09 (UNICEF, 2008; KNBS, 2010). According to a cohort study conducted in Guatemala, America by Corvalan *et al.*, (2007), short length at birth was found to be associated with stunting in childhood and short stature in adulthood. At PGH, Nakuru, 60(30%) of infants were born with a birth length of <46 cm (Table 4.2). These results imply that if the association between birth length and adult height is anything to go by, then Kenya is still far from addressing the problem of stunting among children as these children born with short length at PGH, Nakuru are more likely to grow into stunted children and adults.

Table 4.2: Infants birth length in relation to gestation

Nature of the infant	Type of birth length		Total
	NBL(46 cm and above)	SBL(< 46 cm)	
Term	126(76.4%)	39(23.6%)	165(100%)
Preterm	5(20.8%)	19(79.2%)	24(100%)
Total	131(69.3%)	58(30.7%)	189(100%)

Out of the 200 infants included in the study, 165(82.5%) infants were born after 37 weeks gestation period (term) while 24(12%) were preterm. Information on whether the remaining 11(5.5%) infants were born term or preterm was lacking. Tables 4.2 and 4.3 give a summary of the distribution of infants based on time of delivery and whether they were of LBW or NBW and whether they had a normal birth length or not respectively. From the results displayed in these tables, it is evident that there were 39(23.6%) cases of short birth length and 42(25.5%) cases of LBW among term infants. According to Norton (2000), infants who are born term but with a LBW could be an indication of Intra-uterine Growth Retardation (IUGR) which has been cited as

a major problem contributing to LBW deliveries in developing countries as opposed to developed countries where LBW is due to preterm deliveries.

Table 4.3: Infants birth weight in relation to gestation

Nature of the baby	Type of birth weight		Total
	NBW	LBW	
Term	123(74.5%)	42(25.5%)	165(100%)
Preterm	3(12.5%)	21(87.5%)	24(100%)
Total	126(66.7%)	63(33.3%)	189(100%)

Low birth weight as defined by WHO (2008) is a birth weight of less than 2.5 Kg irrespective of the gestational age and this is because LBW among infants has associated with increased risk of infant mortality. This classification therefore does not take into consideration the birth weights of preterm infants. According to Norton (2000), low birth weight is governed by two major processes: a short gestational period, i.e. the infant is born too soon and is qualified as premature (birth weight < 2500 g and gestational age < 37 weeks), or retarded intrauterine growth, i.e. the infant is small for gestational age (birth weight < 2500 g and gestation age > 37 weeks). Centre for Disease Control and Prevention (CDC) classification takes into consideration an infant's size at birth for gestational age. According to CDC (2005) classification, an infant who is small for gestation age (SGA) is one that weighs less than 10th percentile, appropriate for gestation age (AGA) is one that weighs greater than or equal to 10th percentile and less than or equal to 90th percentile and one who is large for gestation age (LGA) is one that weighs greater than 90th percentile (Appendix 7 for CDC classification). Table 4.4 gives a summary of the distribution of infants at PGH Nakuru based on their size for gestational age.

Table 4.4: Distribution of infants based on gestational age

Nature of the baby	Size for gestational age			Total
	SGA	AGA	LGA	
Term	25(15.2%)	135(81.8%)	5(3.0%)	165(100%)
Preterm	6(25.0%)	18(75.0%)	0(0%)	24(100%)
Total	31(16.4%)	153(81.0%)	5(2.6%)	189(100%)

Source: CDC (2005)

Studies have shown that infants who are SGA experience long term growth deficits later in life and are at a greater risk of developing chronic health conditions such as heart problems and diabetes (Couchard *et al.*, 2004 and Lifshitz, 1996; Gutbrod *et al.*, 2010). The results from these studies that compared the development of SGA infants to the AGA counterparts showed that AGA infants had satisfactory growth up to 56 months compared to SGA infants who were lagging behind in growth. According to WHO (2005), impairment in foetal growth as a result of IUGR that results from foetal malnutrition can have adverse consequences in infancy and childhood in terms of mortality, morbidity, growth and school performance. The results of this study indicate that up to 31(16.4%) of infants (both term and preterm) born at PGH Nakuru are small for their gestational age and this is an indication of IUGR during their foetal development. They may therefore fall victims of the mentioned adverse effects of being born SGA.

The hypothesis that there is no statistically significant relationship between an infant’s birth weight and length at PGH Maternity Ward, Nakuru was derived from the first objective of the study and it was designed to determine whether a significant association existed between the birth weight and length of an infant. To determine this, a correlation analysis was performed and results displayed in table 4.5.

Table 4.5: Correlation between infant's birth weight and length

		Birth weight	Birth length
Birth weight	Pearson correlation	1	0.418
	Sig	-	0.000*
	N	200	200
Birth length	Pearson correlation	0.418	1
	Sig	0.000*	-
	N	200	200

(r=0.418, p=0.000<0.05)

From the results displayed in table 4.5, the birth weight and length of the infant were significantly correlated (r=0.418, p=0.000). This implied that as the birth length of the infant increased so did the birth weight and vice versa. The implication behind this is that the birth weight of an infant shares its variability with birth length and that factors that affect an infant’s birth weight do also affect its length. At the hospital Maternity Ward, LBW infants had a lower mean birth length of 44.52 ± 3.75 cm compared to their normal birth weight counterparts who had a mean birth length of 48.45 ± 3.20 cm. This gives an indication that LBW infants at the

Maternity Ward were also shorter compared to the normal weight infants. Though the correlation results indicated a positive relationship between birth weight and length, this was not adequate in giving the magnitude of association. A simple linear regression analysis was therefore performed to determine the degree of association. Table 4.6 gives the results for the simple linear regression between birth weight and length of an infant.

Table 4.6: Relationship between an infant's birth weight and length

	b	SE b	β	Sig.	95% CI	
					Lower	Upper
Constant	36.187	0.978		0.000	34.258	38.117
Birth weight of infant	3.761	0.331	0.629	0.000	3.109	4.414

($r^2=0.40$, $F=129.33$, $p=0.000$)

From the results displayed in Table 4.6, there was a positive relationship between the infant's birth weight and length ($b=2.761$). The results also indicate that for every unit increase in the infant's birth weight, there was a subsequent significant increase in the infant's birth length by 0.629 cm ($\beta=0.629$, $p<0.05$). This therefore led to the rejection of the null hypothesis that there is no statistically significant relationship between an infant's birth weight and length

4.3.2: Maternal anthropometry; delivery weight, height and Mid-Upper Arm Circumference (MUAC) at PGH Maternity Ward, Nakuru

In this study, maternal anthropometric measurements were delivery weight, MUAC and height measurements. Delivery weights of the mothers were taken just before delivery while MUAC and height measurements were taken after delivery and recorded.

i). Maternal delivery weight

This was taken at the point of admission to the maternity and recorded. Most mothers 136(68%) weighed 60 Kg and above with about 64(30%) weighing less than 60 Kg as displayed in Figure 4.4. The mean delivery weight of the mothers was 65.71 Kg with a standard deviation of 11.27 Kg.

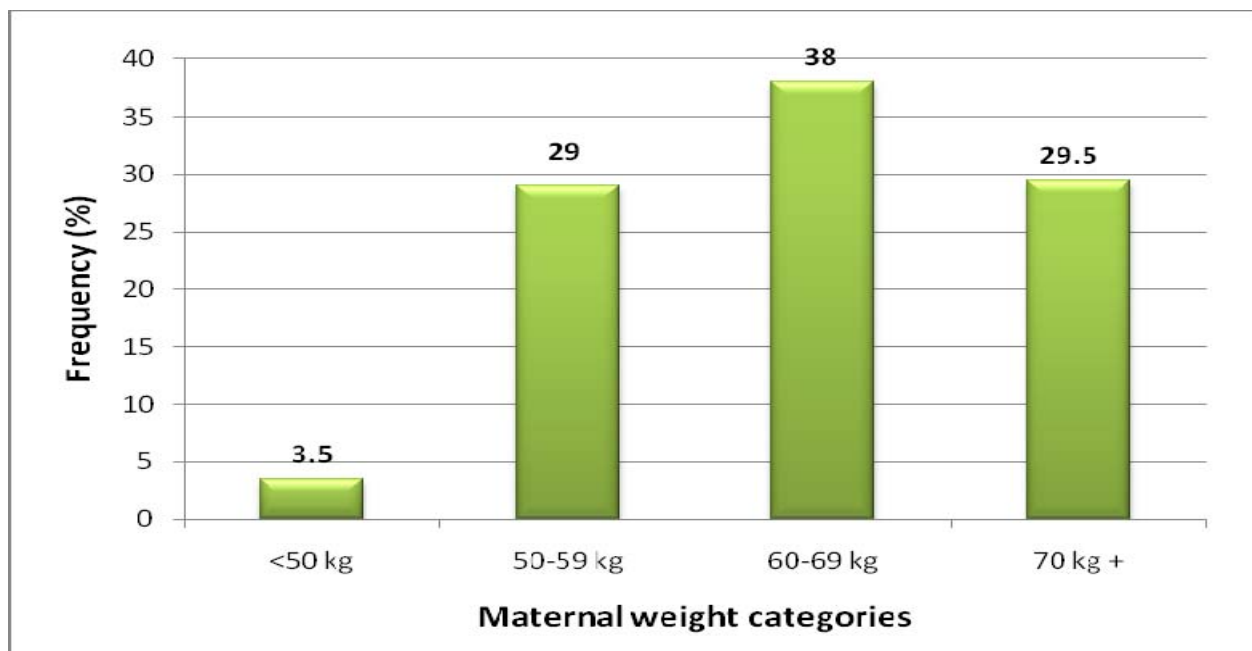


Figure 4.4: Maternal delivery weight distribution at PGH Maternity Ward Nakuru

Maternal delivery weight as a predictor of birth outcomes has gained prominence in a number of studies (Wannous and Arous, 2001; Acharya *et al.*, 2004 and Nahar *et al.*, 2006) conducted in Syria, Karnataka, Udupi district and Dhaka, Bangladesh respectively. This is due to the challenges of keeping track of weight gain among pregnant women. Women in Kenya visit antenatal clinics only once during their last stages of pregnancy and most of them do not know their pre-pregnancy weight and this is according to the KDHS reports of 2003 and 2008-09 (CBS *et al.*, 2004; KNBS, 2010). Maternal delivery weight could be an indication of poor weight gain in the entire course of pregnancy. A study by Wannous and Arous (2001) that was conducted in Syrian Republic hospitals found that mothers who weighed less than 50 Kg were more likely to deliver small babies. At PGH maternity, the mean birth weight of infants who were born to mothers with delivery weight of less than 50 Kg was lower (2.53 ± 0.27 Kg) compared to 2.91 ± 0.64 Kg for those who were born to those with a delivery weight of > 50 Kg and this mean differences were significant at $t=2.937$, $p=0.030$. Most mothers 190 (90%) at the hospital, had a delivery weight of > 50 Kg. This could be an indication that mothers started their pregnancy with a higher pre-pregnancy weight or the weight gain during pregnancy was satisfactory.

ii). Maternal height

The height of mothers at the Maternity Ward was taken after delivery and recorded. Majority of the mothers $n=180(90\%)$ at the hospital had a height of over 150 cm and $n=20(10\%)$ of mothers registered a height of less than 150 cm (Figure 4.5).

