THE IMPACT OF FREQUENT REPRODUCTIVE CYCLE ON PREGNANCY OUTCOME AND MATERNAL NUTRITIONAL STATUS

BY

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DECLARATION

I HEREBY DECLARE THAT WITH THE EXCEPTION OF CITED LITERATURE, THE INFORMATION IN THIS DOCUMENT IS PRODUCED BY ME THROUGH RESEARCH UNDER SUPERVISION IN THE DEPARTMENT OF NUTRITION AND FOOD SCIENCE, UNIVERSITY OF GHANA, LEGON.

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DEDICATION

This work is dedicated to my family whose constant support and encouragement never cease to sustain me.

ACKNOWLEDGEMENT

I wish to thank God Almighty, for the strength given me towards the successful completion of this work. I am most grateful to Dr. Anna Lartey for her patience and thorough supervision that has made this work to be a success. Also, I express my profound thanks to Mr. Francis Tayie and Dr. Tano-Debrah for their technical support.

I wish to express my appreciation to my family and Mr. K. Kyereboah of Ecobank West Africa for their financial and prayer support.

ABSTRACT

Background: Frequent cycles of reproduction (short interpregnancy interval) have been viewed as a risk factor for poor pregnancy outcomes, particularly low birth weight which may increase infant mortality.

Objective: The purpose of the study was to compare the effect of long and short reproductive cycle on pregnancy outcome and maternal nutritional status.

Method: A total of eighty-four pregnant women in their third trimester were enrolled in the study and were followed up till delivery. Forty-two of these mothers were multiparous (mothers with more than four births) with short reproductive cycle, (interpregnancy interval of less than twenty-one months) were compared with forty-two other mothers with long reproductive cycle (interpregnancy interval of more than twenty-one months). The outcome of the pregnancy, and the nutritional status of the two groups was also compared.

Results: The mean birth weights for the two groups were 3.05 $\pm$ 0.49 kg and 3.11$\pm$ 0.36kg for mothers with 1-2 births and the multiparous mothers, respectively. The mean birth lengths were 48.99 $\pm$ 2.91cm and 46.00 $\pm$ 3.42 cm for mothers with 1-2 births and the multiparous mothers, respectively. Birth lengths were significantly different ($p< 0.001$) after adjusting for maternal height. The mean head circumference and the gestational age of the index child were not significantly different between the two groups ($p=0.21$). Maternal haemoglobin concentration at 6th month of pregnancy was significantly different ($p<0.001$) between the two groups. Incidence of stillbirth during the study period was higher in the multiparous women (26.2%) than in the mother with 1-2 births (0%). Maternal height, weight, mid upper arm circumference and triceps skin fold thickness at 6 month were significantly different between the two groups. Except for protein intake at 6 month, the macronutrients and micronutrients of the diets of the two groups were basically the same.

Conclusions: Although there was no significant effect of interpregnancy interval on birth weight, infant weight at 1 and 3 months, there was a significant difference between the birth length and infant length at 1 month in

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infants of mothers with short interpregnancy interval. Maternal haemoglobin concentration at 6 months, maternal weight at 9 months and gestational age were significant determinants of birth weight indicating the importance of maternal nutrition in pregnancy.

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LIST OF FIGURES **PAGE**

LIST OF TABLES **PAGE**

TABLE OF CONTENTS

CHAPTER 1

1.0 INTRODUCTION

Short interpregnancy intervals have been found to increase the possibility of maternal and infant complications and enhance the probability of poor pregnancy outcome and maternal nutritional status. Researchers have explained these findings as due to maternal depletion and postpartum stress (Miller, 1991).

The maternal depletion hypothesis suggests that one or more years between the birth of one infant and the conception of another are essential to restore the maternal nutritional resources essential for a successful pregnancy. The syndrome has been attributed to the nutritional stress of successive pregnancies and lactation and includes inadequate pregnancy weight gain, anaemia, as well as low infant birth weight (applies to all infants who weigh 2.5kg or less) (WHO, 1990). If maternal resources are not replenished, the foetus may not grow adequately in utero or the infant be born too soon.

