PREDICTORS OF BIRTH WEIGHT AMONG

HEALTHY WOMEN

IN LESOTHO

by

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DEFINITION OF TERMS

Low birth weight (LBW): birth weight <2500 grams.

Season: climatic characteristics of Lesotho, divided into four distinct seasons, namely the hungry (growing) season, preharvest, harvest season, and post harvest season.

First and Third Trimester Exposure to Hungry Season: determined by number of weeks within a trimester that coincide with the hungry season and is estimated from the infants' birth date.

Parity: number of children previously borne (the age of the mother may be a factor).

Last Pregnancy Weight: attained pregnancy weight at last antenatal clinic visit.

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INTRODUCTION

Research Problem

In Lesotho low birth weight (LBW = birth weight < 2,500 g) is of public health concern due to its high prevalence and negative health consequences. In a prospective study in two rural Lesotho communities (n=1071) in 1982, the incidence of LBW was found to be 10.3% (de Onis et al, 1998). In 1987, the health monitoring system reported the rate of LBW at 10% (de Onis et al, 1998). This seemed to have declined somewhat by .3%; however, the current estimate for LBW is 11% or more (www.unicef.org, 2001b). Therefore, the incidence of low birth weight in Lesotho is high a figure above the UNICEF cutoff level of 10% incidence rate (www.unicef.org, 2001b). Globally, 17 million infants are born with LBW, representing about 16% of all newborns in developing countries. About 15% of infants in middle Africa and 11% in western Africa are born LBW at term (Pojda & Kelly, 2000).

The significance of the problem lies in the fact that infants who are born with a low birth weight, experience higher mortality and morbidity. Low birth weight infants are more susceptible to all causes of morbidity and mortality throughout their first year of life and beyond as compared with infants born with healthy birth weights. Ideal birth weight ranges from 3500 to 4500 g (de Onis et al, 1998 and Ashworth, 1998). In

Lesotho, infant mortality rate is estimated at 93 per 1,000 live births whilst the mortality rate of infants less than five years of age is 134 per 1,000 live births (www.unicef.org, 2001a). Birth weight is a proxy indicator for maternal nutritional status as well because infant size at birth is modeled by maternal nutritional status and onset of stunting (Neumann & Harrison, 1994).

According to the Situation Analysis (1994), the 1993 Rapid Evaluation of Mother (REM) of the Maternal and Child Health / Family Planning services reported maternal mortality ratio 269/100,000 institutional births. In Lesotho, the underlying causes often cited for this high maternal mortality rate, are natural abortion or miscarriage, hypertension and pelvic inflammatory disease (Situation Analysis of Women and Children, 1994). A survey in 1996 revealed a high prevalence of chronic energy deficiency (BMI < 18.5) in women aged 15-19 years (Women's Health Survey, 1996). The rate was reported to be higher in the rural areas (18.4%) than in the urban areas (9.4%). In the 20-24 age categories, chronic energy deficiency (CED) was 11.9%, whilst in older women (45-50 years) CED ranged from 2% to 6.9%. The results of this study clearly indicate that women may enter pregnancy with sub-optimal prepregnant nutritional status.

Chronic energy deficiency in women believed to be associated with the interplay of many environmental factors. Food insecurity brought by unfavorable climatic conditions on women of childbearing age may contribute to the nutritional insecurity experienced by women of childbearing age.

Communities in Lesotho, like most African countries, depend on subsistence farming for food production, and the seasonal changes bring about a decline in crop production and ultimately food availability. Lesotho's temperate climate has four distinct seasons, spring (post harvest), summer (hungry season), autumn (preharvest) and winter (harvest) (APPENDIX D). The harvest season in Lesotho lasts from May to July. This season is characterized by harvesting of field crops: maize and sorghum. The post harvest season is from August to October and is characterized by the sowing of field crops and by rainfall to facilitate seed germination. The post harvest season has plentiful food stocks making it a more nutritionally favorable season. The hungry season spans from November to December, characterized by maturing of field crops, fruits and vegetables. By this time the food stocks from the previous harvest have declined and new crops are not ready for harvest. Therefore the hungry season is associated with poor nutritional outcomes. The pre-harvest, season covering the months of February to April, is a time for maturation of field crops. However, though immature, the crop is harvested to buffer food household shortages. In addition, fruits and vegetables (including indigenous edible plants) are in abundance. The rainy season in Lesotho lasts from October to April. This season is often characterized by unfavorable climatic conditions such as late rains that are likely to result in crop failure.

The overall hypothesis for this study is that seasonal changes predict birth weight by affecting maternal nutritional status as measured by rate of weight gain. The importance of this study lies in the fact that findings of this research will provide evidence to support strengthening the antenatal nutrition component within the Maternal and Child Health or Family Planning program at the community level.

Moreover, there is a need for baseline data that explores the relationship between birth weight and nutritional status of the mother within the context of agro-climatic conditions. Furthermore, this research will provide valuable information on the seasonal birth weight trends in a temperate climate environment dependent on subsistence farming for food production. Seasonal variations can decrease food availability and contribute to household food insecurity. It has been long established in the research literature (Stein et al, 1975a, 1975b; 1995; Smith et al, 1942; Huxley et al, 2000) that women who enter their third trimester (at the critical period of rapid fetal and maternal tissue growth) during pre-harvest or times of food shortages are likely to deliver infants who have lower birth weight than those who enter their third trimester during periods of plentiful food stocks. Therefore, this study will provide knowledge of the effect of a temperate climate (such as that experienced in Lesotho) on birth weight.

Objectives and Hypotheses

The overall objective of this study is elucidates the relationship between birth weight and season by retrospectively examining antenatal clinic records.

1. Objective: to determine the relationship between birth weight, maternal age, parity, last pregnancy weight, rate of weight gain, and number of weeks exposed to hungry season in first and third trimester.

   Null Hypothesis: There is no relationship between birth weight, maternal parity, age, first pregnancy weight in third trimester and last pregnancy weight, rate of weight gain in third trimester, infants sex and the number of weeks exposed to hungry season in first and third trimester.

2. Objective: to examine mean difference in birth weight and rate of weight gain between first and trimesters not exposed, exposed by 1-4 weeks and 5-12 weeks to the hungry season?

   Null Hypothesis: There is no difference in mean birth weight and mean rate of weight gain between first and trimesters not exposed, exposed by 1-4 weeks and 5-12 weeks to the hungry season.

3. Objective: to compare the differences in mean birth weight by month of birth.

   Null Hypothesis: there is no difference in mean birth weight by month of birth.

4. Objective: to determine the best predictor of birth weight among the independent variables (predictors) that has been examined in this study for first trimester exposure and third trimester exposure to hungry season.

   Null Hypothesis: there is no association between birth weight and the independent variables (predictors) that have been examined in this study for first trimester exposure and third trimester exposure to hungry season.

National health programs and policies are based on review and analysis of existing information obtained through a systematic collection of data before, during and after program implementation. Seasonal factors should be considered in the review of such data in identifying relationships between outcome indicators of nutrition and health status of target populations. Most importantly, the retrospective methodology in this study offers a rapid source of valuable information to assess relationships and trends of indicators for effective program planning and implementation.

Format of Thesis

This thesis will contain five chapters: the introduction, literature review, methodology, one journal article and a conclusion. All chapters will be formatted according to the recommended manuscript preparation style required by the International Journal of Food Science and Nutrition.

CHAPTER II

REVIEW OF THE LITERATURE

Low Birth Weight in Lesotho

The incidence of low birth weight seems to be on the increase in Lesotho, and is of public health concern due to its associated negative health consequences (www.unicef.org, 2001b). In a review of global trends on intrauterine growth retardation, de Onis et al (1998) reported that in 1982, 2 rural communities in Lesotho (n=1071) had LBW incidence of 10.3%. In 1987 the health monitoring system in Lesotho reported LBW incidence at 10%. The current estimate for LBW in Lesotho is 11% or more (www.unicef.org, 2001b). According to de Onis et al (1998) WHO/UNICEF considers an incidence rate of greater than15% LBW and 20% IUGR at term to be a major public health problem. However, UNICEF (de Onis et al, 1998) recommends a reduction of LBW to less than 10%. Infants who are born with a low birth weight, experience higher mortality and morbidity due to all causes throughout their first year of life and beyond compared to infants born with healthy birth weights ranging between 3500 and 4500 g (de Onis, 1998; Ashworth, 1985). In Lesotho infant mortality rate is estimated at 93 per 1,000 live births whilst children less than 5 years of age show a mortality rate of 134 per 1,000 live births ((www.unicef.org, 2001b). Ashworth (1985) reported that birth weights of 3500-4500 g were associated with the lowest risk of pneumonia and diarrhea. Both diarrhea and pneumonia were highest in infants born at < 2500 g. In Lesotho, acute respiratory diseases and diarrhea are the major causes of death in children under the age of five (Situation Analysis, 1994).

According to the UNICEF Nutrition Policy Paper on LBW (Pojda & Kelly, 2000) it is estimated that globally 17 million infants are born every year with LBW, representing about 16% of all new born in developing countries. Almost 80% of LBW infants are found in Asia, mainly south-central Asia. Bangladesh has the highest incidence rate in the world. Africa also experiences a high proportion of infants born with LBW, representing 15% of LBW western and 11% in middle Africa. In contrast the Caribbean and Latin America have a lower incidence (7%) of LBW.

The incidence of LBW in Lesotho is associated with the interplay of many factors such as anemia, preconception nutritional status, short maternal stature and food insecurity. Of these, factors food insecurity brought by unfavorable climatic conditions on women of childbearing age makes them susceptible to delivering low birth weight babies and has not been studied extensively in Lesotho. Studies in Africa specifically tropical Africa reported significantly high incidences of low birth weight as a result of drought and seasonal food shortages (Banje, 1983; Kinabo, 1993; Prentice, 1981 & 1987; Lawrence, 1987; Wendle-Ritcher, 1997; Aitkin, 1990).

According to Vandenbosche and Kirchner (1998), as far back as 1919, underweight infants were categorized as premature with a birth weight of less 2500 g. In the 1961 the World Health Organization classified these infants as LBW. The current World Health Organization criteria for low birth weight is infants born at term with a birth weight below or at 2500 g while prematurity is specified as infants born before or at the 37th week of pregnancy.

The weight of the infant at birth is a reflection of fetal growth and development. Birth weight is an outcome of pregnancy and is related to short and long-term neonatal/ postnatal health consequences (WHO, 1995a). Birth weight is both a reflective indicator of fetal nutritional status and a prospective indicator of postnatal health and survival.

Low Birth Weight is a Public Health Problem

Infants and Children

Although LBW is not a disease state, it is a risk factor for malnutrition in children under five years of age and a reflection of poor maternal nutritional status. Lesotho's food and nutrition situation is characterized by a high degree of food insecurity, aggravated by periodic occurrences of drought and serious soil erosion (Poverty Assessment and Livelihoods, 1999; Climate Change, 1997). This is particularly important because the environment has an impact on pregnancy outcome and chances of survival.