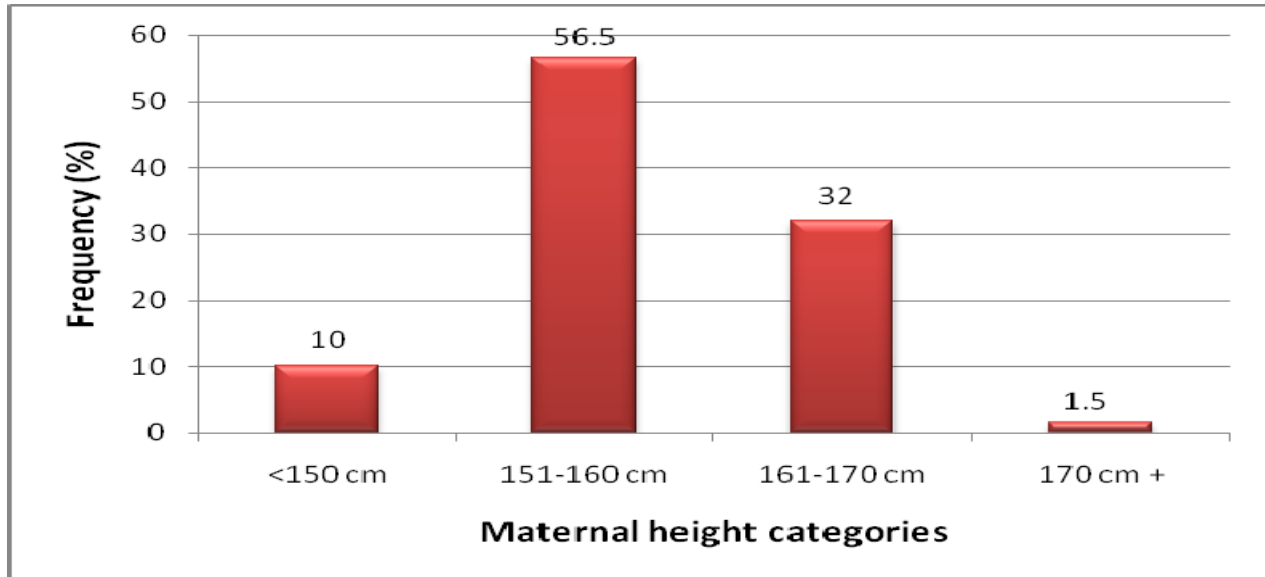


Figure 4.5: Height distribution of mothers at PGH Maternity Ward Nakuru

Apart from weight of the mother being the best predictor of birth outcomes, height too has been found to play a role in predicting birth outcomes. A significant association has also been found to exist between maternal stature and the risk of child death too. Infants born to short mothers (< 150 cm) have been found to have an increased risk of mortality coupled with LBW and short infants at birth (Baqui *et al.*, 1994; Elshibly and Schmalisch, 2008; Ozaltin *et al.*, 2010). At PGH Maternity Ward Nakuru, mothers who had a height of < 150 cm had relatively shorter and lighter infants with a mean length and birth weight of 46.47 ± 3.52 cm and 2.67 ± 0.64 Kg respectively. Infants who were born to mothers with a height of > 150 cm were longer and weighed heavier. Their mean birth length and weight were 47.11 ± 3.90 cm and 2.91 ± 0.64 Kg respectively. Though these slight differences were evident, they were not statistically significant ($p>0.05$) when their means were compared using t-test at $\alpha=0.05$. Lack of significance could be attributed to the fact that the largest percentage (90%) of mothers at the hospital had a height of > 150 cm.

iii). Maternal Mid-Upper Arm Circumference (MUAC)

Apart from weight and height measurements of the mothers, MUAC measurements were also taken and recorded. The mean MUAC measurement in this study was 25.3 cm with the minimum and maximum recorded MUAC measurements being 19.0 cm and 35.0 cm respectively with a standard deviation of 3.21 cm. About 15% of the mothers at the hospital Maternity Ward had MUAC measurements of 22 cm and below with the majority (> 80%) recording a MUAC of 23 cm and above as shown in Figure 4.6. According to Ferro-Luzzi and James (1996), MUAC measurement of < 22 cm is an indication of under nutrition. In this case therefore, up to about n=31(15%) of the mothers at the Maternity Ward were undernourished.

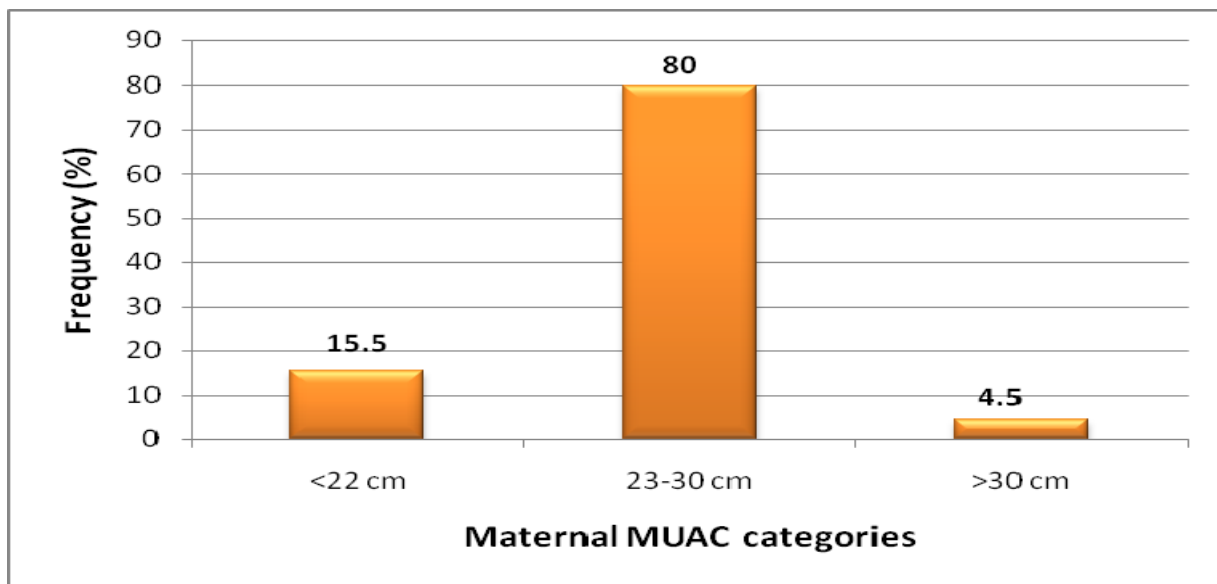


Figure 4.6: MUAC Measurements distribution of the mothers at PGH Maternity Ward Nakuru

Studies have indicated that maternal MUAC measurement of < 22 cm in pregnancy is a risk factor of LBW delivery (Mohanty *et al.*, 2006; Elshibly and Schmalisch, 2008). This study therefore endeavoured to find out number of LBW infants born to mothers with MUAC measurements of < 22 cm. Out of the 67(100%) LBW cases in the study, 15(22.4%) infants were born to mothers with MUAC measurements of < 22 cm, compared to 12% normal weight infants who were born to mothers within the same MUAC category. Table 4.7 gives a summary of distribution of infant birth weight based on maternal MUAC measurements.

Table 4.7: Distribution of infants birth weights based on maternal MUAC categories

Birth weight	Maternal MUAC categories			Total
	< 22 cm	22-30 cm	> 30cm	
NBW	16(12.0%)	111(83.5%)	6(4.5%)	133(100%)
LBW	15(22.4%)	49(73.1%)	3(4.5%)	67(100%)
Total	31(100%)	160(100%)	9(100%)	200(100%)

The hypothesis that there was no statistically significant relationship between maternal anthropometric measurements and infant's anthropometry at PGH Maternity Ward, Nakuru was tested using multiple linear regression to determine whether any significant relationship existed between maternal anthropometry and an infant's birth weight. To determine this, multiple linear regression was run taking into consideration possible confounding factors which were determined through univariate analysis. This analysis was performed to determine factors that had significant interactions to be considered as possible confounding factors. The factors that were found to have significant ($p < 0.05$) interactions were: maternal education level, HIV status, maternal income, age and birth spacing. These factors were therefore adjusted for in multiple linear regression so as to determine the influence of maternal anthropometry on an infant's birth weight. Table 4.8 gives the final model after controlling for the confounding factors.

Table 4.8: Relationship between maternal anthropometry and infant's birth weight

Variable and constant	b	SE b	β	Sig.	95% CI	
					Lower	Upper
Constant	2.105	1.23		0.000	0.833	3.888
Delivery weight	0.029	0.01	0.527	0.005	0.018	0.042
Maternal MUAC	-0.045	0.02	-0.229	0.030	-0.088	-0.007
Height	0.005	0.01	0.045	0.17	-0.011	0.018
Age	-0.010	0.01	-0.082	0.025	0.030	0.046
Monthly income	0.001	0.03	-0.002	0.08	0.013	0.032
Level of education	0.102	0.06	0.124	0.046	0.078	0.095
Maternal HIV status	-0.353	0.18	-0.136	0.268	-0.796	0.223
Birth spacing	-0.016	0.07	-0.021	0.04	0.153	0.166

The results of multiple linear regression displayed in Table 4.8 indicate that maternal anthropometry significantly ($r^2=0.200$, $F=3.337$, $p=0.000$) influenced an infant's birth weight

after controlling for maternal income and HIV status which were not significant and age, level of education and birth spacing which were independently significant in the model. These results therefore led to the rejection of the null hypothesis that there is no significant relationship between maternal anthropometry and an infant's birth weight. Maternal anthropometry was able to explain up to 20% of the variability in the infants birth weight ($r^2=0.200$). From the results, a unit reduction in the maternal delivery weight lead to a significant reduction in the infant's birth weight by 0.527 Kg similarly, a unit reduction in maternal MUAC measurements resulted in 0.229 Kg reduction in the infant's birth weight. Maternal height, however, did not significantly influence the birth weight of an infant. These findings contradict results from a study by Elshibly and Schmalisch (2008) in Khartoum, Sudan which found significant contribution of maternal height alone to infant's birth weight. All the variables included in the model were found not to be linearly correlated when collinearity test was performed.