Postpartum stress may influence births following a short birth interval because the care of an infant or very young child may place a physical and emotional strain on the mother that may interfere with the growth of the foetus or the length of the subsequent pregnancy. A long time interval between pregnancies is very important because having births too close together does not allow the woman's body to recover from the strain of pregnancy, childbirth and breastfeeding. On the other hand, women who because of social or behavioural characteristics are at high risk might experience repeated pregnancies in a short time span. In such cases, the interpregnancy interval (defined as the elapsed time from the end of the next pregnancy) is only a marker for other factors, and modification of this interval would likely have a major effect on birth weight (Klebanoff, 1988).

Good nutrition is needed during pregnancy because the mother has to give birth a child of at least 2.5kg with no congenital malformation and must be alive. Various factors such as maternal pre-pregnancy weight, height and weight gained during pregnancy may affect the birth weight of the infant. A well-nourished woman enters pregnancy with a reserve of several nutrients, which will meet the needs of the foetus without jeopardizing her health and bear a full term infant (≥37 weeks). During pregnancy the mother should consume a diet that is sufficiently adequate in order not to deplete her stores and produce enough milk to nourish her child after birth. Pregnancy outcome (birth weight, birth length, head circumference, gestational age and infant mortality) depends on various factors such as biosocial, biomedical, psychological and nutrition. Since nutrition and socio-economic factors are interrelated, the independent role that nutrition may play in pregnancy outcome has been difficult to elucidate.

Maternal age may be considered a biological determinant of reproductive efficiency because it reflects both the consequences of immaturity of the maternal organs and the consequences of aging. Parity, usually is closely related to age, and reflects the physical effects of previous gestational experience. For childbirth, maternal age and parity are ultimately influenced by a wide variety of intervening factors, such as childhood, adult health and nutritional status. One's lifetime dietary habits, family income, social class, education, work status, attitude towards pregnancy and child spacing may also have an influence on reproductive efficiency.

1.1 RATIONALE OF THE STUDY

Frequent childbearing is threatening maternal health and is detrimental to the health and survival of the child. In Ghana, the impact of frequent reproductive cycling on pregnancy outcome and maternal nutritional status has not been studied in Ghanaian mothers. There's the need to study the effects of repeated reproductive cycle on pregnancy outcome and maternal nutritional status.

1.2 RESEARCH OBJECTIVE

The purpose of this observational study was to compare the effects of long and short reproductive cycling on pregnancy outcome and maternal nutritional status.

SPECIFIC OBJECTIVES

1. To determine the effect o f long ($\geq$ 21 months) and short ($\leq$ 21 months) reproductive cycles on pregnancy outcome (birth weight, birth length, head circumference and gestational age).
2. To determine if differences exist in the nutritional status (dietary, anthropometric, biochemical and clinical picture) of mothers with long or short birth intervals.

HYPOTHESIS

Short reproductive cycle has adverse effects on pregnancy outcome and maternal nutritional status.

CHAPTER 2

LITERATURE REVIEW

2.O BACKGROUND

Little is known about the inter-relationship of frequent reproductive cycle and its influence on maternal nutrition, health and birth outcomes in the lesser economically developed societies, especially Africa. The birth weight of an infant is the most important determinant of morbidity in the neonatal period and may have an influence on health in adult life. An increase prevalence of unfavourable pregnancy outcomes, including low birth weight and preterrm delivery, has been reported to be associated with intervals of less than six months between pregnancies (Mavalankar and Gray, 1991). A short interval between two pregnancies has been investigated as a possible risk factor for poor pregnancy outcome i.e. low birth weight and preterrm birth (Kallan, 1992). Others believe the effect is due to confounding (Klebanoff, 1988). Lang et al (1990) and Rawlings et al (1995) reported an interval of less than twelve months as a risk indicator for poor pregnancy outcome, while Brody and Bracken (1987) did not confirm such results in the population studied.

2.1 BIRTH SPACING AND PREGNANCY OUTCOME

When a woman has pregnancies close together, the likelihood increases that the pregnancy will end in a miscarriage or that an infant born alive will die (Morley, 1973). Women all over the world know the danger of ill-timed pregnancy and having many children. In India, Iran, Lebanon, the Philippines and Turkey, 21,000 women were interviewed in a WHO study (WHO, 1979). More than nine in ten women said the health of the child and the mother are better if the child is born 3 years after the previous birth, rather than an interval of only one year. It was also noted that the number of children a woman already had affects her chances of having a successful pregnancy and a child who survives. Foetal death rates increase with birth order.