In Lesotho, chronic under nutrition is defined as height for age and weight for age below 2SD of reference NCHS growth standards and is indicative of long-term nutritional deprivation. The 1992 national nutrition survey in Lesotho showed that 33% of children under the age of five years had stunted growth, with the highest prevalence in the mountainous areas. During the same period, 2.4% of the children of the same age group were reported to be acutely malnourished and showed wasting which was related to the effects of the drought situation from 1990 to 1993 (Lesotho National Nutrition Plan of Action, 1997).

Currently the incidence of malnutrition seems to be on the increase as shown in the Lesotho Multi Cluster Survey (1997). Chronic malnutrition indicated by short stature is at 44% while underweight indicated by low weight for age is 16% and acute malnutrition indicated by marasmus and kwashiorkor is 5%. Lesotho's unreliable and erratic climatic conditions impinge on nutritional security through its effects on food availability at the household level.

The Nutrition Collaborative Research Support Program in Kenya, Mexico and Egypt (Neumann & Harrison, 1994) observed that there is a relationship between maternal nutrition, infant size and stunting. In this study the onset and evolution of stunting in infants (0 to 6months) and children under the age of five were strongly determined by maternal weight, fat gain during pregnancy and lactation. Moreover, Neumann & Harrison (1994) found that for length attained at 0-6 months, birth weight was the strongest predictor followed by weight, fat gain during pregnancy and lactation.

Women of Child Bearing Age

Food availability is critical during pregnancy for sustaining the health of the mother and for supporting fetal growth (IOM, 1990). Birth weight is conditioned by the health and nutritional status of the mother before and during pregnancy. However, given the vulnerability of Lesotho to unfavorable climatic conditions and food insecurity; women of childbearing age are equally at risk of nutritional insecurity. Birth weight is an indirect indicator of maternal nutritional status and socioeconomic status of communities in which the women live.

The effects of nutritional insecurity as a result of food shortages is more evident among adolescent girls as indicated by the Women's Health Survey (1995) which was conducted in preparation of the Safe Motherhood Initiative. This study showed a high incidence of chronic energy deficiency (CED: BMI<18.5) in young women (15-19 years old) compared to older women (45-50). The rate was reported to be higher in rural (18.4%) than in urban (9.4%) areas. In the 20-24-age category CED was 11.9%, whilst in older women 45-50 CED ranged from 2% to 6.9%. These results show that CED in children is also a major problem in women of childbearing age. These results suggest that low prepregnant weights among very young mothers may predispose them to premature labor and low birth weight infants.

Scholl & Hedigar (1994) reported that although growing teenage mothers less than 19 years had larger gestational weight gains, they had infant birth weights that were significantly lower than those of nongrowing gravidas. The study concluded that young teenage mothers are at higher risk of reduced infant birth weights as a result of competing nutritional needs for adolescent growth at the expense of fetal growth. Naeye, 1979; Stanley et al, 1982) reported that in women of child bearing age sub-optimal prepregnant weight was associated with perinatal mortality and low birth weights. Kusin et al (1994) in East Java, observed that, there was a four fold risk for delivering LBW infants at prepregnant BMI <16 and a two old risk at prepregnant BMI <17. The WHO Collaborative (1995) study found that prepregnant BMI was a predictor of birth weight. These findings were consistent with those of Neumann & Harrison (1994).

Long-term Consequences

More recently epidemiological studies (Barker, 1997) indicate that LBW is associated with long-term consequences by increasing susceptibility to coronary heart disease (CHD) and non-insulin dependent diabetes (NIDDM). Dr. Barker's fetal origins hypothesis maintains that undernutrition predisposes infants and fetuses to permanent changes in body structure and metabolism. The hypothesis further speculates that first trimester undernutrition resulting in a stunted growth increases susceptibility to hemorrhagic stroke. In addition, fetal undernutrition towards the end of pregnancy may result in infants prone to CHD and an increased risk of insulin resistance. Though the hypothesis is not well received in research circles it may have significant implications for developing countries as they experience a high incidence of LBW and IUGR.

Seasonal Situation in Lesotho

Communities in Lesotho, like most African countries, depend on subsistence farming and the seasonal changes that have an effect on crop production and ultimately food availability. Lesotho's temperate climate has four distinct seasons, spring (post harvest), summer (hungry season), autumn (preharvest) and winter (harvest) (APPENDIX D). The harvest season in Lesotho spans from May to July, this season is characterized by harvesting of field crops: maize and sorghum. The post harvest season is from August to October and is characterized by sowing of field and rainfall to facilitate seed germination. The post harvest season has plentiful food stocks making it a more nutritionally favorable season.

The hungry season spans from November to December and is characterized by maturing of field crops, fruits and vegetables. By this time, the food stocks from the previous harvest have declined. Therefore the hungry season is associated with poor nutritional outcomes. The pre-harvest season covers the months of February to April a time for maturing of field crops. However, immature grain crops are harvested to buffer food household shortages. In addition fruits and vegetables (including indigenous edible plants) are in abundance. The rainy season in Lesotho spans from October to April. Unfavorable rains, September-frost, often characterize this season and lengthy dry spells, which are climatic conditions that are likely to result in crop failure.

The Mountain districts (90% rural) experience more food shortage due to the short growing season. Generally food shortages can be experienced at any time of the year but are mostly common during the hungry season (November to January). These seasonal variations decrease food availability and contribute to household food insecurity.

It has been long established in the research literature (Stein et al, 1995; Smith et al, 1942; Huxley et al, 2000) that women who enter their third trimester during pre-harvest or times of food shortages are likely to deliver infants who have lower birth weight than those who enter their third trimester during periods plentiful food stocks.

According to Ferro-Luzzi et al (1994) the agricultural potential of a site is determined by seasonal agro climatic conditions that regulate the vegetative cycle, biomass production and labor input required in terms of food or cash crops. Therefore, climate seasonality is an important aspect in the lives of many rural inhabitants since their survival is dependent on food production. 80 to 84% of Lesotho population resides in the rural areas and subsistence farming is the mode of existence and is largely dependent on agro seasonal conditions. Lesotho, falls under countries categorized as having a low seasonality index (IACS)[1] (Ferro-Luzzi, 1994). Countries that fall under this category are believed not to be as highly vulnerable to seasonal food declines as tropical countries, which have moderate to high seasonality index. However, in recent years, the inadequate food and nutrition situation in Lesotho has been linked to unfavorable climatic changes. Both pregnant women and their infants are vulnerable to such food insecurity conditions because of the increased nutrient demands posed by physiological changes to support maternal status and the growth of the fetus.

Factors that Affect Birth Weight

Physiological Changes in Pregnancy and Nutritional Deprivation

King (2000) defines pregnancy as a dynamic anabolic state resulting in the development of the placenta, changes in maternal anatomy and physiology that regulate the metabolism of nutrients to support fetal growth and development while maintaining maternal homeostasis. These physiological adjustments include: 1) accretion in new tissue or deposition in maternal stores, 2) redistribution among tissues, and 3) increased turnover or rate of metabolism. These complex nutrient adjustments are controlled by hormonal changes, fetal demands, and maternal nutrient supply.

[1] A low Index Agro-Climatic Seasonality (IACS) index of 0.00 to 0.44 allows a vegetative season of >200days per year. Moderate IACS >0.45, vegetative cycle 120 to 200 days per year. A high IACS of >0.065 with a restricted vegetative period <120 days per year.

The first half of pregnancy is primarily a time of preparation for the demands of rapid growth that occurs later in pregnancy. The last half of gestation accounts for the rapid fetal growth (King, 2000).

However, gestation can be divided into trimesters with each approximately 12 to 13 weeks in length (King, 2000). Normal pregnancy takes approximately 40 weeks as measured by the first day of the Last Normal Menstrual Period (LNMP). However, full term is an interval between 37 weeks to 42 weeks.

During the critical period of organogenesis characterized by hyperplasia, fetal tissue differentiation into three primitive cell layers, the endoderm, mesoderm, and ectoderm, which become specific organs and tissues. This stage requires adequate nutrient reserves and an optimal environment. At this stage (Rush, 1999) major congenital anomalies can occur. Thus women with adequate nutrient reserves are at less risk of congenital anomalies than women with marginal nutritional status.

The remaining months of gestation, known as the fetal growth period are characterized by cellular hypertrophy (Mitchell, 1997). At this time needs are high for both quantity and quality of nutrients. Inadequate dietary intake can contribute to preterm birth and fetal growth restriction. According to Rush (1999), rapid fetal growth (12 fold increase between 14 and 28 weeks) in the second trimester is more likely to be influenced by maternal nutrition. During the third trimester, fetal growth and placental growth increases and accounts for half of the maternal weight gain. Generally the fetus gains more than two thirds of its full term birth weight during the last trimester. On average a healthy term infant is about 51 cm (20 in) in length and weighs 3.5 kg (7.5 lb) (Mitchell, 1997; Ashworth, 1998).

Nutrient Requirements of Pregnancy and the Effect of Undernutrition

Pregnancy requires large amounts of nutrients required for growth, and metabolism of maternal and fetal tissues and for nutrient storage in the fetus. The additional need for nutrients is met by maternal food intake and the metabolic adjustments that accompany pregnancy. Extra energy (300 kcal) is needed in the second and third trimester due to increased basal metabolism, protein deposition, fat deposition and increased carbohydrate to spare protein. Energy intakes are major determinants of weight gain.

It is well recognized that maternal nutritional deprivation (Stein & Susser, 1975a; 1975b; Winkvist et al, 1998; Kusin et al, 1994) and chronic energy deficiency has a profound effect on pregnancy. The researchers have established that nutritional deprivation shifts priorities between fetal and maternal nutrient requirements depending on preconceptual nutritional status. These metabolic adjustments favor maternal status and survival at the expense of fetal growth and placental development. However, in well-nourished women there is an even distribution of nutrients to support placental, maternal and fetal tissue accretion to buffer energy deficits (Kusin et al, 1994). Winkvist et al (1998), however, have proposed that nutrient partitioning and utilization is more efficient in malnourished mothers than better nourished demonstrated by a greater weight gain in malnourished women compared to marginally nourished women.

Seasonal Determinants of Low Birth Weight

The cause of low birth weight is multifactorial (Kramer, 1987). Low birth weight (<2500 g) can either result from short gestation and intrauterine growth retardation. Causes range from a complex interplay of seasonal and nonseasonal factors. Variables influenced by season are birth weight, women's nutritional status and gestational weight gain. These variables respond to availability and accessibility of nutritious food, which depends of climatic conditions conducive to food production.