The relationship between the infant's birth length and maternal anthropometry was also explored in this study. Multiple linear regression was run controlling for confounding factors. Maternal delivery weight and height were entered into the model at stages and their influence on the infant's birth length determined by changes in the R-square value. The results displayed in Table 4.9 indicate the relationship between infant's birth length and maternal anthropometry.

Table 4.9: Relationship between maternal anthropometry and infant's birth length

Variable and constant	Model	R ² Change	b	SE b	β	Sig.	95% CI	
							Lower	Upper
Constant			39.611	6.94		0.000	25.919	53.303
Age			0.054	0.049	0.076	0.043	-0.043	-0.151
Income			0.167	0.343	-0.034	0.072	-0.084	0.010
Level of education	1	0.194	0.72	0.157	0.031	0.06	0.237	2.159
HIV status			-0.056	1.123	-0.003	0.096	-2.272	0.032
Gestation period			-4.890	0.784	-0.412	0.000	-6.438	-3.342
Delivery Weight	2	0.244	0.079	0.025	0.228	0.002	0.029	0.223
Height	3	0.248	0.042	0.045	0.064	0.059	-0.048	0.131

($r^2=0.248$, $F=5.914$, $p=0.000$)

The results in Table 4.9 indicate that, maternal delivery weight was positively associated with the infant's birth length and this was significant. For every unit increase in the delivery weight, there was a significant increase in the infant's length by 0.228 cm ($p < 0.05$). The entry of delivery weight into the model with possible confounding factors already in the model improved the model ($r^2 = 0.194$ to $r^2 = 0.244$). This was an indication that delivery weight has significant influence on the birth length of the infant ($p = 0.002$). Height did not improve the model and its contribution towards the birth length of an infant was very minimal. For all the maternal anthropometric measurements that were considered in this study, the delivery weight of the mother was the most significant in explaining the variability in both the infant's birth weight and length. Maternal MUAC measurements were only significant in explaining the variability in the birth weight of an infant.

4.3.3: Maternal socio-demographic factors associated with an infant's birth weight and length at PGH Maternity Ward, Nakuru

The maternal socio-demographic factors considered in these study were: Age, level of education, parity, stage when ANC clinic was first attended, number of ANC clinic visits, income, previous LBW delivery, occupation, marital status and birth spacing. Mothers were asked questions regarding these variables and their responses recorded. This section also included the testing of hypothesis three which stated that there is no statistically significant relationship between maternal socio-demographic factors and an infant's birth weight. Each factor under this section was discussed separately in relation to the infant's birth weight and a decision made on whether to accept or reject the null hypothesis.

Age of the mothers

Out of all the women who were interviewed ($n = 200$), about 58(29%) were less than 20 years of age and 10(5%) were 35 years and above (Figure 4.7). This study adopted this kind of classification of mothers age due to the fact that different epidemiological studies (Karim and Taylor, 1997; Negi *et al.*, 2006) found an increased risk of LBW deliveries among mothers of < 20 years of age and those above 30 years. According to Villamor *et al.* (2002), growth and development are still on going among women who are below the age of 20 years and therefore

these women need nutrients for growth. Pregnancy in these women results into competition between the growing teenager and the developing foetus hence nutrient inadequacies that lead to poor foetal growth hence the risk of LBW deliveries. In this study, the mean age of the mothers at the hospital Maternity Ward, Nakuru was 24 ± 5.65 years. The lowest recorded age was 15 years and the highest 49 years. Figure 4.7 below gives a summary of age distribution of mothers at the hospital maternity.

Age distributon of the mothers

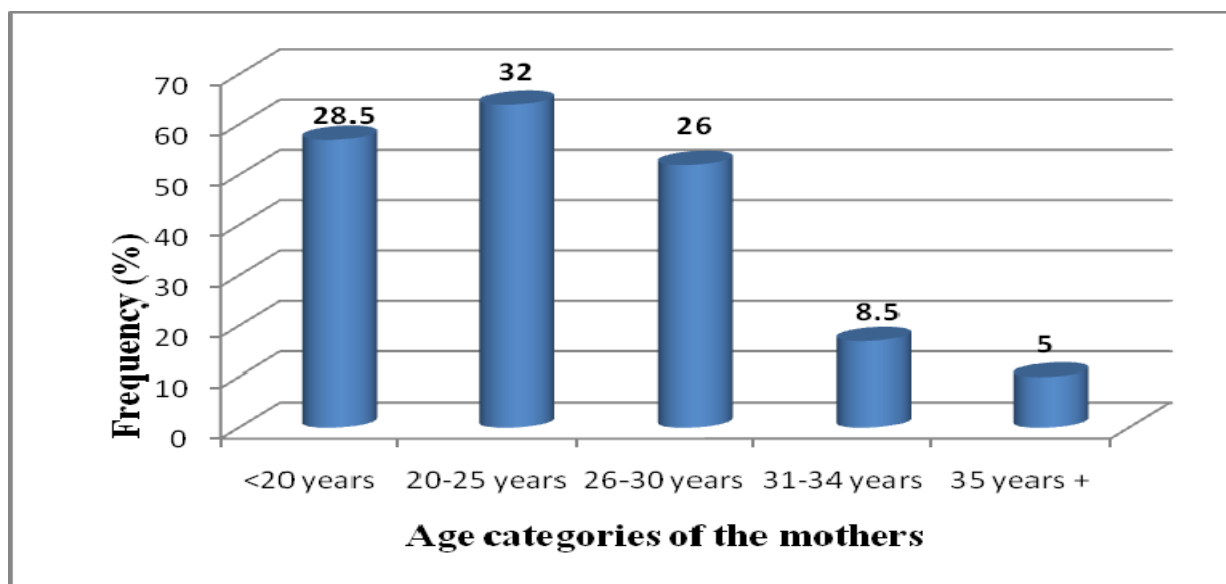


Figure 4.7: Age distribution of mothers at PGH Maternity Ward Nakuru

Apart from distributing mothers based on their age categories, the number of LBW infants born to mothers in each age category was determined hence the hypothesis testing on whether there was any significant relationship between maternal age and the infant's birth weight and this was tested using Chi-square test (Table 4.10)

Table 4.10: Relationship between maternal age and the birth weight of an infant

Birth weight	Maternal age categories in years					Total
	<20	20-25	26-30	31-34	35+	
NBW	18(13.5%)	51(38.3%)	45(33.8%)	14(10.5%)	5(3.8%)	133(100%)
LBW	39(58.2%)	13(19.4%)	7(10.4%)	3(4.5%)	5(7.5%)	67(100%)
Total	57(28.5%)	64(32%)	52(26%)	17(8.5%)	10(5.0%)	200(100%)

Chi-square = 2.26, df = 4, P-value = 0.04 (Critical alpha=0.05)

The Chi-square test output (Table 4.10) shows that there is significant relationship between the age of the mother and the infant's birth weight. The null hypothesis is therefore rejected since the Chi-square test value of 2.26 is significant at $\alpha=0.05$. The results show a decreasing number of LBW infants as the age increases. The highest numbers of LBW infants were born to mothers with less than 20 years 39(58.2%). These results are consistent with the findings from another study by Chen *et al.* (2007) conducted in USA on pregnant mothers aged below 20 years that found a higher risk of LBW deliveries in teenage mothers.

Other socio-demographic characteristics of the mothers at PGH are summarized in Table 4.11. From the study 160(80%) of the mothers had some of education with 88(44%) having attained only the basic primary education. A negligible number of mothers 4(2%) having no education. Majority of mothers 126(63%) visited ANC clinic for the first time in their third trimester of pregnancy with others not attending clinic at all. The results also indicate that 20(10%) of the mothers at the maternity reported to have had a previous LBW delivery compared to 98(49.5%) who had not. The other percentage of mothers 81(40.5%) were first time mothers (Primigravida). With the hospital being a referral facility, most of the mothers included in the study, 156(78%) were not referral cases. Only 44(22%) of the mothers were referral cases. This could be due to the fact that most referred cases were in their last stages of labour hence not possible to take their delivery weight. They were therefore not part of the study sample. The sampling procedure that was used which was non-random could also have excluded some referral cases from being part of the sample.

Table 4.11: A summary of other socio-demographic factors of the mothers

Characteristic	Counts	
	Frequency	%
Level of education		
Completed primary	88	44
Completed secondary	91	45.5
College	15	7.5
None	4	2.0
Other	2	1.0
When ANC clinic was started		
Trimester I	11	5.5
Trimester II	61	30.5
Trimester III	126	63.0
Didn't attend	2	1.0
Number of ANC visits		
None	3	1.5
<2 times	30	15.0
2-4 times	167	83.5
Parity		
Primigravida	75	37.5
Multigravida	125	62.5
Previous LBW delivery		
Yes	20	10
No	99	49.5
Not applicable	81	40.5
Marital status		
Married	167	83.5
Single	33	16.5
Did mother take supplements given at ANC clinic by the doctor		
Yes	137	69.5
No	63	30.5
Is the mother a referral case from another hospital		
Yes	44	22
No	156	78

From the summarized factors in table 4.11, it was also essential to determine the relationship of each factor and the infant's birth weight. To achieve this, Chi-square analysis was performed for each factor in relation to the infant's birth weight.

Maternal level of education

Mothers in the study were asked to give their level of education. Levels of education were categorized into four categories (no education/ basic primary education, secondary, college and other). The infants birth weights were then distributed per each education level category as indicated in table 4.12.

Table 4.12: Relationship between maternal level of education and the birth weight of an infant

Birth weight	No education/primary	Secondary	College	Other	Total
NBW	37(27.8%)	81(60.9%)	13(9.8%)	2(1.5%)	133(100)
LBW	55(82.1%)	10(14.9%)	2(3.0%)	0	67(100)
Total	92(46.0%)	91(45.5%)	15(7.5%)	2(1.0%)	200(100)

Chi-square = 6.09, df = 4, P-value = 0.04 (Critical alpha=0.05)

The study results displayed in table 4.12, indicate that there is a significant ($p < 0.05$) relationship ($\chi^2 = 6.09$) between mothers' level of education and the infant's birth weight. Mothers with no education or with only basic primary education had the highest number of LBW deliveries 55(82.1) compared to those with higher education. The number of LBW deliveries reduced as the level of education increased. The null hypothesis was therefore rejected. These results are similar to those obtained in the KDHS report of 2008-09 which has shown women with higher education to be more likely to receive ANC care from medical doctors than those with no education hence improved birth outcomes (KNBS, 2010). Also as cited earlier in literature, mothers with higher education are more exposed and therefore able to make wiser decisions concerning their health compared to those who are not educated or those with no education (Raun *et al.*, 2001). Lack of education among mothers could explain why some pregnant women at PGH, Nakuru started attending ANC clinics as late as the third trimester during pregnancy.