Data collected in many countries by the World Health Organization and the Pan American Health Organization Have documented an increase in deaths among infants born after short pregnancy intervals. Infants born less than one year after the mother's last pregnancy were much more likely to die than infants born after a longer interval (WHO, 1979). The risk to infant health posed by short birth intervals continues even after the first year of life. Studies done in the Philippines show that, death rate among children in rural and urban settings and among various religious and ethnic groups differ with higher mortality among infants born after short pregnancy interval remains (i.e. less than 12 months).

One consequence of frequent cycles of reproduction is that lactation occurs concurrent with pregnancy. When births are closely spaced, the prevalence of the overlap of lactation with pregnancy increases. The inter-birth interval consists of four periods.

i. The recovery from pregnancy.
ii. A period of amenorrhoea during breastfeeding.
iii. The resumption of the ovulating cycles (which may not take place if a new conception occurs).
iv. Finally, a new pregnancy.

It has often been observed that women living under deprived circumstances experience the dual nutritional insults of inadequate dietary intake and repeated closely spaced reproductive cycles. These insults have a deleterious effect on the health and can result in high rate adverse reproductive outcomes (Fischbeck and Rasmussen, 1987). The birth interval dynamics indicate that, breastfeeding exerts its effects on fertility in two ways. The first and by far the stronger effect comes through prolongation of post-partum amenorrhoea, the time from child birth until a woman resumes ovulation or menstruation. The second effect occurs after the end of the post-partum period, when breastfeeding can reduce the probability that the next ovulation will result in conception. Frequency and extent of breastfeeding are primarily socially determined. Its effect on amenorrhoea is of course biological. Women who do not breast-feed, resume ovulation within a very short time (about 6 weeks) after a live birth (Mc Neilly and Howie, 1982).

In a sample of Guatemalan women it was shown that lactation concurrent with pregnancy resulted in increased supplement intake during the first trimester of pregnancy (Merchant et al, 1990). Another consequence of frequent reproductive cycle is a reduction in the recovery time available to women between reproductive events such as pregnancy and lactation. The Guatemalan study also demonstrated that short recuperative periods (<6 months) resulted in increased supplement intake during the first and second trimesters of pregnancy and slightly reduced maternal fat stores relative to long recuperative periods (> 6 months). The results also suggested that long recuperative periods and the absence of overlap might favour foetal growth slightly (Merchant et al, 1990). Tomkins and Watson (1991), provided an additional support for the hypothesis that short recuperative interval (< 9 months) is stressful for the mother and it increases supplement intake as well as reduces fat stores.

Fourn et al, (1990), in their cohort study taking into account socio-demographic factors and previous obstetrical history, found no relationship between pregnancy interval and preterrm low birth weight. However, maternal age, number of previous births, maternal nutritional status and educational level correlated with low birth weight. An inquiry was also made into birth interval dynamics and maternal and child health in rural Java. It was observed that postpartum abstinence appears to play a vital role in birth spacing for many women (Hull, 1983). The nutritional stress imposed by reproduction, affects maternal and foetal outcomes. Maternal nutrient stores can be depleted and foetal growth can be restricted in association with shorter birth intervals (< 9 months). Perinatal nutrition may be improved by adequate spacing of pregnancies with appropriate birth control (Khan et al, 1998).

2.2 MATERNAL NUTRITION AND PREGNANCY OUTCOME

The term “Nutritional status” is the condition of health as influence by the utilization of nutrients. The relation of the nutritional status of the mother to the course of the pregnancy and to the health of the infant has been the subject of much study. A short interval between two pregnancies may affect the outcome of the next pregnancy if it has an impact on the mother's ability to re-establish a proper hormonal balance and recover from nutritional depletion after the previous pregnancy (Wynn, 1987 and Kallan, 1992).