Seasonal Trends in Birth Weight

Earlier studies in Lesotho have not observed seasonal effect on birth weight. The Situation Analysis in Lesotho (1994) reported a steady decline in birth weights between January 1992 and June 1993 from the Queen Elizabeth II Maternity Ward (located in the capital city-Maseru) with mean birth weight over 2500 g. The summer months November, December and January saw slightly higher birth weights (3000 g). In a prospective study (n=832) to determine the distribution of birth weight in a remote mountain hospital of Lesotho, Tjon-a-Ten et al (1981) did not find any seasonal pattern in birth weights, but reported a mean birth weight of 3068 g and a 7.5% incidence of low birth weight. The results of this study may have been obscured by the high influx of food donations in respond to the drought at that the time of the study.

However, seasonal inferences have been made as a plausible explanation for trends in high rates of chronic energy malnutrition among women and children in Lesotho. The Lesotho climate change report (1997) indicated that Lesotho is highly susceptible to climate changes that influence food insecurity among rural inhabitants.

Seasonal factors have been observed in tropical African countries where seasonality is highly pronounced due to the wet and dry season. During the dry season (post harvest/harvest) food stocks are high and there is reduced labor on women hence it is associated with favorable pregnancy outcomes. The wet season is characterized by preharvest food shortages and also known as the hungry season. The wet season is a time of heavy rainfall with high incidence of parasites and intense peak agricultural labor demand on women. This depressed health status has been associated with poor pregnancy outcomes in Tanzania. Banje (1983) in his assessment of the seasonal distribution of birth weight, observed an overall mean birth weight of 3009 g. The study showed a seasonal curve revealing lower birth weight 2972 g in March (wet season) and higher birth weights 3035 g in the dry season. Kinabo (1993) made similar observations where mean birth weights varied with season. The lowest incidence (9%) of LBW was reported during the dry season while the highest incidence (14%) of low birth weight was reported during the rainy season.

Amongst the Mendi of Sierra Leon, Aitkin (1990) reported that rice cultivation was a determining factor of LBW. The lowest birth weights were associated with the times of planting and harvesting whiles the highest birth weights were associated with the completion of the harvest and during the labor lull before the harvest. Wendle-Richer (1997) made similar observations where mean lower birth weights coincided with preharvest food shortages and increased maternal labor demand as well as decreased food intake.

In Gambia, Prentice et al (1987) observed that maternal dietary supplementation was associated with a higher incidence (23.7%) of LBW in the wet season and lower incidence (12.5%) in the dry season. Improvement of weight as a result of supplementation was more significant in the wet season compared to the dry season in which the proportion of LBW was reduced from 23.7% to 7.5% ($p<.002$). Overall, the annual rate of LBW was reduced from 18% to 8%. Clearly, in these studies, the agro climatic conditions had an indirect effect on birth weight most probably through modifying maternal food intake during the critical time of fetal growth.

Seasonal Effects on Women of Child Bearing Age

In communities, which experience seasonal food shortages, women undergo seasonal cycling of body weight changes. In Ethiopia, Ferro-Luzzi et al (1990) reported that rural non-pregnant women showed a seasonal disturbance in BMI in that women with BMI <17.5 weighing 40kg lost less than .5 kg or .5% of their weight during the wet season. Women with BMI > 20.5 and a mean body weight of 52 kg, lost 1.7 kg or 3% of their weight in the wet season. Weight loss was attributable to depletion of domestic food availability and was aggravated by concomitant increases in energy output. In the same study, the researchers demonstrated a seasonal trend in basal metabolic rate but not total energy expenditure. Minimal values (27 kcal/kg) were observed during the preharvest season and higher values (31 kcal/kg) during the post harvest season. The lack of seasonal effect on total energy expenditure was explained by the habitual reduction in the level of physical activity. Similarly, Schultink et al (1990) found that Benise women experienced weight loss imposed by season.

In India where seasonality, low birth weight and maternal labor are high, Durnin et al (1990) did not observe any seasonal nutritional disturbances among women of child bearing age contrary to Ferro-Luzzi et al (1990) and Schulink et al (1990) findings. It is apparent that women of childbearing age face seasonal nutritional insecurity. Kigutha et al (1995) in Kenya observed large interseasonal weight losses of

5.6 kg at the rate of 1.1 kg/month among lactating women, more so during the preharvest season.

Gestational Weight Gain and Birth Weight

During pregnancy, maternal caloric intake and nutritional stores (mostly fat) are the sole source for fetal energy requirements. Weight gain during pregnancy would be expected to affect intrauterine growth (Kramer, 1987). According to Kramer (1987), the components of weight gain are fat deposition, growth of the breast and uterine tissue, increased plasma volume, and growth of the fetus, placenta, as well as an increased amniotic fluid. Fat deposition, tissue growth and increased plasma volume contribute to fetal energy reserves. For these reasons, gestational weight gain is a proxy for current and past nutritional status (WHO, 1995a; 1995b).

Gestational weight gain is vital for maintaining maternal health while promoting fetal growth and serves as an indicator for both maternal and fetal outcomes. The WHO Expert Committee (1995a) reported that weight gains of 1.5 kg per month predict ideal birth weights in developing countries, while pregnancy weight gains at 2.0 kg per month in developing predict the same ideal birth weights. In order to achieve an ideal birth weight of 3500 g at term a weight gain of 1.5 kg/month is recommended irrespective of gestation age and prepregnancy BMI. Low prepregnancy weight and inadequate weight attained at the 5^{th}, 7^{th}, and 9^{th} months of gestation are the best predictors of birth weight (WHO, 1995b).

Nutritional status before and during pregnancy is highly associated with pregnancy outcomes and maternal health. Nutrition is directly related to food availability. Food availability is associated with environmental factors such as climate.

In rural Africa, adults undergo annual seasonal body weight changes and women of childbearing age are no exception.

Effects of nutritional deprivation in pregnancy and its concomitant association with poor pregnancy outcomes have long been documented in literature dating as far back as the Second World War, which brought about a decline in food stocks and significant low food rations. During the Dutch (The Hague and Rotterdam), famine study, (Smith et al, 1947) caloric deprivation during the third trimester was shown to be an important determinant of birth weight. In this study, infants born before the hunger months had adequate birth weights. But those born during hunger months were significantly below the expected weight and length at birth. Huxley and his associates (2000), in their review of a study done in 1942 and 1944, evaluated the effect of dietary supplementation (extra rations of fruit, dairy products, and cod liver tablets) during wartime and observed that birth weights of infants born in the 1942 were 174.7 g heavier than infants born in 1944. In 1942 pregnant mothers received extra food rations during the war. The mean birth weight in 1942 was 3325 g (± 3408) compared with the mean birth weight 3148 g (± 3236) in 1944. Moreover, the incidence of LBW in 1942 was 2.7% compared to 13.7% in 1944.

Reanalysis of the Dutch famine cohort study (Stein et al, 1995) revealed that women exposed to famine in the third trimester gained less weight (0.77 kg ± 2.82 kg, $p<0.001$) as compared to those unexposed in their third trimester (3.15 kg ± 3.09 kg). However, women exposed in the first trimester and delivered after the liberation had highest weight gains (5.51 kg ± 3.35 kg, $p<0.001$). The mean rate of weight gain for women exposed in their third trimester was 0.05 kg/week (± 0.027 kg/week, $p<0.001$)

compared to those exposed in the first trimester (0.46 kg/week ± 0.26 kg/week, $p<0.001$). Similarly low or moderate weight gain in the third trimester (range: -0.5 to + 0.5 kg/week) was significantly associated with infant's birth weights, length and ponderal index ($p<0.001$). As a result of the effect of maternal nutritional deprivation on gestational weight gain, infants exposed in the first trimester were 148.5 g heavier ($p<0.001$) and infants exposed in the third trimester were 87.1 g lighter ($p=0.06$) than infants not exposed infants exposed.

Several studies have shown an association between gestational weight gain and low birth weight in response the seasonal stress of inadequate food stocks. In rural Africa as is the case in Kaneba-Gambia, adults and pregnant women alike undergo seasonal body weight changes. Prentice et al (1981) examined energy intake in relation to successful reproduction and lactation performance in Gambia. They reported stable energy intake at 1483 kcal /day in the dry season whilst there was a reduction to 1302 kcal/ day in the wet season amongst pregnant women. The study also indicated that all pregnant women had inadequate weight gains at 0.4 kg/ month during the wet season and 1.4 kg/month during the dry season. The researchers concluded that there was mobilization of fat stores during the nutritionally debilitating wet season. The wet season had the lowest birth weights (2.78 ± 0.11 kg) than the dry season where the birth weights were higher (2.94 ± 0.07 kg). In Kenya Neumann & Harrison (1994) found that on average pregnant women gained 6.2 ± 3.4 kg in the second and third trimester combined. In this group of women food intake was between 1700 to 1800 kcal/ day during first and second trimester and it reduced to 1400 kcal/ day during the third trimester.

In another study conducted in Gambia, Lawrence et al (1987), women were provided with supplementation because seasonal cycling and its related negative health consequences were common among Gambian women. The researchers observed seasonal changes in the rate of weight gain between supplemented and unsupplemented women. Supplemented women gained more weight (7.9 kg ± 0.06) than the unsupplemented women (6.3 kg ± 1.0) by week 35. Unsupplemented women whose second and third trimester coincided with the rainy season gained 11.2 kg before the rains and 2.3 kg during the rainy season. Unsupplemented women whose second and third trim gained and 11.2 kg in the period before the rains. Overall, fat net gain in body fat was 3 kg while fat loss was 4.7 kg irrespective of time of year.

In another Gambia study, Prentice et al (1987) compared 192 supplemented women who received an energy prenatal supplementation with data from 182 women from 4 baseline years. These researchers reported that pre-supplementation pregnancy weight gains of 12.5 kg or 1.4 kg per month were in compliance with international standards during the dry season. During the wet season birth weights declined to 2808 ± 41 g accompanied by inadequate maternal weight gains (<500 g/month). Furthermore, supplementation was more effective during the wet season but not in the dry season. Prentice et al (1987) did not find a significant effect of supplementation on maternal anthropometry.

Strauss et al (1999) investigated the relationship of maternal weight gain in individual trimesters to risk of IUGR (defined as <2500 g in term infants) in two cohorts of women enrolled in the National Collaborative Perinatal Program (NCPP) and Child Development Study (CHDS) in the USA. The study revealed that low pregnancy weight gains in the second and third trimester increased the relative risk of IUGR significantly (1.8 in the NCPP and 2.6 in the CHDS during the second trimester, 1.7 in the NCPP and 2.5 in the CHDS during the third trimester). The researchers concluded that the higher the weight gains and fat gain per month the lower the risk of LBW and IUGR.

Non-Seasonal Determinants of Birth Weight

The non-seasonal determinants of birth weight are factors that do not respond to seasonal food availability. These include maternal parity, age, sex of the infant as well as maternal health conditions (pre-eclampsia, diabetes, and anemia) and socioeconomic status. Maternal parity, age and sex of the infant will be discussed in this review.