Parity of the mother

Parity of the mothers was another variable that was considered in this study. Mothers were asked to say whether they were first time mothers (primiparous) or whether they had other children (multiparous). This variable has been found in other studies to predict LBW deliveries. Table 4.13 gives the distribution and the relationship between the infant's birth weight and parity.

Table 4.13: Relationship between parity and the birth weight of an infant

Birth weight	Parity of the mother		Total
	Primigravidae	Multigravidae	
NBW	33(24.8%)	100(75.2%)	133(100%)
LBW	42(62.7%)	25(37.3%)	67(100%)
Total	75(37.5%)	125(62.5%)	200(100%)

Chi-square = 0.94, df = 1, P-value = 0.03 (Critical alpha=0.05)

The Chi-square value of 0.94 is significant at $\alpha=0.05$ ($p<0.05$) as shown in Table 4.13. This results show that there is a significant relationship between parity of the mother and the infant's birth weight. The null hypothesis is therefore rejected. First time mothers had a significantly higher number of LBW infants 42(62.7%) compared to multiparous mothers 25(37.3%). These results are consistent with the findings from a study conducted in Khartoum, Sudan on 1000 singleton mothers that found LBW rate to be nearly twice in first born infants compared to those born to multiparous mothers (Elshibly and Schmalisch, 2008). Similar results were also found in another study by Wannous and Arous (2001) that was conducted in Syrian Arab Republic hospitals which found firstborn babies to likely be of LBW than second or more births. All these results give an indication that parity plays a pivotal role in predicting the risk of LBW delivery among pregnant women. This is because first time mothers from the study (38%) were more likely to be teenagers who are already at a higher risk of giving birth to LBW infants.

Previous LBW delivery

To obtain information on this variable, mothers were asked to say whether their last delivery was a LBW infant or not. This only applied to mothers who had other children and those who could remember the birth weights of their infants especially those who had delivered in hospitals. Infants birth weights were then distributed as indicated in Table 4.14.

Table 4.14: Relationship between mothers' previous LBW delivery and the birth weight of an infant

Birth weight	Previous LBW delivery		Total
	Yes	No	
NBW	69(88.5%)	9(11.5%)	78(100%)
LBW	30(73.2%)	11(26.8%)	41(100%)
Total	99(83.2%)	20(16.8%)	119(100%)

Chi-square = 4.68, df = 2, p-value = 0.03 (Critical alpha=0.05)

From the Chi-square test output in Table 4.14 there is significant relationship ($p < 0.05$ at $\chi^2 = 4.68$) between mothers' previous LBW delivery and an infant's birth weight. The null hypothesis that there is no statistically significant relationship between mothers' previous LBW delivery and an infant's birth weight is thus rejected. Mothers who self reported to have had a previous LBW delivery had a higher rate 30(73.2%) of LBW deliveries compared to their counterparts who did not have a previous LBW delivery 11(26.8%). These results agree well with the findings from a study by Negi *et al.* (2006) who found a higher risk of LBW delivery in mothers with a history of LBW deliveries. This could be due to the fact that factors which might have led to the previous LBW delivery in these mothers could still be present thus LBW delivery could still be expected (Wannous and Arous, 2006).

Number and timing of ANC care visits

Antenatal care is beneficial in preventing adverse pregnancy outcomes when it is sought early in pregnancy and is continued through delivery. This is according to the Kenya Demographic Health Survey report for 2008-09 (KNBS, 2010). Table 4.15 gives a summary of the distribution of infants based on the timing of ANC clinic among women who participated in the study.

Table 4.15: Relationship between stage of pregnancy when ANC clinic was started and the birth weight of an infant

Birth weight	Stage when ANC clinic was started				Total
	Did not attend	Trimester I	Trimester II	Trimester III	
NBW	1(0.8%)	7(5.3%)	35(26.3%)	90(67.7%)	133(100%)
LBW	1(1.5%)	4(6.0%)	26(38.8%)	36(53.7%)	67(100%)
Total	2(1.0%)	11(5.5%)	61(30.5%)	126(63.0%)	200(100%)

Chi-square = 3.94, df = 3, p-value = 0.27 (Critical alpha=0.05)

The Chi-square test output in Table 4.15 indicate that there is no significant relationship ($P > 0.05$ at $\chi^2 = 3.94$) between stage when ANC clinic was started and the infant's birth weight. The null hypothesis was therefore accepted. These results contradict the findings from other studies (Wannous and Arous, 2001 and Negi *et al.*, 2006) that found a relationship between these variables. Mothers who visit ANC clinics early enough in pregnancy receive the necessary interventions including supplementation aimed at improving the birth outcomes. From the results displayed in the table, this is not the case, low numbers of normal weight infants 7(5.3%) were recorded among mothers who attended ANC clinics early in pregnancy compared to those who attended late 90(67.7%). These results give an indication that these mothers may have only attended the ANC clinic once at an early stage yet the minimum recommended number of times is four times as per the refocused antenatal clinic requirements. Table 4.16 gives a summary of distribution of infants based on the number of ANC visits made by their mothers.

Table 4.16: Relationship between number of ANC visits and the birth weight of an infant

Birth weight	<2 times/no visit	2-4 times and above	Total
NBW	13(9.8%)	120(90.2%)	133(100%)
LBW	20(29.9%)	47(70.1%)	67(100%)
Total	33(16.5%)	167(83.5%)	200(100%)

Chi-square = 2.28, df = 2, p-value = 0.03 (Critical alpha=0.05)

The Chi-square value of 2.28 is significant at $\alpha=0.05$ ($p<0.05$) as shown in Table 4.16. This indicates a significant relationship between number of ANC clinic visits and an infant's birth weight. This therefore led to the rejection of the null hypothesis that there is no significant relationship between number of ANC clinic visits and an infant's birth weight. The results displayed in this table also indicate that a higher number of normal weight infants 120(90.2%) were born to mothers who had > 2 times of ANC visits compared to those who had few (< 2 times) ANC visits 13(9.8%). These results agree well with the KDHS findings that have shown a decline in the proportion of women who make four or more ANC visits among mothers from 52% in 2003 to 47% in 2008-09 (KNBS, 2010). According to the report, up to 12% of women have a minimum of one ANC visit or none in pregnancy.

The study findings at the hospital indicate that a total 33(100%) of infants were born to mothers with less than 2 or no ANC visit and that a higher percentage 20(60.6%) of infants within this category were of LBW compared to normal weight infants 13(39.4%). A higher number of normal weight infants 120(71.9%) were recorded among mothers with > 2 ANC visits compared to LBW infants 47(28.1%) within this category. Similar results were also obtained in a study by Negi *et al.* (2006) that found an increased likelihood of LBW delivery among mothers who attended clinic only once. These results could explain why there was no significant relationship between the stage when ANC clinic was started and the infant's birth weight. This could be because though mothers may have started ANC clinics early enough in pregnancy they may only have attended once. This therefore does not make any difference between mothers who start ANC clinics early and those who start late in terms of the birth weight of their infants. In this study therefore, the number of visits to ANC clinic was more important than the stage of pregnancy a mother starts clinic. Other factors that were considered in this study and are known to affect birth outcomes were the occupation of the mother and that of the spouse, birth spacing, monthly income of both the mother and the spouse.

Monthly income of both the mother and the spouse

Mothers were asked to say if they earned some income and if they did, they were to state approximately how much they earned. They were also asked about their spouse earnings and this was recorded.

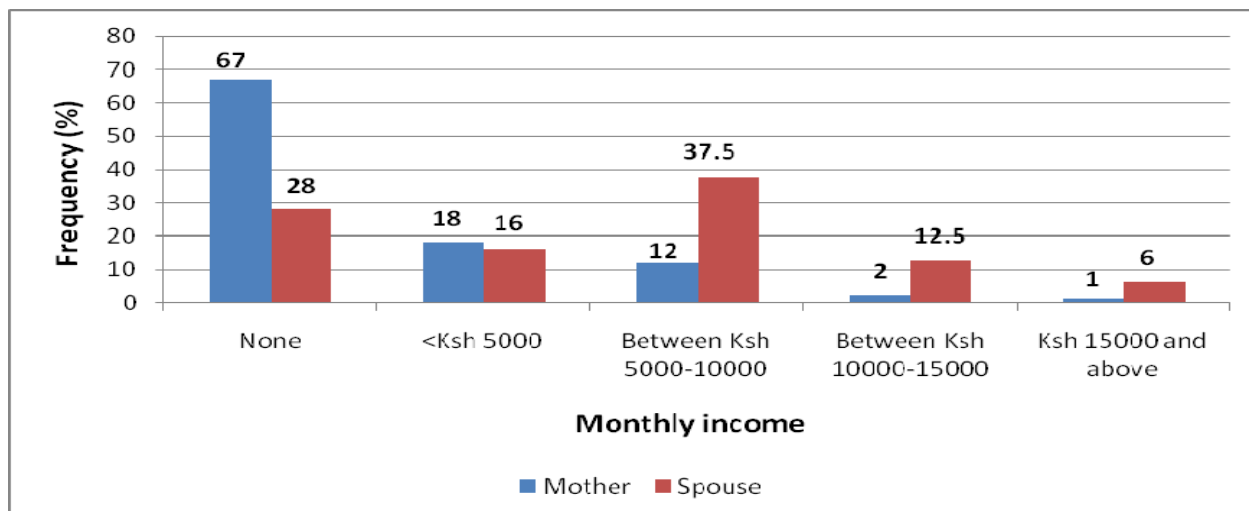


Figure 4.8: Monthly income summary of both the mother and the spouse at PGH Maternity Ward Nakuru

Most of the women 134(67%) at the hospital had no form of income as the majority of them were only house wives without any occupation to earn them an income (Figure 4.8) while their spouses had some income while 56(28%) of their spouses had no income. For the spouses who earned some income, 74(37%) had a salary income of between Ksh 5000-10000 with 12(6%) of them earning over Ksh 15000. This study also classified the infants birth weight based on mothers income to see whether a relationship between birth weight and maternal income existed. A Chi-square test was performed and results displayed in Table 4.17.