According to numerous studies, there are fewer stillbirths, premature births, toxaemia of pregnancy, and illness in the newborn infant, if the mother has consumed optimal diet before her pregnancy and during gestation. Some of the warning flags for poor maternal nutrition include frequent pregnancies, a history of low birth weights, diseases that affect nutrition such as diabetes and anaemias. Various factors influence the type of food eaten, and the regularity of meals in communities, families and with individuals. Prominent among these factors are the social and economic variables. Poverty again accentuates the problem of ignorance in dealing with feeding pattern in the home, and it may also undermine the emotional stability of the mother to develop a good food habit and hence better nutritional status. The nutritional status of the mother at the time of conception is known to be as important for the outcome of her pregnancy as is the diet during gestation. Good nutrition during pregnancy speeds up recovery during the puerperium. Moreover, good nutrition during the post partial period results in a greater ability to cope with the experience of mothering.

The infant's weight, length, and brain development all depend on the expectant mother's nutrition. The long-range effects continue to influence the child's entire physical and mental growth and development. The relationship of maternal nutrition and pregnancy outcome has been established mainly from large-scale observation and in crisis situations like war and famine (Goodhart and Shils, 1989). The general evidence indicates that good nutrition is necessary for efficient pregnancy outcome, and also sets the stage for successful breast-feeding.

The most dramatic observations are those made in Great Britain during World War II. Under the food rationing policy, pregnant women were given special priority, and the low-income groups were significantly enhanced. The stillbirth rate fell from a previous rate of 38 per 1000 live births to 28, a fall of about

25% during a period when many aspects of the physical environment were deteriorating (Food and Nutrition Board, 1971).

Famine, during any part of pregnancy, long enough to deplete maternal nutrient reserves has been shown to reduce birth weight, increase perinatal complications, and mortality of both mother and infant.

It is generally recognized that in populations where chronic undernutrition is common, low birth weight deliveries, poor growth and development and even death in infancy are prevalent (Food and Nutrition Bulletin, 1984). The maternal and foetal effects of the nutritional stress imposed by reproduction in a cohort of 278 women followed over two consecutive pregnancies were evaluated. The study revealed that maternal nutrient stores can be depleted, and it explained how foetal growth can be affected by shorter birth intervals of < 6 months. Perinatal nutrition may be improved by adequate spacing of pregnancy with appropriate birth control (Khan et al, 1998).

Another study which looked at anthropometric (weight, mid-arm circumference and skin fold) predictors of low birth weight outcome in teenage pregnancy revealed that the highest relative risks of low birth weight were found among births to teenage mothers. The sample consisted of 100 girls less than 17 years old. Data were collected from 19 to 35 weeks' gestation. Adolescent mothers who delivered low birth weight (LBW) infants demonstrated different patterns of anthropometric changes than adolescents who delivered normal birth weight infants (NBW). Increase in mean mid-arm circumference in the

LBW group (0.05mm/wk) was significantly less ($p < 0.05$) than mean increases in the NBW group (0.80mm/wk).

Changes in maternal nutritional status may in part mediate the birth weight outcomes in adolescent pregnancy. Anthropometry may be useful in predicting those teens at highest risk of bearing LBW infants (Maso et al, 1988).

The interaction between nutritional status estimated by using body mass index and fertility outcome was tested in two female samples from Northern Namibia. It turned out that Kung San undernourished females had significantly more total and surviving offspring than well nourished and overweight females of these population. In contrast, within the Kavango group, well-nourished females had the highest reproductive success (Kirchengast and Winkler, 1996). In India, a study conducted on the relationship between maternal nutritional status and spontaneous abortion revealed that the incidence of pregnancy wastage was high among poor women. Though the aetiology of spontaneous abortion is multifactoral, nutritional deficiency was considered to be an important contributory factor (Neela and Raman, 1997).

The relationship between maternal nutritional status and infants weight and body proportions at birth was investigated in Kingston, Jamaica. Records for 2394 live, singleton births, between 200-305 days gestation were looked at. The main outcome measures were birth weight, crown heel length, head circumference, ponderal index, head circumference: length ratio, placental weight, placental: birth weight ratio. The data support the hypothesis that poor maternal nutrition is associated with foetal growth restraint. Poor maternal nutrition as indicated by low weight, height, and BMI are associated with smaller, shorter babies with smaller heads (Thames et al, 1997).