Maternal Age and Parity

According to Kramer (1987) pregnancy outcomes, including birth weight and gestational age, are generally less favorable in younger adolescent women and women over 35 years of age. Adolescents within 1 or 2 years of menarche who have not completed growing are likely to have lower weight for height than older women, and may consume fewer calories and nutrients. Pregnancy outcomes are more favorable for multiparous women than primiparous women who generally younger than multiparae. However grand multiparty, is often believed to constitute risk (Kramer 1987).

A study in Ethiopia by Feleke & Enquoselassie (1999) reported that as parity and age increased so did birth weight. Birth weight of infants increased significantly ($p<0.0001$) with parity. Primiparae had babies with the lowest birth weights (2054 ± 433) and had the highest incidence of low birth weight (11.7%). The incidence of low birth weight was highest amongst the 19 year old age group (13.9%) with mean birth weights of 2904 g ± 432. Ali & Lulseged (1997) compared birth weight of babies of adolescent and non-adolescent women and found that low birth weight was positively influenced by low parity followed by lack of antenatal care and young maternal age. Walraven et al (1997) found that nulliparity was significantly associated with higher incidence of low birth weight in Tanzania. Brabin et al (1998) identified that 40% of primiparae (<17 years) gave birth to low birth weight infants while multiparae had a rate of 28.3%. In this study low birth weight was significantly associated with antenatal care visits. Ali & Lulseged (1997) also found that low parity; lack of antenatal care, and young maternal age had positive contributions to birth weight in descending order of strength. These studies agree that there is appositive relationship between parity and age as ell as predicting birth weight of infants.

Anemia and Birth Weight

Pregnancy is characterized by a 50% increase in maternal blood volume. However the maternal blood volume increases more rapidly than the red blood cell mass leading to hemodilution otherwise known as physiologic anemia (Steer, 2000; Allen, 2000). The resulting increases in plasma volume leads (observed from 6 to 8 weeks) to a decreased blood viscosity vital for potency of utero-placental transfer (Steer, 2000). The rapid change in plasma volume corresponds with increases in fetal and placental growth that occurs in third trimester of pregnancy. In the third trimester (IOM. 1990) the hemoglobin concentration gradually increases to mean of 12.5 g/dL at 36 weeks of gestation. Normally increases hemoglobin concentration during pregnancy follows a U-shaped pattern wherein concentrations at mid pregnancy are low due to an increase in blood volume making it difficult to differentiate between true anemia and that due to hemodilution (IOM, 1990; Rasmussen, 2001). Despite the difference in gestational hemoglobin concentration, the World Health Organization (1968) recommends a uniform criterion for anemia in pregnant women which is a hemoglobin concentration of <10 g/dL.

Anemia defined as hemoglobin concentration of <10 g/dL (WHO, 1968), is a serious health problem worldwide, more so in developing countries. It accounts for increased morbidity and mortality and is associated with poor pregnancy outcomes (IOM, 1990). Anemia during pregnancy is highly prevalent among women both in industrialized and developing countries. However it is estimated that a higher proportion (35% to 75%) of pregnant women are anemic come from developing countries, while 18% to 25% come from industrialized countries. Moreover, the prevalence of anemia is reported to be higher among non-pregnant women (43% in developing countries) than in industrialized countries (12%) (Lindsay, 2000).

In developing countries such Uganda, Kiwanuka et al (1999) reported that pregnant women who register for antenatal clinic for the first time (irrespective of gestational age) as well as those not receiving supplementation have hemoglobin concentration levels indicative of anemia (<10 g/dL). In Johannesburg, South Africa, Lamparelli et al (1988) found low indices of iron status such as serum ferritin and transferrin saturation amongst women at first antenatal booking. Serum ferritin and transferrin saturation are more sensitive indicators of iron deficiency than hemoglobin. This study revealed that 18.9% of women were anemic in their third trimester with 64% having transferrin saturation of <16% and 68% having serum ferritin concentrations below 12 μg/L. Hemoglobin concentration increased with each trimester, 4% of women in their first trimester had hemoglobin concentration less than 11g/dL, 17.4% in the second and 18.9% in the third trimester. This study suggests that iron deficiency is prevalent in the population, which is not reflected by hemoglobin levels below 10 g/dL. Anemia in pregnancy develops towards the later part of gestation even in women who enter pregnancy with adequate iron stores (Lindsay, 2000; Msolla et al, 1997).

Anemia in pregnancy results from a number of factors ranging from diet and infectious diseases (Stoltzfez et al, 1999) such as malaria and parasitic infections. Climatic exposure to pathogens such as malaria is common occurrence in tropical Africa and further compromises the iron status of pregnant women who already consume diet low in iron sources such as animal protein (Stoltzfez et al, 1999; Banje, 1983; Msolla et al, 1997; Kinabo, 1993). So far, Lesotho is free from many climate related diseases common in the tropics because of its high altitude and severe winter.

The 1994 National Micronutrient Survey in Lesotho, revealed the prevalence of anemia at 7.3% (n=15) in pregnant women and 15.1% (n=225) in nonpregnant women. The sample size for pregnant women was far too small to provide any meaningful interpretation of the problem. However, the overall 10% prevalence of anemia in the entire study population indicated mild anemia (<10 g/dL to 12 g/dL) (WHO, Anemia Consultative Group, 1968). The low prevalence is believed to be due to use of cast iron pots in traditional cooking and beer brewing as well as high intake of green leafy vegetables (National Micronutrient Survey, 1994). However, in the Women's Health Survey (1995), women reported a low consumption of meat including food of animal origin due to high cost. Based on the two studies it can be surmised that diet may be a determining factor for anemia among women in Lesotho but a more comprehensive survey should be undertaken to assess the prevalence and causes of iron deficiency.

An examination of anemia status is routinely assessed in antenatal clinics based on hemoglobin concentration since it is related poor pregnancy outcomes. Several research studies suggest a positive relationship between maternal anemia, size at birth, perinatal deaths. In the Cardiff Births Survey, Murphy et al (1986) observed that, LBW was minimal when maternal hemoglobin value at booking was 10.4-13.2 g/dL irrespective of gestational age. In this study the frequency and perinatal mortality was higher at high hemoglobin concentrations of over 14.5 g/dL as in hypertensive disorders of pregnancy. In a more recent study done in the United Kingdom, Steer et al (1995) found LBW rates were lowest at maternal values of 9.6-10.5 g/dL.

Unlike studies conducted in the United Kingdom, in developing countries the lowest hemoglobin concentrations were associated with LBW. In India, Singla et al (1997) reported significantly low indices of fetal growth such as birth weight, chest and mid upper arm circumference and crown heel length in infants born to mothers with hemoglobin concentration of 6.1 to +/- 8.5 g/dL. Furthermore, serum ferritin concentration <10 μg/L was significantly associated with LBW, mid upper arm circumference (MUAC), and crown heel length. In Nigeria, Onadeko et al (1996) found a high frequency of LBW (20.7%) infants among teenage mothers, and the highest low birth weight was associated with low hemoglobin concentration (11 gm/dL).

CHAPTER III

METHODOLOGY

Retrospective Research Design

The data was collected retrospectively from antenatal clinic records covering a period of three years (May 1998 to April 2001) at Scott Hospital in Morija. Morija is located 45 Km south of Maseru, the capital city of Lesotho. Scott Hospital is one of the nine CHAL (Christian Health Association of Lesotho) hospitals that are responsible for 45% of the health services in the country. Scott Hospital's Health Service Area (HSA) covers a population of approximately 170,000 people. Villages covered are within close reach of the main road which connects Morija to the capital and large areas of the foothills, situated several hours drive from the main road. It should be noted that due to its accessibility by public transport some women travel from as far as Mohaleshoek and Mafeteng south of Morija for ANC services.

The hospital was selected due to the fact that it's well known for its good record keeping and easy access from the main capital city. Moreover, the hospital has a unique record for good Antenatal Care program and as well as a nursing school for nurse assistants. Six-nurse assistant's students from the Morija nursing college were employed to facilitate transfer of data from the clinic records.

Procedure

The Oklahoma State University Institutional Review Board, the Ministry of health in Lesotho and the Christian Health Association of Lesotho, approved the study protocol. The nursing students were trained, familiarized with the data collection instrument and informed on the selection criteria of the study.

Sample Selection

Subject selection was based on convenience sampling methodology. The subjects of the study were antenatal clinic records of women attending antenatal clinic at least five times or more. The inclusion criteria for the antenatal cards comprised of; normal healthy pregnancy without complications, full term singleton live births infants, a clinic attendance of five or more times cards (www.who.org, 1994). Excluded in the study were women with pregnancy complications such as pre-eclampsia (>90mmg) and reported hypertension on the obstetric record, diabetes, multiple pregnancies, stillbirth and congenital abnormalities. Identifying these health conditions was made easy because they were recorded on the obstetric record attached to the ANC card (APPENDIX F). Research literature (Kramer, 1987) indicates that these health conditions have a confounding effect on birth weight and their control is beyond the scope of this research study.

Selection of maternal records was based on systematic sampling. Before selection the cards were categorized into four years then stratified according into months of the year. After excluding files that did not qualify as per selection criteria, a random start was employed and 11 to 16 files were systematically selected from each month. The names of subjects appearing on the chart were concealed with a tape for confidentiality, which was then removed once all data are transferred from the ANC card to the data matrix (APPENDIX E).

The study variables were selected from measurements that are routinely done in ANC clinics by trained and well-experienced Nurse Midwifes. The variables of interest included: Last known menstrual period (LNMP), expected date of delivery (EDD), infants date of birth, weight and length, two maternal Hemoglobin ([Hb]) measurements at booking and during the last antenatal visit, monthly maternal weights date of first and last antenatal visit. At least, 90.6% of women in Lesotho attend antenatal care clinics of which 37% begin before the fifth month of gestation whilst 40.2% attend for the first time in their third trimester (Situation Analysis,1994).

Calculations

Gestational Age

The last normal menstrual period is defined as the date of the last menses as recalled by the women. It is mainly used to calculate the duration of pregnancy. This is calculated as the interval between the women's reported date of the last menstrual period and date of birth of infant (Alexander, 1995). There are limitations associate with gestational age calculated from such as LNMP from: gestational age was inconsistent with birth weight, recall error, variation in the pre-ovulatory interval, sporadic bleeding during pregnancy and unrecognized abortions. However, in developing countries it is used as a method for dating because the more accurate ultrasonic measurement is not available.

Gestational Rate of Weight (kg/week)

The rate of maternal weight gain is routinely measured at every clinic visit attendance using a platform beam scale with minimum clothing. The monthly weights are for monitoring pregnancy weight gains as it an important reflection of maternal nutritional status and fetal growth. The World Health (1995) organization recommends a maternal rate of weight gain of 1.5 kg per month. The rate of weight gain is calculated by subtracting the first weight in the third trimester from last weight recorded on the ANC record then divided by the number of weeks from the date of the first month and last month in the third trimester.