Table 4.17: Relationship between mothers' monthly income and the birth weight of an infant

Birth weight	Mothers' monthly income in Ksh					Total
	None	<5,000	5,000-10,000	10,000-15,000	15,000 and above	
NBW	87(65.4%)	21(15.8%)	20(15.0%)	4(3.0%)	1(0.8%)	133(100%)
LBW	47(70.1%)	15(22.4%)	4(6.0%)	0	1(1.5%)	67(100%)
Total	134(67.0%)	36(18.0%)	24(12.0%)	4(2.0%)	2(1.0%)	200(100%)

Chi-square = 6.54, df = 4, p-value = 0.09 (Critical alpha=0.05)

The null hypothesis for this variable in relation to the infant's birth weight was that: there is no statistically significant relationship between mothers' monthly income and the infant's birth

weight. The Chi-square test output (Table 4.17) indicates that the Chi-square value of 6.54 at $\alpha=0.05$ was not significant ($p>0.05$). The null hypothesis was therefore accepted. Though the relationship was not significant, mothers' income is an important factor as far as LBW is concerned. From the results displayed in the table, LBW incidences reduced as mothers' income increased. Mothers in developing countries who earn some income are said to be able to provide their families with nutritious food without necessarily waiting for their spouses to provide (Karim and Mascie-Taylor, 1997). On the other hand, lack of a significant relationship could be due to the fact that mothers may not be able to make wise food choices to provide nutritious meals even with the income hence mothers may not be meeting their nutritional needs during pregnancy. This could be closely related to the fact that 46% had no education and others had basic primary school education as earlier discussed.

Occupation of the mothers

For this variable, mothers were asked if they had any form of occupation and their responses were recorded. Figure 4.9 gives a summary of different occupation that were common among the mothers at the hospital. From the results displayed, slightly more than half 111(55.5%) of women at the maternity were house wives and did not have any source of income 134(67%). Small percentages of women reported to be casual workers 5(2.5%), farmers 19(9.5%) and business women 2(1%). This explains the reason why most women at the hospital did not have any form of earning as most of them are just house wives.

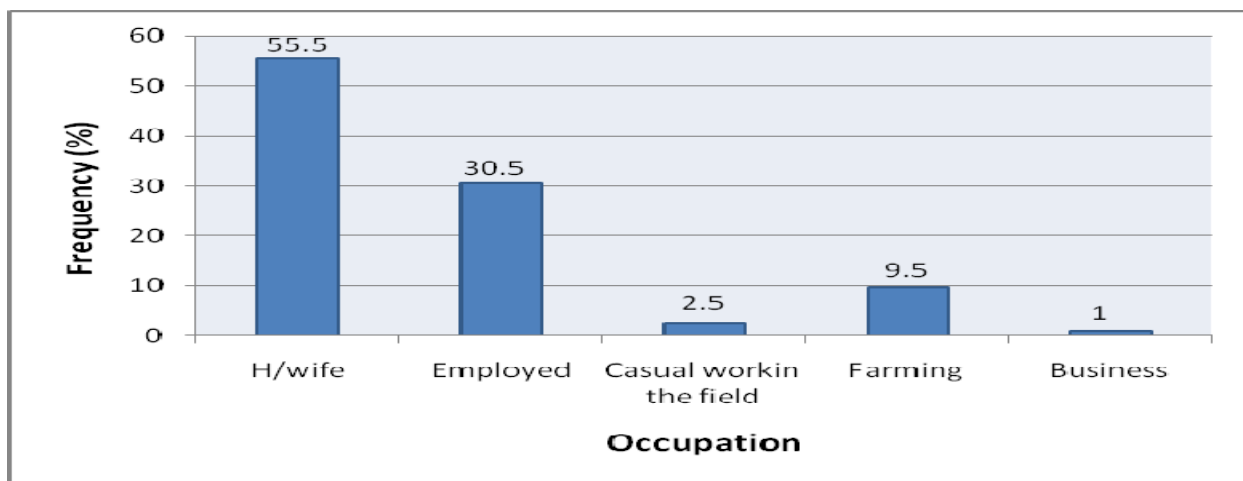


Figure 4.9: Occupation categories of the mothers at PGH Maternity Ward, Nakuru

Further, the study tested the hypothesis that there is no statistically significant relationship between mother's occupation and an infant's birth weight using Chi-square and the results are presented in Table 4.18.

Table 4.18: Relationship between maternal occupation and the birth weight of an infant

Birth weight	Maternal age occupation					
	H/wife	Employed	Casual work in the field	Farming	Business/other	Total
NBW	41(30.8%)	59(44.4%)	5(3.8%)	23(17.3%)	5(3.8%)	133(100%)
LBW	60(89.6%)	2(3.0%)	0	2(3.0%)	3(4.5%)	67(100%)
Total	101(50.5%)	61(30.5%)	5(2.5%)	25(12.5%)	86(43.0%)	200(100%)

Chi-square = 10.53, df = 5, P-value = 0.04 (Critical alpha=0.05)

The results in Table 4.18 show that the Chi-square value of 10.53 was significant at $\alpha=0.05$ ($p<0.05$). This implies that there was a significant relationship between maternal occupation and the infant's birth weight. The null hypothesis is therefore rejected. The highest number of LBW infants 60(89.6%) were recorded for mothers who were just house wives compared to those who had some form of occupation. Mothers who were employed had the least number of LBW infants. This could be an indication that these mothers were earning some income hence able to afford nutritious food during pregnancy and they could also afford proper medical care which led to improved birth outcomes. Good nutrition and medical care during pregnancy are also key factors to improved pregnancy outcomes (Udipi *et al.*, 2000). Mothers who practiced farming also recorded low numbers of LBW infants. This could be due to the fact that these mothers are able to grow nutritious food plants such as green vegetables making them readily available to the family without necessarily buying them. They may also be getting some income from farm produce hence able to afford medical care.

Birth spacing

Birth spacing between children was another factor that was considered in this study and it was evident that a birth spacing of more than 24 months was common among mothers who had other children. A negligible number of mothers at the maternity 4(2%) had a birth spacing of less than

12 months. However, 76(38%) of mothers did not have other children and therefore this factor was not applicable to them (Figure 4.10).

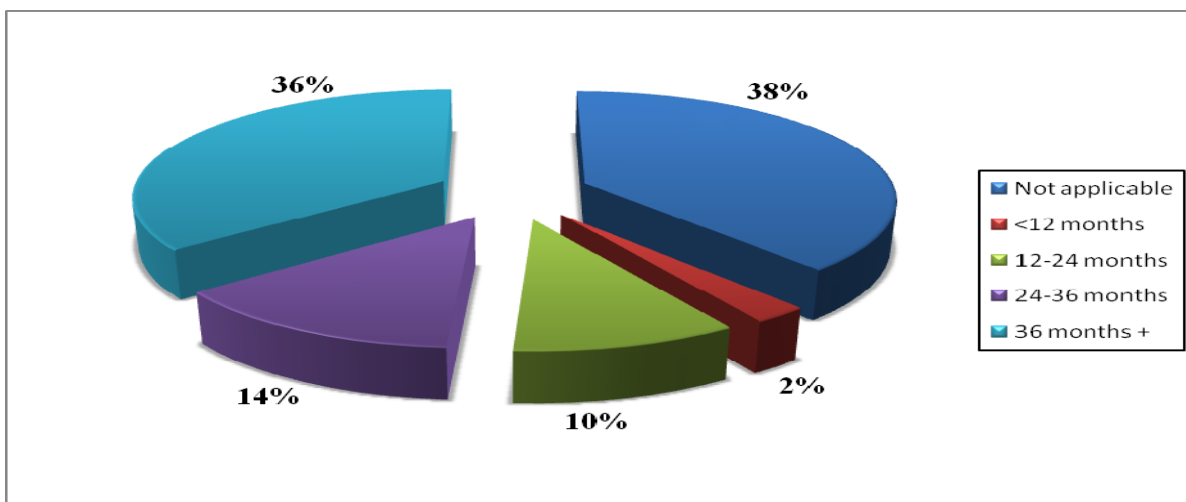


Figure 4.10: Birth spacing categories of the mothers at PGH Maternity Ward Nakuru

To test for the null hypothesis that there is no relationship between birth spacing and an infant's birth weight, Chi-square test was performed. Results in Table 4.19 give a general distribution of infants birth weights based on birth spacing.

Table 4.19: Relationship between birth spacing and the birth weight of an infant

Birth weight	Birth spacing in months				Total
	<12	12-24	24-36	36 and above	
NBW	1(20.0%)	14(70.0%)	16(59.3%)	45(63.4%)	79(64.2%)
LBW	4(80.0%)	6(30.0%)	11(40.7%)	26(36.6%)	44(35.8%)
Total	5(100%)	20(100%)	27(100%)	71(100%)	123(100%)

Chi-square = 1.14, df = 3, p-value = 0.04 (Critical alpha=0.05)

The Chi-square test output in Table 4.19 shows that there is statistically significant relationship between birth spacing and the birth weight of an infant. The null hypothesis is therefore rejected since the Chi-square value of 1.14 is significant at $\alpha=0.05$ ($p<0.05$). From the results, birth spacing for mothers who had other children was not a problem as the majority of the mothers had a reasonable spacing between births. These results are similar to those obtained earlier at the same hospital in study by Mbuthia (2006) that found reasonable birth spacing among mothers at the hospital. However, for the few mothers who had a birth spacing of less than 12 months, LBW

rate was higher 4(80%) compared to normal weight infants 1(20%) within this category. Mothers who had a reasonable birth spacing of 36 months and above, higher number of normal weight infants 45(63.4%) were recorded compared to LBW infants 26(36.6%) within this category. This is due the fact that with a reasonable birth spacing period of 2 years and above, mothers are able to regain their health and replenish their nutrient stores before another pregnancy.

4.3.4: Health status of the mothers at PGH Maternity Ward, Nakuru.

Under the health status of the mothers, the study considered the Hb status of the mother, HIV status, presence of hypertension and diabetes during pregnancy. The null hypothesis that there is no statistically significant relationship between maternal health status (Hb and HIV status) was tested using Chi-square test.

Hb status of the mothers

Information regarding the Hb status of the mothers was obtained from their clinic cards and hospital files as recorded by the health care providers at the hospital. According to WHO (2005), anaemia is defined as the reduction in circulating haemoglobin mass below the critical level. The normal Hb concentration in the body is 12-14 g/dl. In pregnancy, a Hb level of < 11 g/dl is indicative of anaemia. Any Hb level less than 11g/dl in pregnancy is an indication of anaemia. It is in this light that the study classified the mothers at the hospital maternity into mild, moderate, severe or very severe degree based on their Hb levels that were recorded in their clinic cards. From the study results, there were no severe and very severe cases of anaemia recorded, however, 72(36%) of mothers had mild anaemia and only 4(2%) were moderately anaemic. The rest of the mothers 78(39%) had normal Hb levels. The results also indicate that 46(23%) of the mothers at the maternity did not have their Hb status tested while 134(77%) of the mothers had their Hb taken and recorded (Figure 4.11).