The relationship between maternal dietary intake and infant birth weight was investigated. Twenty-four hour recalls were used to measure energy, zinc, folate and other nutrient intakes at 18 and 30 weeks of gestation. Subjects in the study were offered daily folic acid (1.0mg) and iron (60mg as ferrous sulphate) at enrolment. Folate intake, although significantly associated with birth weight, was a weak predictor while maternal intake of zinc and other nutrients was not associated with birth weight (Neggers et al, 1997).

In order to determine the relationship between maternal anthropometric indicators and birth weight, crown-heel length and newborn's head circumference were measured. Ninety-two women were followed till term at the prenatal service of a hospital in Brazil. The following variables were established for the mother: weight, height, mid-upper arm circumference, pre-pregnancy weight, gestational weight gain and Quetelet's indexes. For the newborn: birth weight, Dubowitz's score recorded, crown-heel length, head circumference and gestational age. Significant associations were noted between gestational age and newborn variables. In addition, maternal mid-arm circumference (MUAC) and pre-pregnancy weight were found to be positively correlated with birth weight ($r = 0.399$; $r = 0.378$, respectively). Similarly, MUAC was significantly associated with crown-heel length ($r = 0.306$; $p < 0.003$). The study showed that maternal mid-upper arm circumference is a potential indicator of maternal nutritional status. It could be used in association with other anthropometric measurements (Ricalde et al, 1988).

2.3 ENERGY NEEDS DURING PREGNANCY

For a typical pregnancy weight gain of about 12.5kg and a median infant birth weight of 3.3kg, the average extra energy cost of pregnancy has been calculated to be about 80,000kcal over the nine-month period (FAO/WHO, 1985). This amount of energy is distributed as an extra 150kcal/day during the first trimester and 350 kcal/day during the second and third trimesters (FAO/WHO, 1985).

A cautious policy was adopted for an amount of energy allowance of 285kcal/day if healthy women reduce their activities during pregnancy (James and Schofield, 1990). Measurement of basal metabolic rate (BMR) shows modest increase in late pregnancy with a reduction in the metabolic response to food. Reported studies have indicated that even in women who do not take in commensurate amount of energy, enough fat provides the reserve needed for subsequent lactation, and the foetal and maternal tissues grow satisfactorily (FAO/WHO, 1985).

Studies of well-nourished pregnant women show that maternal physical activity is reduced to conserve energy during pregnancy. For instance, slowing of self-paced work, example in climbing stairs is common, so that the energy expended per unit time is maintained at approximately the same level as in the non-pregnant state. On this it has been suggested that a modest increase in intake of 100kcal per day might have been barely detectable but would have covered the observed increase in BMR (James and Schofield, 1990). The FAO/WHO consultative group agreed on two values as follows:

a. Pregnancy requirement; 100kcal/day (for well-nourished pregnant women).

b. Pregnancy active allowance; 285kcal/day (for poorly nourished pregnant women) (James and Schofield, 1990).

2.4 PROTEIN NEED DURING PREGNANCY

The total protein requirement of a woman gaining 12.5kg of extra weight during pregnancy and who delivered 3.3kg infant has been estimated to be 47g per day throughout pregnancy (FAO/WHO, 1985). The rate of storage is not constant. Estimates provided for the first, second. Third and fourth quarters are respectively, 0.64, 1.84, 4.76 and 6.10g of protein per day (FAO/WHO, 1985). Thus, it is estimated that the protein requirement should be increased by an average of 6g per day throughout pregnancy. These amounts should be added to be added to the non-pregnancy allowance of 41g per day and the sum corrected for digestibility (FAO/WHO, 1985).

In an attempt to determine the relationship between maternal protein nutriture and foetal size at birth, serum samples at 18 and 30 weeks gestation were obtained from 289 indigent multiparous women. The concentrations of albumin, prealbumin and retinal-binding protein correlated with birth weight, foetal growth and others of nutritional status. It was found that serum albumin levels at 18 weeks correlated inversely with birth weight ($p < 0.05$). this negative correlation was explained by an inverse relationship between albumin concentration and maternal body mass index (BMI). There was no significant correlation between albumin levels at 30 weeks and birth weight, or between birth weight and the concentrations of the other two proteins at either gestational age. It was evident that serum protein levels are not predictive of birth weight or growth retardation at birth, but do correlate significantly with a number of other measures of nutritional status (Maher et al, 1993).