Birth Weight (gm)

Birth weight is a mostly used anthropometric indicator of size and highly associated with gestational age. A birth weight of 2500 g is defined as low birth weight (1995). Nurses in the maternity ward measure infants' birth weight with electronic digital scales. Infant's length is measured with length board.

Birth Length (cm)

Length is a measurement of proportionality in newborn infants. Length is routinely measured after in delivery with a length board to the nearest.

Hemoglobin Concentration [Hb]

Hemoglobin is routinely measured at first and last visit at ANC. The purpose of measuring Hemoglobin is to screen pregnant women for anemia. Its importance lies in the fact that anemia is very common during pregnancy, more so in developing countries where the intake of iron rich foods is low. And infectious diseases are prevalent. Hemoglobin concentration was determined by the cynamethemoglobin method.

Determination of Exposure to Hungry Season

Exposure to Hungry Season was determined by calculating the number of weeks in the first and third trimester exposed to the hungry season based on the infant's birth date. Therefore, the pregnancy could have been one to thirteen weeks in the hungry season. The hungry season spans from November to January. Note that infants exposed to the hungry season in their first trimester had their third trimester in the good months. Infants that were born in April were not exposed to the hungry season in both first and third trimester. Infant exposure to the hungry season is based on birth date:

First Trimester Exposure		**Third Trimester Exposure**	
Birth month	Month in Hungry	Birth month	Month in Hungry
May	Nov	November	Jan
June	Nov, Dec	December	Nov. Dec
July	Nov, Dec, Jan	January	Nov, Dec, Jan
August	Dec, Jan	February	Nov, Dec
September	Jan	March	Jan
October	Jan		

Statistical Analysis

Statistical analysis was based on the hypothesis generated from the following research hypothesis:

1. Null Hypothesis: There is no relationship between birth weight, maternal parity, age, first pregnancy weight in third trimester and last pregnancy weight, rate of weight gain in third trimester, number of weeks exposed to hungry season in first and third trimester, infants length and sex.
2. Null Hypothesis: There is no difference in mean birth weight by month of birth.
3. Null Hypothesis: There is no difference in mean birth weight and mean rate of weight gain between first and trimesters not exposed, exposed by 1-4 weeks and 5-12 weeks to the hungry season?
4. Null Hypothesis: What is the best predictor of birth weight among the independent variables (predictors) that have been examined in this study for first trimester exposure and third trimester exposure to hungry season?

Analytical Model

Statistical analysis was based on determining the association between the dependent variable birth weight and independent variables: maternal parity, and last pregnancy weight, rate of weight gain in third trimester, number weeks of first and third trimester in hungry season in hungry season. Descriptive statistics were determined for all study variables as mentioned. SPSS for Windows version 10.0.5 (1999) Statistical

Package for Social Sciences was utilized to carry out the analysis. The probability level of all the statistical analysis will be set at α=0.05.

Models

To test the first research hypothesis, Pearson product moment will be utilized to assess the relationship between dependent variable and independent variables.

To test the second research hypothesis, ANOVA (one way analysis of variance) will be utilized to determine the mean differences birth weight and rate of weight for trimesters not exposed to hungry season, exposed by 1-4 weeks and 5-12 weeks in the first and third trimester of pregnancy. Furthermore, ANOVA will be employed to establish the differences in between mean birth weight by month of birth. Scheffe method will be utilized for ANOVA post hoc.

To determine the best predictor of birth weight, stepwise multiple linear regressions will be utilized. The independent variables will be selected based on assessment of the inter-correlations from the Pearson product moment; the variables with high correlations will be selected for inclusion in the regression equation. First and third trimester exposure will be analyzed separately in multiple linear regression analysis.

Model 1 - First Trimester Exposure

BW = a + b_0 (maternal parity) + b_1 (last pregnancy weight) + b_3 (number of weeks of first trimester in hungry season) + b_4 (rate of weight gain in third trimester)

Model 2 - Third Trimester Exposure

BW = a + b_0 (maternal parity) + b_1 (last pregnancy weight) + b_3 (number of weeks of third trimester in hungry season) + b_4 (rate of weight gain in third trimester)

CHAPTER IV

PREDICTORS OF BIRTH WEIGHT AMONG HEALTHY WOMEN IN LESOTHO

Abstract

Objective: This study explores the relationship between birth weight and exposure to the hungry season in the first and third trimester of pregnancy and determines the best predictor of birth weight this cohort. Methods: Data from 477 full term singleton live births were systematically and retrospectively extracted from Antenatal Clinic (ANC) records May 1998 to April 2001. Data were analyzed utilizing correlation and regression. Setting: The study was conducted at Scott Hospital-Morija, which services rural communities in Lesotho. Subjects: Women with normal healthy pregnancies without complications, with a clinic attendance of five or more times who had full term singleton infants were included. Results: The best predictors of birth weight were maternal parity (p=. 0001) and last pregnancy weight (p=. 0001) for first and third trimester exposure to the hungry season. Conclusions: In agreement with other studies, maternal parity and last pregnancy weight were best predictors of birth weight. It is highly likely that length of exposure to the hungry season during the third trimester is important in determining pregnancy outcomes. Increased surveillance of primigravida, improving pregnancy weight gain for optimal weight at term and supplementation during the hungry season are recommended.

Introduction

It is well recognized that birth weight is the single most important factor that determines infant and childhood morbidity and mortality (Ashworth, 1998; Ashworth & Freachem, 1985; de Onis et al, 1998). Birth weights that range from 3500 to 4500 g have been associated with favorable outcomes whilst birth weights below 2500 g have been associated with increased episodes of diarrhea and pneumonia in children under the age of five. More recently, research also indicated that birth weight was significantly associated with early onset of stunting (Neumann & Harrison, 1994). Birth weight is also an important determinant of maternal health and nutritional status, especially in environments that are vulnerable to seasonal food shortages. Thus studies have demonstrated that adults, especially women, undergo seasonal body weight losses (Durnin et al, 1990; Ferro-Luzzi et al, 1994; 1990; Schultink et al, 1990).

Earlier research literature (Smith et al, 1947; Stein et al, 1975a, 1975b, 1995; Huxley et al, 2000) documented that nutritional deprivation brought about by famine during the Second World War, early in pregnancy and during the third trimester was associated with poor pregnancy outcomes. Several research studies (Prentice et al, 1981, 1987; Lawrence et al, 1987; Neumann & Harrison, 1994) conducted in Tropical Africa indicated that women whose third trimester of pregnancy coincided with the nutritionally debilitating season (hungry or wet season) experienced lower pregnancy weight gains and lower birth weights (Banje, 1983; Kinabo, 1993; Aitkin, 1990; Wendle-Ritcher, 1997). The dry season is characterized by favorable pregnancy outcomes (due to decreased maternal labor and plentiful food stocks) as evidenced by birth weights well above 3000 g and maternal weight gains (> 0.500 g/week) that are comparable to industrialized countries. Studies conducted in developing countries showed that pregnancy weight gains were generally inadequate, averaging 6.3 kg for the entire pregnancy at any time of the year season (Prentice et al, 1987; Lawrence et al, 1987; Neumann & Harrison, 1994).

Birth weight is also influenced by nonseasonal factors such as maternal parity and age. Researchers showed that birth weight increased with increasing maternal age and parity (Feleke & Enquosellassie, 1999; Ali & Lulseged, 1997; Walvaren et al, 1997).

Lesotho's food and nutrition situation is characterized by unfavorable climatic conditions contributing to food insecurity especially for the 80 to 84% of the population who live in rural areas (Ministry of Health and Social Welfare, 1997). Food insecurity becomes more pronounced during the hungry season. Stunting amongst children under the age of five years and chronic energy deficiency in women of childbearing age are the most prevalent forms of malnutrition in the country (Ministry of Health and Social Welfare, 1995; Bureau of Statistics, 1998). Lesotho has a low birth weight incidence above the recommended 10% (U.N.I.C.E.F, 2001a; 2001b).

Given the situation, it is therefore important to study the effect of season on birth weight in a temperate climate such as that in Lesotho (Lesotho Government Ministry of Natural Resources, 1997). Unlike the tropics, a temperate climate has short four distinct climatic seasons that can permit food production through out the year. The tropical climate is characterized by two seasons, the dry and wet season (lean or preharvest season) and a short vegetative cycle. Given the climatic situation in Lesotho, it is therefore important to study the effect of season on birth weight in a temperate climate.

Research Design and Methods

Setting: The data was collected retrospectively from antenatal clinic records covering a period of three years (May 1998 to April 2001) at Scott Hospital in Morija. Morija is located 45 Km south of Maseru, the capital city of Lesotho. Scott Hospital is one of the nine Christian Health Association of Lesotho hospitals that are responsible for 45% of the health services in the country. Scott Hospital's Health Service Area covers a population of approximately 170,000 people. Women pay for ANC services at the hospital.

Sample selection: 477 ANC records were systematically selected for the study. The records were categorized by years then stratified according to months of the year. A random start was employed and 11 to 20 files were selected from each month. Women without pregnancy complications who attended a clinic at least five times and who delivered a full term singleton live birth were included in the study. Women with pregnancy complications such as pre-eclampsia and hypertension, diabetes and multiple pregnancies as reported on the obstetric record were excluded from the study. Research literature (Kramer, 1987) indicates that these health conditions have a confounding effect on birth weight and their control is beyond the scope of this research study.

Data collection: The study variables were selected from measurements that are routinely done in ANC clinics by trained and well-experienced nurse midwives. Trained nursing students extracted data from the ANC records. The Oklahoma State University Institutional Review Board, the Ministry of Health in Lesotho and the Christian Health Association of Lesotho approved the study protocol.

Statistical analysis: All data were analyzed by SPSS for Windows Version 10.0.5 (1999). Descriptive statistics were performed for all 477 infant births. There was no significant difference in birth weight by year for all the three years combined. Analysis of variance (Scheffe Post Hoc test) was utilized to examine the differences in birth weight by birth month. Pearson product moment correlation analysis was used to assess the relationship between birth weight, maternal parity, maternal age, rate of weight gain, last pregnancy weight, number of weeks exposed to the hungry season in the first and in the third trimester of pregnancy. Stepwise linear regression was used to determine the best predictor of birth weight among the independent variables: maternal parity, last pregnancy weight, rate of weight gain and exposure to the hungry season. Exposure to hungry season was determined by calculating the number of weeks in the first and third trimester exposed to the hungry season based on the infant's birth date.

Results

Descriptive statistics: Data on the 477 antenatal clinic records of women who delivered singleton term infants were analyzed. There were only 5% low birth weight infants (weight less than 2,500 g). The mean maternal birth weight was 3.237 kg (±. 433) and the mean birth length was 48.9 cm (± 5.18). The mean maternal weight at last ANC visit was 74.2 kg (± 11.63). The average maternal parity was 2.4 (± 1.6) pregnancies and maternal age was 26.8 (± 6.2) with an age range from 16 to 44 years. Overall the rate of weight gain in the third trimester was computed for 95.4% (n=456) of all subjects, and showed a mean rate of weight gain at .386 g/week (± 305). Descriptive data for male and female infant are presented in Table 1.