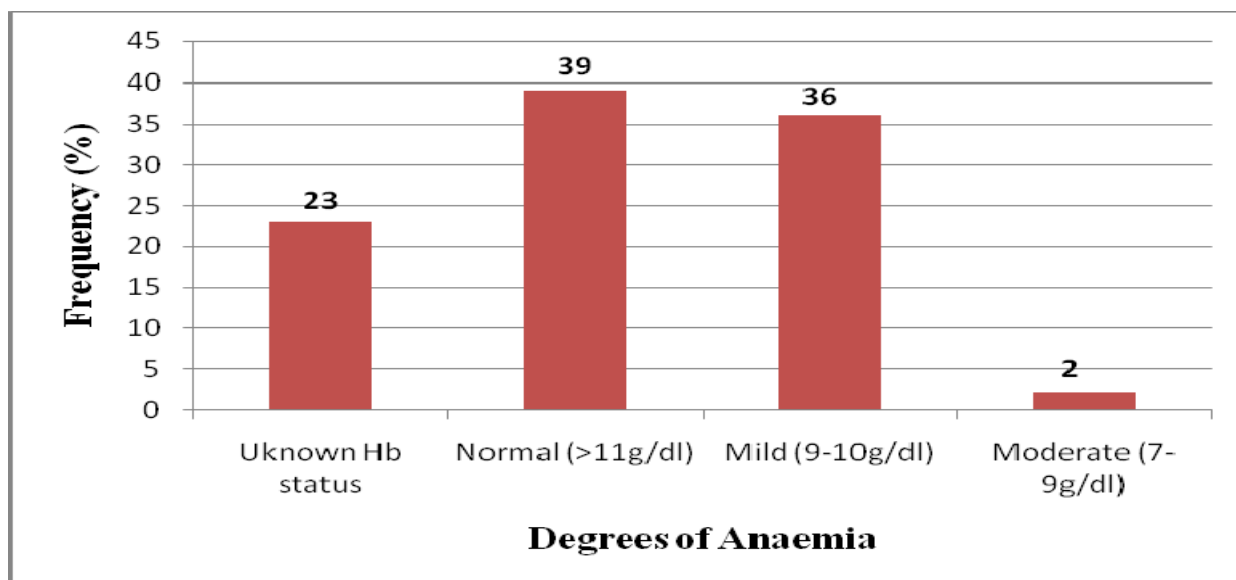


Figure 4.11: Hb status of the mothers at PGH Maternity Ward Nakuru

Lack of Hb testing for 46(23%) of the mothers could be attributed to the fact that most of the mothers 126(63%) start their antenatal clinic late in pregnancy in their third trimester hence their Hb status is not tested. Also the test is offered to the mothers at a fee which most of them may not be able to afford hence they do not benefit from the service. To test for the hypothesis that there is no statistically significant relationship between mothers' health status Hb status and the birth weight of an infant at PGH maternity, Nakuru, Chi-square test was performed and results displayed in Table 4.20.

Table 4.20: Relationship between maternal Hb status and the birth weight of an infant

Birth weight	Hb levels		Total
	<11g/dl	>11g/dl	
NBW	28(27.5%)	74(72.5%)	102(100%)
LBW	46(88.5%)	6(11.5%)	52(100%)
Total	74(48.1%)	80(51.9%)	154(100%)

Chi-square = 1.14, df = 3, p-value = 0.04 (Critical alpha=0.05)

From the Chi-square output, there is a significant relationship ($P < 0.05$ at $\chi^2 = 1.14$) between maternal Hb status and the infant's birth weight (Table 4.20). The null hypothesis is thus rejected. Anaemia in pregnancy is associated with poor birth outcomes including LBW deliveries (Wannous and Arous, 2001). From the results, Hb levels of less than 11g/dl were associated with

a higher rate of LBW infants 46(88.5%) compared to Hb levels of >11g/dl which was associated with the least number of LBW infants 6(11.5%). Despite Hb status of the mother being an important factor in predicting the birth weight of an infant, not all mothers had a chance of their Hb status being taken. This is because some mothers do not attend ANC clinics at all. Those with poor Hb status could be due to the fact that they do not attend ANC clinics in good time as seen earlier hence they miss out on the necessary interventions aimed at boosting their Hb levels.

HIV status of the mothers

The HIV status of the mothers was determined from their clinic cards and also from the mother's history notes in their files at the maternity and the finding was that 194(97%) of the mothers were HIV negative, 12(6%) of the mothers were positive and 6(3%) of the mothers did not have their HIV status tested (Figure 4.12).

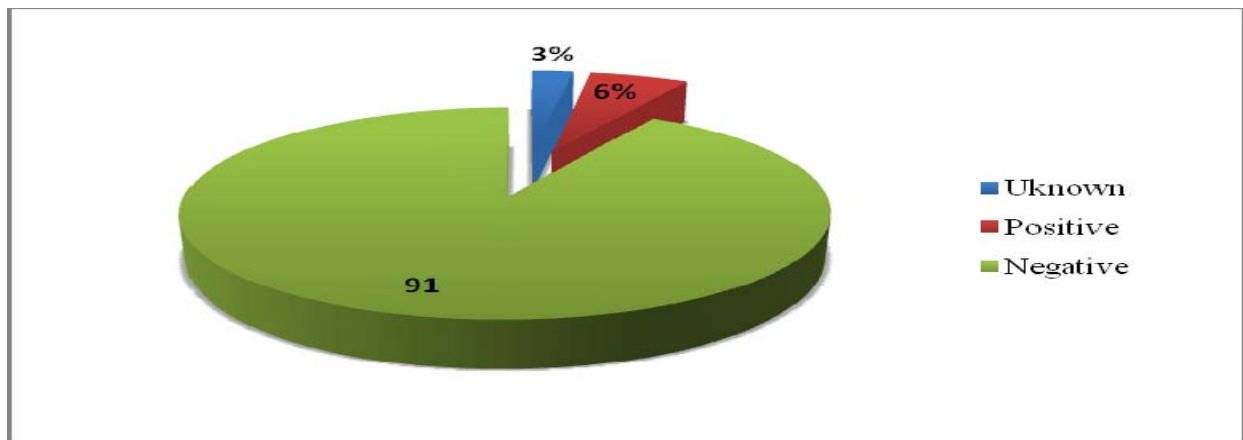


Figure 4.12: HIV status of the mothers at PGH Maternity Ward Nakuru

After determining the HIV status of the women at the hospital maternity, it was also important to determine whether a significant relationship existed between maternal HIV status and the infant's birth weight. To test for this hypothesis, a Chi-square test was performed and results displayed in Table 4.21.

Table 4.21: Relationship between maternal HIV status and the birth weight of an infant

Birth weight	Maternal HIV status		Total
	Positive	Negative	
NBW	10(7.6%)	121(92.4%)	131(100%)
LBW	2(3.1%)	62(96.9%)	64(100%)
Total	12(6.2%)	183(93.8%)	195(100%)

Chi-square = 1.51, df = 1 p-value = 0.22 (Critical alpha=0.05)

A number of studies have found an increased risk of LBW deliveries among HIV positive mothers compared to HIV negative mothers (Osman *et al.*, 2001 and Coley *et al.*, 2001). This however, was not the case from this study. The results displayed in Table 4.21 show that there was no significant relationship between the HIV status of the mother and the birth weight of an infant ($p > 0.05$ at $\chi^2 = 1.51$). The null hypothesis was therefore accepted. T-test statistic revealed no statistically significant differences in the birth weights of infants born to HIV positive and negative mothers ($p = 0.15 > 0.05$ at $t = 1.443$). These results are similar to those obtained in another study by (Mbutia, 2006) in the same hospital. Other studies with similar findings include Bobat *et al.* (2001) in South Africa and Watts (2002). This scenario could be due to the fact that the HIV positive mothers included in the study were very few hence the significance could not be detected at the alpha level of 0.05. This could also be explained by the fact that these mothers were not symptomatic at the time of the study hence were not statistically different from the HIV negative mothers.

Other health conditions that were considered in this study were diabetes and hypertension though they were not common among mothers at the maternity. Mothers who were found to have any of these conditions were classified as high risk cases and this was indicated in bold letters on their hospital files. This made it easier to identify these cases during the study. Only 4(2%) and 8(4%) of the mothers at the maternity were diabetic and hypertensive respectively. Majority 188(94%) of the mothers did not have any of these conditions according to the hospital records (Table 4.22).

Table 4.22: Other health conditions among mothers at PGH maternity, Nakuru

Condition	Frequency	%
Diabetic	5	2
Hypertensive	8	4
Without risky health conditions	187	94
Total	200	100

Logistic Regression Analysis

This was performed to determine the likelihood of a mother delivering a LBW infant based on the socio-demographic factors under the study. Maternal delivery weight and MUAC measurements were considered to be possible confounding factors and hence they were controlled for in this analysis. Table 4.23 gives a summary of the socio-demographic factors with their associated odds of a LBW delivery among mothers.

Table 4.23: Binary Logistic Regression

Maternal factors	Categories	No. of Newborns	LBW		Odds Ratio	95% CI	P-value
			No.	%			
Parity ¹	Primigravida	75	45	39.3	2.33	2.73-2.51	0.001*
Age ²	< 20 years	116	40	34.5	1.94	0.31-2.03	0.003*
	>30 years	57	9	33.3	0.48	1.12-2.48	
Level of education ³	Basic primary and below	92	2	40.2	1.95	0.45-1.04	0.023*
Hb status ⁴	<11 g/dl	74	28	37.8	2.56	1.38-3.87	0.030*
Number of ANC visits ⁵	None	3	47	66.7	4.03	0.36-1.21	0.031*
	< 2 times	30	8	31.7	2.01	1.33-4.56	
Previous LBW delivery ⁶	Yes	20	56	62.4	2.74	0.47-1.18	0.044*
Maternal delivery weight ⁷	< 50 Kg	15	15	22.7	3.62	1.45-2.89	0.021*
MUAC ⁸	< 22 cm	31	21	31.8	1.45	0.89-1.35	0.49*

* Predictor significant at $\alpha = 0.05$

¹Reference group- Multigravida, ²Reference age category- mothers 20-30 years, ³Reference category- Secondary and college education, ⁴Reference group- Hb levels >11 g/dl, ⁵Reference category- > 2 times ANC clinic visits, ⁶Reference category- No previous LBW delivery, ⁷Reference category- > 50 Kg, ⁸Reference category- > 22 cm

Numerous socio-demographic factors were considered in this study and hence there was need to determine good predictors of LBW delivery. The stepwise method in the binary logistic regression model was able to remove factors step by step leaving the best predictors of an infant's birth weight starting with the most important factor. As revealed from the logistic regression model, parity, age of the mother, level of education, Hb status, number of ANC clinic visits and a mother's history of a LBW delivery were all significant in predicting LBW delivery in the order displayed in the table after controlling for maternal delivery weight and MUAC which were also significant in the model. The addition of other predictors in the study (i.e. mother's income, occupation, HIV status, time when ANC clinic was started and marital status of the mother) did not improve the model.