2.5 IRON NEED IN PREGNANCY

Iron needs during pregnancy cannot be met through dietary iron intake. It is recommended that iron supplementation during pregnancy must not be limited to women in whom anaemia has been identified (Tomkins and Watson, 1991). Nonetheless, diets can increase iron status in three main ways;

a. By increasing the intake of heam iron from animal products.
b. By increasing the intake of vitamin C, along with foods promoting iron absorption, for example, acidic and fermented foods.
c. By reducing the intake of inhibitors of iron absorption; for example; coffee, tea and some cereals.

Such dietary modifications, in addition to allowing cultural constraints especially concerning animal products, provide a potential solution to reducing iron deficiency anaemia.

For prevention of iron deficiency anaemia in pregnant and lactating women, 60mg elemental iron (200mg ferrous sulphate, often with 250mg folate) per day (1 tablet) for four months is recommended in areas where iron deficiency anaemia is low prevalence. In areas of higher prevalence, 2 tablets i.e. 400mg ferrous sulphate per day is recommended (Tomkins and Watson, 1991). The iron dose for treatment of anaemia depends on the degree of the anaemia. For severe anaemia, (Hb < 7g/dl), in pregnant and lactating women, 60mg elemental iron (200mg ferrous sulphate) three times daily is recommended, twice daily for mild and moderate anaemia (Tomkins and Watson, 1991).

During pregnancy, a number of health intervention measures are taken with the aim of ensuring favourable outcome of pregnancy. Some of the health measures include immunization against tetanus infection (UNICEF, 1991), supplementation of mineral and vitamin intakes and advice on good health and nutritional practices during pregnancy. These measures lead to adequate weight gain and also increases foetal size and hence increase birth weight. However, their effects on pregnancy outcome and labour need careful examination. If the effect of such interventions operates across the range of birth weight distribution, one of the effects might be to increase the likelihood of difficult labour resulting from cephalopelvic disproportion. The trend towards slightly larger infants has been accompanied by increase use of caesarean delivery in developed countries (Garner and Kramer, 1992).

To determine the extent of iron deficiency in the western Canadian artic, the prognostic value of prenatal ferritin levels and the desirability of prenatal iron supplementation were used. Dietary iron intake were determined in 171 women and ferritin levels determined in 121 women during pregnancy, 79 at delivery and 77 postnatally, as well as in 65 of their infants at birth and 74 postnatal. Iron deficiency (ferritin < 15ng/ml) was present in 34% of the women during the first two trimesters, 25% (20/79) at delivery and in 51.7% (15/29) of mothers and 31% (9/29) of infants beyond four months after delivery. Maternal follow-up ferritin levels correlated poorly with dietary iron intake but well with prenatal ferritin levels, which appeared to be good predictors of the effectiveness of supplementation. Mean infant follow-up ferritin levels were 105.6 ± 115.2ng/ml with, and 46.7 ± 63.5 without maternal prenatal supplementation ($p < 0.03$), respectively; corresponding maternal value were 45.5 ± 40.9ng/ml and 12.8 ± 9.2, respectively ($p < 0.001$). Measurements of prenatal ferritin levels to determine risk of iron deficiency and routine prenatal iron supplementation are recommended (Godel et al, 1992).

2.6 ANAEMIA IN PREGNANCY

Anaemia is usually defined as a significant reduction in the concentration of haemoglobin per 100ml of blood, or in the volume of packed red cells per 100ml of blood, or in the number of erythrocytes per cubic millimeter of blood (DeMaeyer, 1989). Anaemia in pregnancy is not only a major public health problem in developing countries, but is a significant problem in the developed world. In developing countries 55-60% of pregnant women are anaemic, and in the developed countries, this drops to 18% (WHO, 1990).