Figure 1 illustrates the distribution of birth weights by month for the three years combined. Birth weights were slightly lower in the months of November to January (hungry season) and May to July (harvest season). Slightly higher birth weights were in August to October (post harvest season) and February to March (preharvest season). There was no significant effect of month of birth on birth weight ($p=. 233$).

Relationship Between Birth Weight and Independent Variables

Correlation coefficients were determined for the analysis of the relationship between birth weight, maternal parity, maternal age and last pregnancy weight. The analysis revealed significant positive relationships between birth weight and maternal age, parity and last pregnancy weight as shown in Table 2. The number of weeks in the first and third trimester exposed to hungry season had a negative relationship with birth weight. However the number of weeks of third trimester in the hungry season was significantly associated with the rate of weight gain in the third trimester of pregnancy ($r = -.104$, $p = .027$).

The Best Predictor of Birth Weight Among Independent Variables

The best predictors of birth weight (BW) were maternal parity (MP) and last pregnancy weight (LPW) (Table 3). The following predictive model equation was derived:

$$BW = 2.513 + [0.0591\ (MP)] + [0.0078\ (LPW)]$$

The model indicates that for each increase in maternal parity there was a 0.0591 kg increase in birth weight. In addition the regression equations indicated a 0.0078 kg increase in birth weight for each kilogram of last pregnancy weight. The rate of weight gain and exposure to the hungry season were not significant predictors of birth weight. These predictors explained 34% of the variation in infant birth weight (p= 0.0001).

Discussion

Birth weight. In this study we found that the mean birth weight of 3,237 kg (± .433) was comparable to mean birth weight found in industrialized countries (Strauss & Dietze, 1999). Furthermore, the mean birth weight in the present study was higher than the mean birth weight (3068 g ± 415) reported by Tjon-A-Ten et al (1986) in a remote mountain area of Matsonyane, Lesotho. We need to take into account that in this study pregnancy complications were eliminated and that the mothers in this cohort paid to attended ANC at least five times. Therefore this sample includes the most health conscious mothers in the area.

Seasonal distribution in birth weight: In agreement with the findings of Tjon-A-Ten et al (1986), we found no significant effect of season on birth weight. In Lesotho the hungry season coincides with the sowing and planting whilst the harvest season is characterized by heavy agricultural labor that could influence energy balance in pregnant mothers. Studies by Aitkin (1990) and Wendle-Ritcher (1997) in Sierra Leone and Burkina Faso observed that the lowest birth weights were associated with the rice cultivation and harvesting of field crops.

Associations with birth weight: Maternal parity and age were significantly positively associated with birth weight. Other studies in Ethiopia (Feleke & Enquoselassie, 1999; Ali & Lulseged, 1997; Walraven et al, 1997) confirm our findings, where higher birth weights were associated with higher parity and older age. In contrast, in Malawi Brabin et al (1998) identified that the likelihood of delivering low birth weight infants was the same between primiparae and multiparae women. Kramer (1987) reported that pregnancy outcomes were less favorable between younger adolescents and women over the age of 35 years than women aged 25 to 34.

Pregnancy weight at last ANC and rate of weight gain in the 7th to 9th month of pregnancy visit have been associated with positive pregnancy outcomes in developing countries where women attend ANC in their late second and third trimester (WHO Collaborative Study, 1995b). Our study showed that pregnancy weight at last ANC visit was positively associated with birth weight. However the rate of weight gain in the third trimester was not associated with birth weight. Other researchers found that a low rate of weight (below 0.3 kg/week in late third trimester) was associated with increased risk (relative risk 1.7 to 2.5) for low birth weight babies (Straus & Dietze, 1999). In another study, Stein et al (1995) showed that weight gains below 0.5 kg/wk in third trimester were associated with a greater risk of low birth weights.

The third trimester of pregnancy is a critical period for increased maternal tissue growth and fetal development. Moreover, it is a period vulnerable to nutritional deprivation (Stein et al, 1975a; 1975b; Prentice, 1981; 1987; Rush et al, 2001). In this study the relationship between the rate of weight gain and number of weeks of exposure in the third trimester was significant. This is clinically significant since women who are exposed for a longer period to the hungry season in the third trimester are vulnerable to poor pregnancy outcomes.

These results are consistent with results of the previous studies where mean birth weight were lower after the third trimester exposure to periods of food shortages (Stein and Susser, 1975a; 1975b; Stein et al, 1995). Other studies in Africa also found that third trimester exposure to the hungry was an important determinant of low birth weight (Prentice et al, 1987; Aitkin, 1990; Kinabo, 1993; Banje, 1983).

In conclusion: exposure to the hungry season did not show a significant effect on birth weight. But a positive linear trend was observed between maternal age, parity, last pregnancy weight and birth weight. Infants who were exposed to the hungry season during the first trimester exposure experienced more favorable food availability in the third trimester. The rate of weight gain did not show a relationship with birth weight, however it was positively associated with the number of weeks of the third trimester in the hungry season. The results of the study showed that there was no effect between birth weight and season of birth given the fact that fact that Lesotho has temperate climate with a low seasonality index.

Implications: The results of this study emphasize the importance of maternal parity and last pregnancy weight as valuable indicators of pregnancy outcomes and should be included in regular monitoring system for risk assessment

Recommendations: the findings of this research will provide valuable information to improve the Maternal and Child Health / Family Planning Services in Lesotho. Inclusion of variables that will strengthen risk assessment such as gestational age, ponderal index, and socioeconomic variables; and Incorporation of the home based maternal record in the Safe Motherhood Initiative for the vast majority of women who do not attend antenatal clinic and who can not afford clinic fees. This is in effort to extend maternal care to community level. Further research is needed to determine the impact of season throughout the course of pregnancy that will include determining food intake behavior and maternal care practices in a prospective community based study where measurements are fully controlled and in an area with high prevalence of malnutrition.

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Table 1. Descriptive Summary by Gender

Variable	Female			Male		
	n	mean	SD	n	mean	SD
Birth weight (kg)	225	3.168	.420	252	3.299	.4369
Birth length (cm)	225	48.7	5.70	252	49.2	4.67
Maternal parity	225	2.2	1.53	252	2.5	1.66
Maternal age (year)	225	26.3	6.15	252	27.2	6.40
Last pregnancy weight (kg)	225	73.9	11.23	252	74.5	11.10
Rate of weight gain (3rd trimester) (kg/week)	217	0.388	0.269	239	0.384	0.335
1st trimester weeks exposed to hungry season	225	1.84	3.30	252	2.15	3.43
3rd trimester weeks exposed to hungry season	225	2.38	3.53	252	2.22	3.37

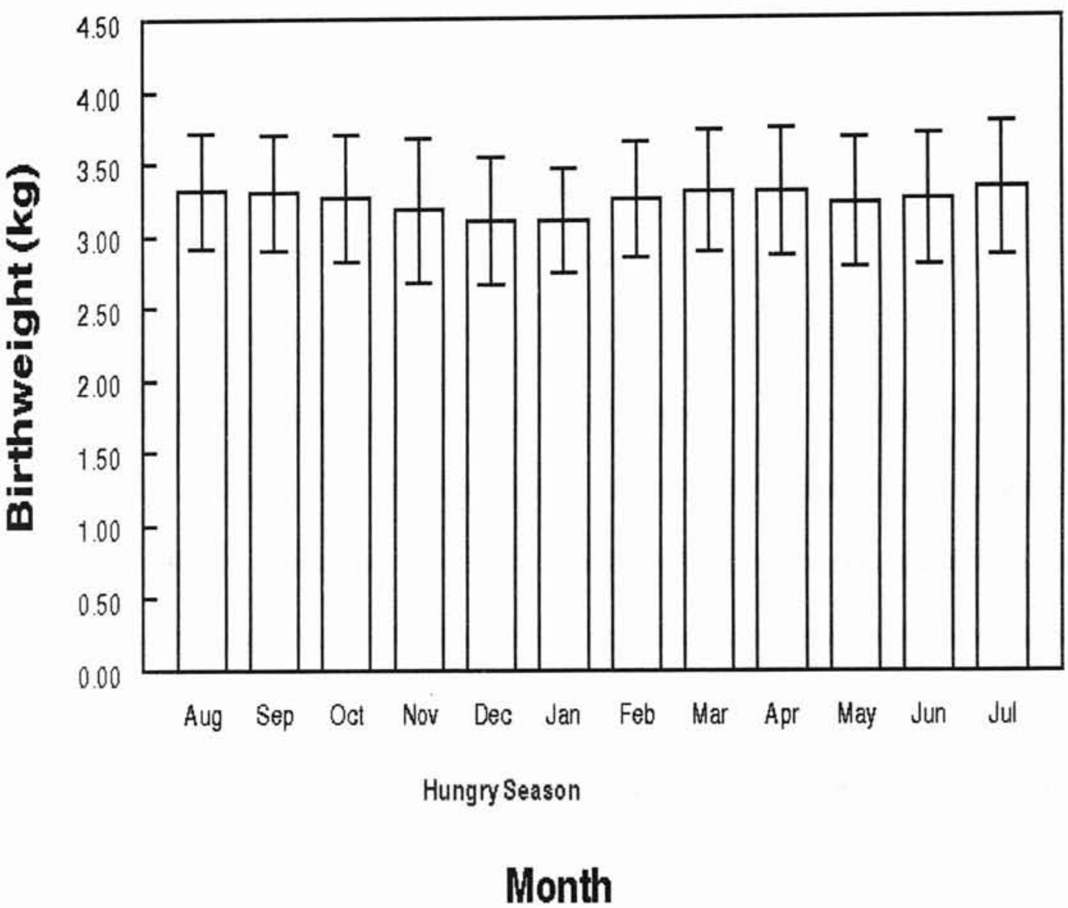
Table 2. Correlation Coefficients Describing the Relationship with Birth Weight

Variable	n	r	sig
Maternal Age	477	.202	.0001
Maternal parity	477	.276	.0001
Last pregnancy weight (kg)	477	.268	.0001
Rate weight gain in 3rd trimester (kg/week)	456	.015	.751
Number of weeks of first trimester exposed to hungry season	477	-.063	.170
Number of weeks of third trimester exposed to hungry season	477	-.061	.180

Table 3. Linear Regression Analysis for Predictors of Birthweight for First and Third Trimester Exposure to Hungry Season (n=477)

Variable	Unstandardized Coefficients B	SE	Standardized Coefficients Beta	t	sig
Maternal Parity	0.0591	.012	.219	4.782	.0001
Last Pregnancy Weight	0.0078	.002	.208	4.536	.0001
Rate of Weight Gain (kg/week)	0.0393	.064	.028	.610	.542
1st trimester weeks exposed to hungry season	0.0014	.006	.012	.225	.822
3rd trimester weeks exposed to hungry season	0.00393	.006	-.065	-1.193	.233

Figure 1. Comparison of Mean Birth Weight by Month of Birth



CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

This study was designed to retrospectively explore the relationship between birth weight and exposure to the hungry season in the first and third trimester of pregnancy. This was achieved by describing the study population. First, by exploring the comparing the birth weight by month of birth. Second, by exploring the differences between birth weight and rate of weight first and third trimester exposure into the hungry season according to the following categories: not exposed, exposed by 1-4 weeks and exposed by 5-12 weeks. Lastly, by determining the best predictor of birth weight among the independent variables. Data of 477 full term singleton live births were systematically extracted retrospectively from Antenatal Clinic (ANC) records covering a period of three years from May 1998 to April 2001, at Scott Hospital-Morija in Lesotho. The subjects were comprised normal healthy pregnancies without complications, full term singleton live birth infants with a clinic attendance of five or more times.