Parity of the mothers emerged to be the best predictor of LBW birth weight of an infant. Primigravida mothers were 2.33 times more likely to give birth to LBW infants compared to multigravida mothers and this was significant ($p = 0.001$). Mothers who were below the age of 20 years were almost twice (OR 1.94) more likely to deliver LBW infants compared to those above 20 years. The odds of LBW delivery was also high (OR 1.95) among mothers who had no education and those who had only basic primary education. These results are similar to those obtained in a study in Germany by Karim and Mascie-Taylor (1997) and also in another study by Raun *et al.* (2001). Both studies found an increased risk of LBW deliveries among women with no education. The explanation behind this is that without education, mothers are still not able to make wise decisions about their health and good food choices in pregnancy even with the income they obtain from their occupations (Villamor *et al.*, 2002). It was evident from the results that mothers who had secondary and college education had a reduced risk of delivering a LBW infant compared to their counterparts with no education or only basic primary education.

A larger percentage of LBW infants 46(88.5%) were born to mothers who had Hb level of <11g/dl compared to 6(11.5%) of those who had a Hb of >11 g/dl. Mothers who had Hb levels of <11 g/dl were 2.56 times more likely to deliver LBW infants as shown in Table 4.23. Mothers who did not attend ANC clinic at any time in pregnancy had a greater risk (OR 4.03) of LBW delivery compared to those who visited ANC clinics. Similarly mothers who self reported to

have had a previous LBW delivery in the study were 2.75 times more likely to give birth to LBW infants. These results agree well with similar studies carried out in other countries such as Sudan and Germany which found these factors to be associated with an infant's birth weight (Acharya *et al.*, 2004; Negi *et al.*, 2006; Elshibly and Schmalisch, 2007).

4.3.5: Differences between mothers with normal birth weight infants and those with LBW infants in terms of their anthropometric characteristics and some socio-demographic factors at PGH Maternity Ward, Nakuru.

Differences between mothers with LBW infants and those with normal weight infants was determined using students t-test at $\alpha=0.05$. The hypothesis that there is no statistically significant difference between mothers with LBW infants and those with normal weight infants was therefore tested using a t-test. The results are as displayed in Table 4.24. The results indicate that mothers who had LBW infants in this study were significantly lighter in weight at recruitment compared to their counterparts who had normal weight infants. The observed differences in the delivery weight between the two categories of mothers were statistically significant. These mothers also had slightly lower MUAC and height measurements, they were younger in age and the birth spacing for their children was slightly shorter compared to those who had normal weight infants. They also visited ANC clinic for the first time at a later stage in pregnancy. Mothers therefore had similar characteristics during the study period with significant differences in their delivery weights.

Table 4.24: Differences between mothers with NBW infants and those with LBW infants

Measurement at recruitment	Mean (SD)		Sig.	95% CI	
	NBW Infants	LBW Infants		Lower	Upper
Delivery weight (Kg)	67.33 (11.72)	62.40 (9.55)	0.004*	1.62	8.22
MUAC (cm)	25.42 (3.11)	25.02 (3.40)	0.399	-0.54	1.36
Height (cm)	158.76 (6.20)	157.05 (5.52)	0.05	-0.05	3.48
Age (years)	25.18 (6.18)	24.43 (5.38)	0.377	-2.42	0.92
Birth spacing (years)	2.48 (0.60)	2.40 (0.74)	0.575	-0.33	0.19
Trimester at 1 st clinic (months)	5.86 (1.81)	6.19 (1.87)	0.250	-0.23	0.87
Number of visits (counts)	2.83 (1.02)	2.61 (1.14)	0.164	-0.09	0.54

*The variable was significant

These results show that mothers who had a lower MUAC and height measurements, and who were younger with shorter birth spacing and visited ANC clinic at a later stage in pregnancy did not necessarily give birth to LBW infants. However, delivery weight significantly predicted the birth weight of the infants.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter outlines a brief summary of the results, gives conclusions and recommendations resulting from the study. It also indicates the theoretical value of the study in terms of filling a gap in knowledge relating to maternal and child health issues. The chapter also gives suggestions for further research in this area.

5.2 Major findings from the study

The study found out that LBW deliveries are still a problem at the hospital with an incidence rate of 17.3% which was recorded during the study period that lasted from February to April, 2010. This rate was higher than the incidence of 13.8% reported earlier at the hospital in 2009. Both the figures are considerably high considering that LBW rate in Kenya is 10% and that LBW is among the major causes of infant mortality in developing countries. The findings from the study also indicated that an infant's birth weight was significantly ($p=0.000$) related to birth length. Infants who were born with LBW were also stunted. This gave an indication that with the continued trend of LBW deliveries at the hospital, stunting among children under the age of five years will continue to be a problem as a short length at birth has been associated with stunting in childhood (Corvalan *et al.*, 2007).

It was also evident from the study findings that maternal delivery weight and MUAC measurements were better predictors of an infant's birth weight after controlling for possible confounding factors i.e. maternal age, income, education, HIV status and birth spacing and they explained up to 20% of the variability in an infant's birth weight ($r^2=0.20$, $F=3.338$, $p=0.000$). Maternal delivery weight was also found to be a good predictor of an infant's birth length explaining up to 24.8% of variability in length ($r^2=0.248$, $F=5.914$, $p=0.000$). These results therefore gave an indication that there were other factors other than just maternal anthropometric factors that were responsible for predicting the birth weight of an infant. Maternal socio-

demographic factors were therefore explored in this study to determine their relationship with an infant's birth weight.

Chi-square test was employed in testing the relationship between maternal socio-demographic factors and an infant's birth weight. The socio-demographic factors that were considered in this study were: maternal age, parity, marital status, occupation, mothers' income, history of previous LBW delivery, Number of ANC clinic visits, time when ANC clinic was started in pregnancy, maternal level of education, HIV and Hb status of the mother. Chi-square findings showed that all the mentioned factors were significantly associated with the birth weight of an infant hence the rejection of the null hypothesis that there is no significant relationship between maternal socio-demographic factors and an infant's birth weight. However, mothers' income, time when ANC clinic was started and the HIV status of the mother were found not to be significant. Mothers who started ANC clinics early still had a high rate of LBW infants. This could be due to the fact that these mothers may not have continued with the ANC visits as required or may not have adhered to the interventions prescribed to them at the clinic. On the other hand, mothers who were HIV positive did not necessarily give birth to LBW infants may be because they were not symptomatic at the time of the study and also the HIV positive cases in the study were very few (6%).

From the results already discussed, it was clear that numerous factors were found to be associated with the birth weight of an infant. It was therefore important to determine most essential predictors of an infant's birth weight hence the use of the logistic regression analysis. This analysis was able to remove factors one by one based on their contribution towards an infant's birth weight. From this analysis, six factors emerged to be better predictors of an infant's birth weight after controlling for other factors, these factors were: parity, age, Hb status, previous LBW delivery, number of ANC visits and level of education in their order of importance. Each factor had associated odds for delivering a LBW infant. Primigravida mothers were 2.33 times more likely to deliver LBW infants compared to multigravida. Mothers who were below the age of 20 years were almost twice more likely to have LBW infants similarly to those who had no education or had only primary education. Mothers who had Hb levels of < 11 g/dl were 2.56 times more likely to give birth to LBW infants while those who did not attend any ANC clinic

and those who reported to have had a previous LBW delivery were 4.03 and 2.74 times respectively more likely to deliver LBW infants. All these predictors were significant ($p < 0.05$).

There were no differences between mothers with LBW infants and those with normal weight infants in terms of their MUAC measurements, height, age, birth spacing, and trimester at 1st ANC clinic and number of ANC clinic visits. This implies that all mothers had similar characteristics during the study period. However, mothers were statistically different in terms of their delivery weights. Mothers who were heavier were more likely to give birth to heavier babies. This indicates that delivery weight is also an important factor in predicting an infant's birth weight. Though chronic conditions are highly linked to LBW deliveries, these conditions were rare among mothers in the study. Most mothers did not have these conditions and yet LBW was still a problem.

5.3 Conclusion

From the study results, the following conclusions were arrived at based on the study objectives and hypotheses:

- i). Low birth weight was observed at the hospital and the rate was 17.3% which is higher compared to 10% LBW rate in Kenya. An infant's birth weight was also found to be significantly ($p < 0.05$) associated with its birth length ($r^2 = 0.40$, $F = 129.33$, $p = 0.000$).
- ii). All maternal anthropometric measurements that were considered in this study were significantly ($p < 0.05$) associated with an infant's birth weight and they explained up to 20% of the change in the infant's birth weight after controlling for age, income, education, HIV status and birth spacing ($r^2 = 0.200$, $F = 3.337$, $p = 0.000$). Maternal delivery weight, however, was found to be the most sensitive anthropometric measurement associated with both the infant's birth weight and length as it had the highest contribution in the regression models. Infants who were born to mothers with delivery weights of < 50 Kg were lighter compared to those who were born to mothers with delivery weights of > 50 Kg and these differences were statistically significant.
- iii). All the socio-demographic factors under study were found to be significantly ($p < 0.05$) associated with an infant's birth weight at varying degrees using Chi-square analysis apart from maternal income and time when ANC clinic visits were started, however,

logistic regression analysis revealed that the most essential predictors of an infant's birth weight were parity, age of the mother, level of education, number of ANC clinic visits and a mother's history of a LBW delivery in their order of importance. Low birth weight deliveries were higher in first time mothers than in multigravida mothers. Each predictor had its associated odds of delivering a LBW infant.

- iv). Haemoglobin levels of less than 11 g/dl of blood were highly associated with LBW deliveries, however, HIV status was found not to be significantly associated with birth weight. Chronic conditions were not common among mothers at the maternity. Only 6% of the mothers were hypertensive and diabetic. Up to 94% of the mothers were free of these conditions.
- v). Mothers who had LBW infants were lighter in weight and slightly shorter, younger, and with a shorter inter-pregnancy spacing. They also had a slightly lower MUAC measurement and visited ANC clinic later in pregnancy with fewer number of ANC clinic visits. However, only delivery weight differences were statistically significant ($p=0.004$).

5.4 Recommendations

The following are recommendations resulting from the study conclusions:

- i). Low birth weight is of concern at the hospital as high cases of LBW deliveries are still being recorded at the facility.
- ii). Efforts should be directed towards improving an infant's birth weight as a significant relationship exists between the birth weight and length of an infant. Therefore improving birth weight will significantly improve the birth length of an infant hence improved later development.
- iii). Maternal anthropometric measurements especially weight and MUAC measurements in pregnancy should be monitored regularly as they play an important role in determining birth outcomes. The records on maternal delivery weights could act as a guide for appropriate interventions for weight gain in subsequent pregnancies.