The results of the study revealed significant association between birth weight and maternal parity and age, last pregnancy weight. Maternal age and parity had the strongest, significant relationship. The rate of weight gain in the third trimester was significantly associated with the number of weeks of the third trimester exposed to the hungry season. The best predictors of birth weight for first and third trimester exposure to hungry season were maternal parity and last pregnancy weight.

Results of the present study confirm that there is an effect of the length of exposure to the hungry season in the third trimester of pregnancy on rate of weight gain an important factor in determining on pregnancy outcome, however the length of exposure was not significantly associated with birth weight in this study population.

Conclusions

In conclusion: Exposure to the hungry season did not show a significant effect on birth weight. But a positive linear trend was observed between maternal age, parity, last pregnancy weight and birth weight. Infants who were exposed to the hungry season during the first trimester exposure experienced more favorable food availability in the third trimester. The rate of weight gain did not show a relationship with birth weight, however it was positively associated with the number of weeks of the third trimester in the hungry season. The results of the study showed that there was no effect between birth weight and season of birth given the fact that fact that Lesotho has temperate climate with a low seasonality index.

Recommendations

Recommendations: the findings of this research will provide valuable information to improve the Maternal and Child Health/Family Planning Services in Lesotho. Inclusion of variables that will strengthen risk assessment such as gestational age, ponderal index, and socioeconomic variables; and incorporation of the home based maternal record in the Safe Motherhood Initiative for the vast majority of women who do not attend antenatal clinic and who can not afford clinic fees. This is in effort to extend maternal care to community level. Further research is needed to determine the impact of season throughout the course of pregnancy that will include determining food intake behavior and maternal care practices in a prospective community based study where measurements are fully controlled and in an area with high prevalence of malnutrition.

Ponderal Index

Ponderal index is defined as a measure of the relation ship between birth weight and body length. Length is a measurement of proportionality in newborn infants. A commonly used measurement is Rohrer's Ponderal Index (weight in g $\times$ 100/recumbent length^3). Its importance lies in the fact that it may reveal infants who have retarded growth but with normal weights (WHO, 1995a). Length is more vulnerable to chronic malnutrition as opposed to acute malnutrition. Therefore, shorter length at birth is associated with longer term gestational stress (WHO, 1995a).

Villar et al (1986) found that populations in developing countries to have higher incidence of chronically malnourished neonates as depicted by IUGR-API (appropriate ponderal index) (defined as IUGR infants with adequate ponderal index and referred to as symmetric/proportionately growth retarded or stunted). The study revealed that high incidence of acutely malnourished infants as indicated by IUGR-LPI (low ponderal index) (defined as disproportionately growth retarded/ asymmetric/ wasted. In another study, Villar et al (1990) found that infants with LPI but normal birth weight had higher neonatal morbidity than infants API. In addition Morris et al (1998) revealed that infants born with short stature and low-PI experienced a 4 fold greater risk of mortality in late/ post-neonatal period and a 2.5-fold greater risk of hospitalization.

Chard et al (1992) investigated the neonatal anthropometric indices (PI, mid arm circumference (MAC) /occipito-frontal circumference (OFC) and birth weight among infants >37 weeks gestation and more than 2500 g, the study revealed highly significant linear correlation between PI and BW ($r=0.56$, $P<0.001$) irrespective of parity and sex. In another study Cole et al (1993) investigated the effectiveness of how well the PI, Benn Index and BMI at adjust for length at the different gestations. Chard et al (1992) past 39 weeks BMI was better indicator of BW for length. In this study PI failed to adjust for gestational age for measuring intrauterine growth retardation. Based on these most recent studies there is not enough evidence to suggest that PI is not a good indicator of intrauterine retardation.

Furthermore, Pike (2000) examined pregnancy outcomes in Nomadic Turkina Pastoralists of Kenya and observed that desirable infants' length (50.8± 6.8 cm) at birth was associated with dry season and was predicted by better maternal health, and full term delivery. However, in this study average PI was 2.72 above cut off value.

In this thesis factors that influence birth weight have been categorized into seasonal and non-seasonal determinants. The non-seasonal factors comprise maternal age, parity and anemia status. The seasonal determinants that directly influence birth weight include maternal nutritional status as measured by rate of weight during pregnancy and weight attained in the in ninth month of pregnancy. These factors are greatly dependent on seasonal availability of nutritious food to support maternal nutritional status and fetal growth. Because birth weight is conditioned by the health and nutritional status of the mother, the proportion of infants born with low birth weight closely reflects the health status of the communities in which they born.

Implications

Implications: The results of this study emphasize the importance of maternal parity and last pregnancy weight as valuable indicators of pregnancy outcomes and should be included in regular monitoring system for risk assessment. Implications: The results of this study emphasize the importance of maternal parity and last pregnancy weight as valuable indicators of pregnancy outcomes and should be included in regular monitoring system for risk assessment

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APPENDIXES

APPENDIX A

Country Profile

Geography and People

Lesotho is a small landlocked country completely surrounded by the Republic of South Africa. The Kingdom covers an area of approximately 30,300 Km and is situated 28 and 30 degrees south and between 27 and 30 degrees east. (Climate Change, 1997). Therefore Lesotho lies outside the Tropics making it free of tropical diseases. All of the land is above the height of 1500 m above sea level. The mountain plateau rises to over 3000 m east of Lesotho. The country is divided into 4 ecological zones, the lowlands the foothills the mountains and Senqu river valley. Only 9 percent of land is arable. A large proportion of the population resides in northwestern part of the country that occupies 1/3 of the total land area contributing to the highest population density. However, 80% of Lesotho's 1.9 inhabitants live in the rural areas (Poverty Mapping, 1999). Unlike most African countries Lesotho is characterized by ethnic homogeneity, all inhabitants are Lesotho is Basotho with single culture and language.

History, Social and Political Structure

Prior to independence Lesotho was known as Basutoland. Lesotho attained its independence from Britain in 1966. King Moshoeshoe I founded the country in the early nineteenth century. His kingdom at the time stretched from present day Lesotho into what is now the Orange Free State of South Africa. During a series of wars much of the agricultural land in the west was lost to the Boers. In 1868, in order to save Basutoland from further encroachments, Moshoeshoe I sought protection from the

British government. Lesotho was administered from Cape Colony but in 1884 the British government took over direct responsibility for the protectorate. At independence the constitution provided for a constitutional monarchy headed by King Moshoeshoes II, a direct descendent of the nations founder, and limited constitutional powers since 1993. The present constitution provides for a bicameral legislature with an elected 65 member lower house and 33-member upper house with 11 nominated persons and 22 principal chiefs.

Climate

Lesotho has a temperate climate marked by four seasons: winter, summer, autumn and spring. Lesotho normally receives 85% of its average annual rainfall of 700mm in the seven months from October to April, with higher averages of 1200 mm recorded in the mountain region, and low average in of 500 mm in the Senqu River Valley, which forms a rain shadow. Rainfall has become increasingly erratic in recent years, resulting in periodic droughts and unfavorable agricultural activity. The National committee on climate change reported that "in the last twenty years Lesotho has seen the highest occurrence of drought than any period of similar life span in the last 200 years;" the drought conditions have been linked with the El Nino (Climate Change, 1997). Similarly, these highly variable climate conditions are also common feature in the Southern African Region (www.sadc.org, 2000). The severe droughts in 1991/1992 and 1993/1994 resulted in poor crop harvest and large livestock losses to rural farmers, exacerbating poverty and suffering. Rainfall is often torrential and associated with severe soil erosion. Snow is a common feature in the mountain, the coldest region of the country. The lowest temperature of –20 degrees Celsius has been recorded and on the other hand, the highest temperature recorded in the country is 38.5 degrees Celsius (Report on Climate Change, 1997). The uncertainty of weather conditions is increasingly making the already low agricultural productivity a more risky occupation.

Agriculture and Food Security

"The importance of the agricultural sector lies in the fact that 80% of Lesotho's population resides in the rural areas, 50% of whom derive some of their livelihood from crop and livestock production. Therefore dependence on agriculture remains an important mode of existence. Although agriculture accounts for 15% of the exports and gives partial employment to 60% of the labor force, Lesotho remains a net importer of agricultural goods as domestic production only meets 25% of the consumption needs of the population."(Situation Analysis, 1999).

The production of major cereal crops have been on the decline since the 1970, despite massive donor and government supported projects. The cereal crop production per capita per year decline is below 150 Kg per capita per year from late 1980s to date (Situation Analysis, 1999). The country cannot feed its growing population at the FAO minimum level of 180Kg per capita per year. However the 1996/97 crop year had an increase cereal crop production mainly due to good rains where the area harvested to a mixture of maize and beans, maize and sorghum, sorghum and beans went up more than 15% however maize production in general decreased by 25% in 1996/97 from 188,489 to 142,050 metric tons.

Lesotho's agriculture has serious implications for food security. Conceptually food security comprises adequacy or availability, stability of supplies and access, food access as the critical component, especially for vulnerable households (Sitauation Analysis, 1999).

The national status over the period from 1987 t0 1996 indicates the actual cereal consumption by citizens of Lesotho to be approximately at 208 kg per capita per year (a level lower than SADC/FAO desired nutritional requirement of 213 kg per capita per year). According to these figures, it appears that there is enough food available to the Nation, however national food security does not necessarily translate to accessibility critical for household food security of vulnerable households.

The sources of access include own production, purchase ability derived from various sources of income and food obtained from relief distributions. The three pillars of food access in Lesotho are agriculture, livestock and remittances from mineworkers. The drought conditions and retrenchment of miners brought about a significant decline in the food accessibility. The Poverty Assessment Survey (2000) reported that the percentage of household that are self-sufficient in cereals to have declined from 4.3% to 2.8% in 1999. The most vulnerable households are those from non-mineworker family in drought prone districts in particular female de jure headed households (Situation Analysis, 1999).

Economy

An important feature of the Lesotho economy is its heavy reliance on externally based production activity in the form of Basotho men working in the mining industry of

South Africa (Situation Analysis, 1999). In 1996, 91% of the net income came from abroad and was made up of migrant labor remittances, accounting for 33% of the GNP and 295 of the national domestic income (Climate change, 1997). When compared to countries in the SADC region, Lesotho performed exceptionally well economically partly due to structural adjustment program and the construction of the Lesotho High Water Project and the rapid expansion of the manufacturing sector. During the 1986 to 1996 the real GDP grew at an average 7.8% real GNP at 4.1%, and inflation dropped from 17.9% to 9.1% (Situation Analysis, 1999). However, on a year-to-year analysis the (Poverty Assessment, 2000) country's growth rates are volatile to recurrent droughts and retrenchments (from the mines of South Africa) as well as the activities of the highlands water project. Despite the economic boom the rate of unemployment among women increased from 26.5% in 1986 to 48.6 in 1997. It is noteworthy, to mention that the political disturbances of 1998 reduced the growth rate of the GNDI from 5% to –2.6% (Situation Analysis, 1999).

Health System

The Ministry of Health has the primary responsibility for health activities in Lesotho, both curative and preventive services. The comprehensive Health System is provided by both the government and nongovernmental agencies. The system has four basic layers of institutions and personnel. At the village level, village health posts, a network of 4000 volunteers: Village Health Workers (VHW) and Traditional Birth Attendance (TBA) are supported by the village development councils. Above the village, a series of health centers, each with a catchment population of 6,000 to 10,000 persons staffed with a nurse clinician; nursing sister and Nursing Assistance in most cases some health centers staff may be limited to one or two of the above health workers. Above the clinic, are 18 Health Service Areas (HSA) which cover the entire country, each with a general hospital as the first line of referral and its own health team which liaise with the District Development Committee. The 19th HSA is served by Flying Doctor Service (LFDS). The LFDS delivers drugs and medical staff to ten largely inaccessible mountain clinics, and operates an air ambulance service. The MOH operates nine general hospitals with a total of 1137 beds, including Queen Elizabeth II hospital (QEII) in Maseru, which also serves as the national referral hospital.

The other nine hospitals, accounting for another 851 beds, are owned and operated by church missions, which together constitute the Christian Health Association of Lesotho (CHAL). CHAL facilities account for about 45% of all health services in Lesotho. Generally, CHAL institutions serve underserved and widely spaced communities. On aggregate CHAL services a smaller proportion of the population (GOL 58.2%, CHAL 41.8%) Health services at the primary referral level are provided by 62 government and 86 CHAL rural clinics or health centers.

Antenatal Care

Maternal and Child Health /Family Planning services constitute part of the preventive services, providing ANC and postnatal care (PNC) to women of childbearing age. Its aim is to persuade women to attend antenatal clinic at least four times during pregnancy (WHO recommended level) (www.who.org, 1994) to have all births supervised by trained personnel, to encourage all high-risk pregnancies to deliver at health facilities, to ensure that women attend postnatal clinics, and to have contraceptives available on request. Antenatal care is an essential service that is fundamental to good maternal health and pregnancy outcome.

Antenatal clinic attendance is high in Lesotho ranging from 87 to 90% (1994 Situation Analysis, 1994 and Womens Health Survey, 1995). Overall, 40% of women attend ANC in their third trimester while 37.9% attend before the fifth month of gestation and 69.6% attend at least four times (Situation Analysis, 1994). The Women's Health Survey focus groups reported that the majority of women said they attended clinic four more times. In this study clinic attendance was higher in the urban areas (86.5%) than rural (81.5%). Among many of the reasons cited by women for low clinic attendance was long distance to health facilities. However attendance of Post Nata Care (PNC) was reported to be low, mainly due to lack of awareness on the part of the women and the women perceived it as primarily for the benefit of the child.

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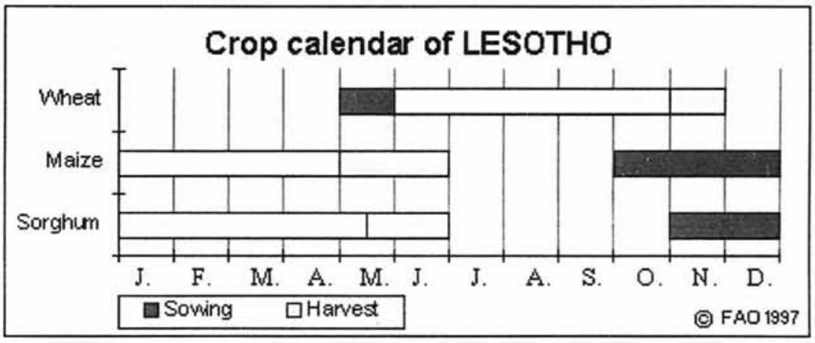
APPENDIX B

DISTRICT MAP OF LESOTHO

APPENDIX C

1.3 LESOTHO HEALTH SERVICE AREAS

APPENDIX D


Crop calendar of LESOTHO
Wheat
Maize
Sorghum
J. F. M. A. M. J. J. A. S. O. N. D.
Sowing
Harvest
© FAO 1997

APPENDIX E

Data Matrix

Hospital/Clinic.. Date..

				ID	
				area/village	
				Mother's Age	
				Parity	
				Infants Length	
				LNMP	
				EDD	
				Infant's Date of Birth	
				Infant's Birth Weight	
				Infant's Sex	
				Date of first Visit	
				Hb--1	
				Hb--2	
				APGAR	
				1	Pregnancy Weight Gain & Date
				2	
				3	
				4	
				5	
				6	
				7	
				8	
				9	
				10	
				11	
				12	

APPENDIX F
Record Card

Ante Natal/Delivery/Post Natal Record No. ....

Name: .... **Address:** ....
Age: .... **Years Married:** .... **Gravida:** .... **Group;** .... **Hb:** ....
Medical History: – T.B. .... **Rheumatic Fever:** .... **Diabetes:** .... **Hypertension:** ....
Renal Disease: .... **Heart Disease:** .... **Gynae.Ops:** .... **Pelvic Fracture:** ....
Family History: – T.B. .... **Diabetes:** .... **Hypertension:** .... **Heart Diseases:** .... **Renal Disease:** ....
Twins: .... **Remarks:** .... **Height etc:** ....
Past Obstetric History: ....

No	Years	Place	Condition at Birth	Delivery	Hours of Labour	Alive Now?	Birth Weight	Age at Death	Remarks Infant	Mother

MENSES: Regular / Irregular **Length of Menses** **L.N.M.P.** **E.D.D.**

ABNORMALITIES/THIS PREGNANCY (Bleeding, Cough, Discharge p.v. etc.)

Date	Gestation Dates	Palp	PRS	LIE	F.H.	Urine Alb.	Sug.	B.P.	Wt.	Oedema	Remarks	Next Visit

IV. PELVIC ASSESSMENT **DATE:**

T. Conj. Isc. Spines A.P. Out
Tr. Briam Bi. S. Diam S.P. Arch
Shape/Inlet Sidewalls I. Tub. Liam.
Remarks:
At risk Factors: (in red)

V. SUMMARY OF DELIVERY **DATE:**

Normal/Forceps/Vacuum etc/C. Section Baby
Sex
Apgar Score-If S.B.
Tick Fresh/Mascrated
Post Delivery Complications Discharge Weight
BCG
Hb. Abnormalities
Treatment Comments

VI.

POST NATAL CHECK: .... **Date:** .... **Examine by:** .... **Check by:** ....
B.P. .... **H.B.** .... **Micturition:** .... **Urine Test:** ....
Breasts: .... **Abdomen:** .... **Uterous:** ....
Pap Smear: .... **CX:** ....
Perineum: .... **P.V. Discharge:** .... **Others** ....
Infants Weight: .... **Condition:** .... **Feedings Problem** ....
Treatment ordered: ....

GPL 432/00 - 10m

APPENDIX G

Hospital Approval

LESOTHO

Ministry of Health and Social Welfare

P. O. Box 514

<u>MASERU</u> 100

06 August 2001

<u>Research on Maternal Nutrition and Birth weight</u>

This is to certify that the above research to be conducted by Lineo Mathule meets the Ministry of Health and Social Welfares Ethics code and **Requirements stating that confidentiality of** subjects name and identification be maintained throughout **the study period.**

Sincerely.

<u>DR. T. RAMATLAPENG</u>
DGHS

cc: CHAL EXECUTIVE SECRETARY
RESEARCH COORDINATOR MOH
HEAD FAMILY HEALTH DIVISION
LINEO MATHULE

APPENDIX H

Oklahoma State University
Institutional Review Board

Protocol Expires: 10/1/02

Date: Tuesday, October 02, 2001 IRB Application No HE028

Proposal Title: SEASON AFFECTS BIRTHWEIGHT IN LESOTHO

Principal
Investigator(s):

Lineo Mathule
102 NUP #5
Stillwater, OK 74075

Maria Spicer
425 HES
Stillwater, OK 74078

Reviewed and
Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

Dear PI

Your IRB application referenced above has been approved for one calendar year. Please make note of the expiration date indicated above. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved projects are subject to monitoring by the IRB. If you have questions about the IRB procedures or need any assistance from the Board, please contact Sharon Bacher, the Executive Secretary to the IRB, in 203 Whitehurst (phone: 405-744-5700, sbacher@okstate.edu).

Sincerely,

Carol Olson

Carol Olson, Chair
Institutional Review Board

VITA 2

Lineo Margaret Mathule

Master of Science

Thesis: PREDICTORS OF BIRTH WEIGHT AMONG HEALTHY WOMEN IN LESOTHO

Major Field: Nutritional Science

Biographical:

Education: Graduated from Machabeng High School, Maseru, Lesotho in June 1983; received Bachelor of Science in Human Ecology with a major in Food and Nutrition from Mount Saint Vincent University, Halifax, Canada from 1985/1987 to September 1989 and May 1991; Completed the requirements for a Master of Science degree in Nutritional Science at Oklahoma State University in May, 2002.

Experience: Employed by the Ministry of Finance, Department of Sales Tax as an assistant Sales Tax Clerk in 1983 to 1985;employed by the United Nations Children's Fund Maseru, Lesotho as an assistant to a consultancy working on Standardization of the Lesotho Child Health Growth Monitoring Chart and Health Booklet from September to December 1987;employed by the Ministry of Agriculture-Food and Nutrition Coordinating Office 1988 to 1989 as an Assistant Nutritionist; Employed by The Ministry of Health and Social Welfare, Family Health Division – Nutrition Section as a Nutritionist in 1991 to1995; Employed by the Lesotho Agricultural College as a Senior Lecturer Department in 1995 to 2000(Acting Head of Home Economics 1999 to 2000); currently employed by the National University of Lesotho, Faculty of Agriculture – Home Economics Department as a Lecturer from 2000 to date.