- iv). Intervention programs aimed at improving birth outcomes at the hospital should take into consideration the following maternal factors early in pregnancy: parity, age of the mother, level of education, Hb status, number of ANC clinic visits, a mother's history of a LBW delivery, delivery weight and MUAC measurements as they emerged to be good predictors of an infant's birth weight.

5.5 Suggestions for further research

- i). A similar study should be carried out in other hospitals to determine the magnitude of the problem of LBW deliveries and the associated factors.
- ii). It may also be important to determine reasons for poor adherences to the ANC policy.
- iii). Further research should also focus on birth length of an infant and later development.

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APPENDIX 1: CONSENT FORM FOR THE MOTHERS

It is my pleasure to notify you that you have been identified to participate in this study on **“Relationship between Maternal Anthropometry, Socio-demographic and Infant’s anthropometry at birth”**. The study aims at investigating the association between maternal anthropometric measurements, socio-demographic factors and an infant’s anthropometry at birth. The results of the study will be used in the decision making of determining other interventions that need to be put in place to improve on pregnancy outcomes at the hospital. Your responses will be treated as confidential as possible and for research purposes only.

You are therefore requested to append your signature after your name as a sign of acceptance to participate in the study.

THANK YOU

Mother’s name.....

Signature.....

Date.....

APPENDIX 3: QUESTIONNAIRE TO THE MOTHERS

PART A: MATERNAL ANTHROPOMETRY

Anthropometry	Measurement
Weight at delivery	Kgs
MUAC	cms
Height	cms

PART B: INFANT'S ANTHROPOMETRY

Anthropometry	Measurement
Birth weight	g
Length at birth	cms

Sex of the infant: 1. Male []

2. Female []

(Tick appropriately)

Date of delivery ___/___/___

PART C: MATERNAL SOCIO-DEMOGRAPHIC DATA

1. How old are you?
2. Date of birth ___ ___ / ___ ___ / ___ ___
3. Marital status: 01. Married [] 02. Single [] 03. Widow [] 04. Other []
4. Place of residence 01. Within Nakuru [] 02. Outside Nakuru []
5. Is the mother a referral case? 01. Yes [] 02. No []
6. Do you have children? 01. Yes [] 02. No []
7. If yes above, how many children do you have?
- Girls Birth weight (s) _____
- Boys Birth weight (s) _____

8. When did you have your last birth?

9. At what stage/age of this pregnancy did you start the antenatal clinic?
 I Trimester (0-3 months) []
 II Trimester (3-6 months) []
 III Trimester (6-9 months) []

10. How many times did you visit the antenatal care clinic during pregnancy:
 01. Once [] 02. Twice [] 03. Three times [] 04. Four times []
 05. None []

11. In your own opinion, when should one start the antenatal clinic?

12. How many times should one visit clinic during pregnancy?

13. Were you given any supplements? 01. Yes [] 02. No []

14. If yes above, did you take the supplements? 01. Yes 02. No []

15. Size of household (family size)

16. Level of education: 01.Primary [] 02.Secondary [] 03.College []
04.None [] 05. Other []

17. Mother's occupation:

01 House wife [] 02 Employed [] 03 Casual work in the field 04 Farming []
05. Other (specify).....

18. Spouse occupation: 01. Employed [] 02. Casual work [] 03. Farming []
04. Other (specify).....

15. Mother's monthly income: 01 < Ksh. 5000 []
02 Between Ksh. 5000 – 10000 []
03 Between Ksh. 10000 – 15000 []
04 Ksh. 15000 and above []

19. Monthly income of spause: 01. < Ksh. 5000 []
02. Between Ksh. 5000 – 10000 []
03. Between Ksh. 10000 – 15000 []
04. Ksh. 15000 and above []

20. What is the birth spacing between your last delivery and this one?

01. < 12months []
02. 12 months []
03. 12-24 months []
04. 24 months + []

21. In your own understanding, what is a normal birth weight for an infant?

22. How do you consider the weight of your infant?

01. Normal [] 02. Low birth weight [] 03. Don't know []

APPENDIX 4: WHO GROWTH STANDARDS FOR LENGTH FOR GIRLS

SIMPLIFIED FIELD TABLES
Length-for-age
GIRLS Birth to 13 weeks (percentiles)

Weeks	3rd	15th	Median	85th	97th
0	45.6	47.2	49.1	51.1	52.7
1	46.8	48.4	50.3	52.3	53.9
2	47.9	49.5	51.5	53.5	55.1
3	48.8	50.5	52.5	54.5	56.1
4	49.7	51.4	53.4	55.4	57.0
5	50.5	52.2	54.2	56.3	57.9
6	51.3	53.0	55.1	57.1	58.8
7	52.1	53.8	55.8	57.9	59.6
8	52.8	54.5	56.6	58.7	60.4
9	53.4	55.2	57.3	59.4	61.1
10	54.1	55.8	57.9	60.1	61.8
11	54.7	56.4	58.6	60.7	62.5
12	55.3	57.0	59.2	61.4	63.1
13	55.8	57.6	59.8	62.0	63.7

WHO Child Growth Standards

APPENDIX 5: WHO GROWTH STANDARDS FOR LENGTH FOR BOYS

SIMPLIFIED FIELD TABLES
Length-for-age
BOYS Birth to 13 weeks (percentiles)

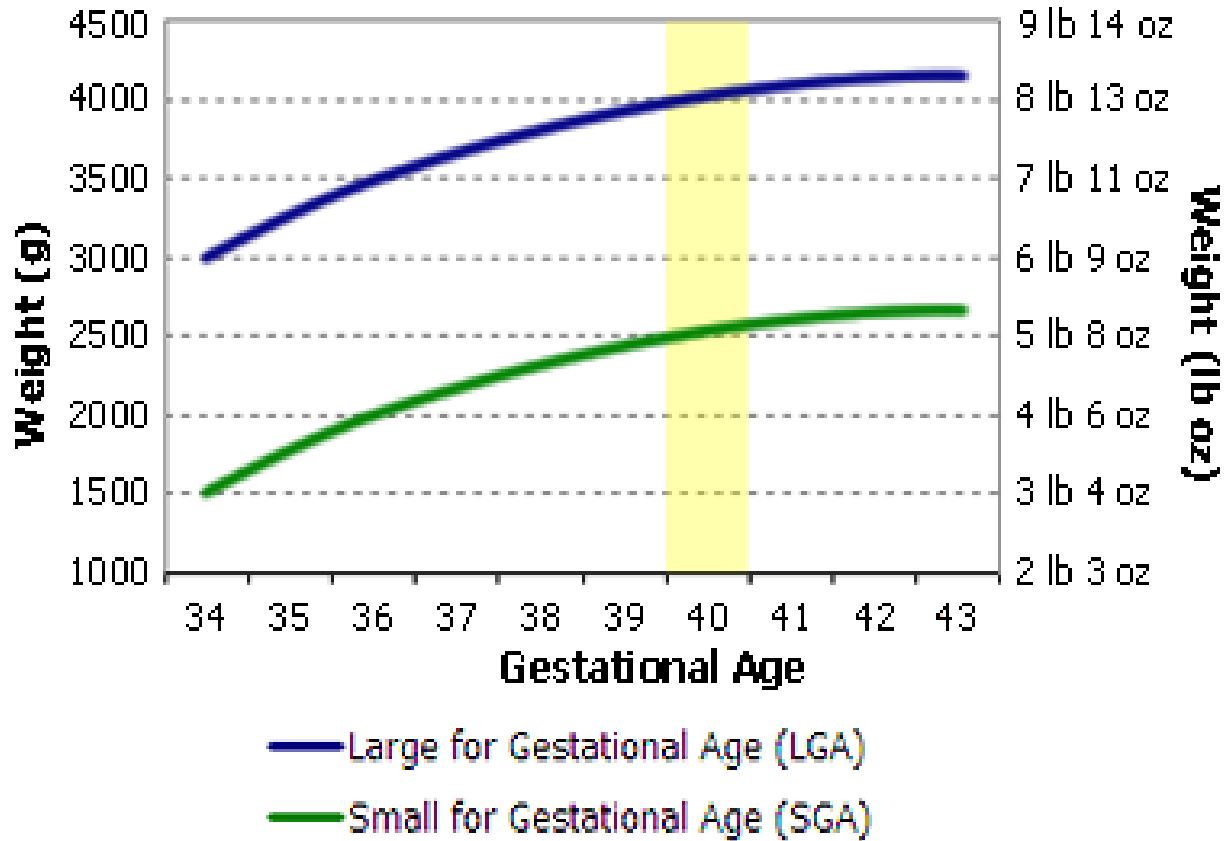
Weeks	3rd	15th	Median	85th	97th
0	46.3	47.9	49.9	51.8	53.4
1	47.5	49.1	51.1	53.1	54.7
2	48.8	50.4	52.3	54.3	55.9
3	49.8	51.4	53.4	55.4	57.0
4	50.7	52.4	54.4	56.4	58.0
5	51.7	53.3	55.3	57.4	59.0
6	52.5	54.2	56.2	58.3	59.9
7	53.4	55.0	57.1	59.1	60.8
8	54.1	55.8	57.9	60.0	61.6
9	54.9	56.6	58.7	60.7	62.4
10	55.6	57.3	59.4	61.5	63.2
11	56.3	58.0	60.1	62.2	63.9
12	56.9	58.7	60.8	62.9	64.6
13	57.6	59.3	61.4	63.5	65.2

WHO Child Growth Standards

APPENDIX 6: NAKURU MAP



APPENDIX 7: BIRTH WEIGHT AND GESTATION AGE



SOURCE: Centre for Disease Control and Development (CDC) Growth Reference Standards

APPENDIX 8: RESEARCH PERMIT

CONDITIONS

1. You must report to the District Commissioner and the District Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed with-out prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2)/four(4) bound copies of your final report for Kenyans and non-Kenyans respectively.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice



REPUBLIC OF KENYA

RESEARCH CLEARANCE PERMIT

GPK6055(3m)10/2009

(CONDITIONS— see back page)

PAGE 2

THIS IS TO CERTIFY THAT:

Prof./Dr./Mr./Mrs./Miss JUDITH ANDAYE
MUTALA

of (Address) EGERTON UNIVERSITY
BOX 536- 20115 NJORO

has been permitted to conduct research in.....

.....**Location,**
NAKURU **District,**
RIFTVALLEY **Province,**

on the topic "Relationship between
maternal anthropometry, socio-
demographic factors and infant's
anthropometry at birth: The case of
the Provincial General Hospital
Nakuru, Kenya" **31ST DECEMBER, 10**
for a period ending.....**20**.....

PAGE 3

Research Permit No. NCST/RRI/12/1/MAS/27/4
Date of issue 12.3.2010
Fee received KSHS.1000



Judith Andaye
Applicant's
Signature

[Signature]
Secretary
National Council for
Science and Technology