The world Health Organization defines anaemia in pregnancy as haemoglobin levels less than 11.0g/dl. Conservative estimates indicate that 1500 million people are anaemic worldwide, with the majority (1400 million) in the developing world, mainly in South Asia and Africa (WHO, 1990). This value is women during the first two trimesters, 25% (20/79) at delivery and in 51.7% (15/29) of mothers and 31% (9/29) of infants beyond four months after delivery. Maternal follow-up ferritin levels correlated poorly with dietary iron intake but well with prenatal ferritin levels, which appeared to be good predictors of the effectiveness of supplementation. Mean infant follow-up ferritin levels were 105.6 ± 115.2ng/ml with, and 46.7 ± 63.5 without maternal prenatal supplementation ($p < 0.03$), respectively; corresponding maternal value were 45.5 ± 40.9ng/ml and 12.8 ± 9.2, respectively ($p < 0.001$). Measurements of prenatal ferritin levels to determine risk of iron deficiency and routine prenatal iron supplementation are recommended (Godel et al, 1992).

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Pregnancy imposes a substantial burden on the maternal haematopoietic system because of the need for augmented erythropoiesis in the face of an expanding plasma volume and obligatory placental transfer of the two most important micronutrients involved, iron and folic acid (Serge and Galan, 1986).

Other important causes of anaemia in deprived pregnant mothers are:

a. Increased blood loss due to system infection including malaria, bacterial bacterial and viral infestations, or intestinal parasitism notably, hookworm and roundworm infestation.
b. Increased iron requirements for foetal growth.
c. Dietary iron deficiency due to insufficiency of iron in the diet or low physiological availability.
d. Inability of women with initially depleted iron stores to make up for blood loss during previous childbirths because pregnancies are too close each other (Shah, 1981).

In tropical countries, other causes of anaemia like inflammatory syndrome and sickle cell anaemia are possible (Serge and Galan, 1986).

In Ghana, data show that 69% of women tested at antenatal clinics in 1987 were anaemic by World Health Organization (WHO) standards, i.e. haemoglobin level below 11.0gdl (UNICEF, 1990). A 1986 survey found majority of women in Ashanti Region to be anaemic (UNICEF, 1990). Ministry of Health (MOH) nutritional surveys in 1986 and 1988 also found greater percentages of women in Volta and Northern regions to be anaemic compared with other regions (UNICEF, 1990).

A WHO report on maternal Health and safe motherhood (1992) stated that 56% of women in West Africa have haemoglobin levels below normal, and 64% of Ghanaian women have haemoglobin levels below normal and of this 11% had haemoglobin level below 10g/dl (WHO, 1992).

To identify biochemical indices for iron and protein nutriture as well as acute-phase reactants as predictors of preterrm delivery in a case control study, serum samples were obtained at about 24 weeks gestation from 94 indigent multiparas. These cases were defined as having a spontaneous delivery of 32 weeks or less (n=31) with two control groups, one delivering spontaneously at 33-36 weeks (n=32) and the other delivering spontaneously at 37 weeks or more (n=31). The concentration of iron, ferritin, transferrin saturation and transferrin receptor were measured as indices of iron status. The concentrations of acute-phase reactants (C-reactive, protein, alpha-2-macroglobulin, beta-2-microglobulin and ceruloplasmin) were measured, along with albumin, prealbumin, retinal-binding proteins copper and zinc. The study found that, elevated serum ferritin levels during the second trimester are predictive of early spontaneous preterrm delivery, possibly because these reflect an acute-phase reaction to sub-clinical infections that are closely associated with preterrm delivery (Tamura et al, 1996).

2.7 PREGNANCY WEIGTH GAIN AND ITS EFFECT ON PREGNANCY OUTCOME

Women gain weight and body fat during pregnancy and tend to lose it during lactation (Food and Nutrition Board, 1991). The amount of weight gained during pregnancy is higher with better living circumstances. The amount of weight retained after delivery shows this same discrepancy between poor and rich countries. In the United States, the rate of weight loss post-partum is often higher among lactating women than among non-lactating women (assuming that the women are not consciously dieting) (Dewey at al, 1993).

Several factors have been associated with gestational weight gain. These include maternal pre-pregnancy weight for height, maternal height, ethnic background, age and parity, cigarette smoking, socio-economic status and energy intake. Pregnancy is associated with physiological adjustments and synthesis of maternal tissues including the growth of the foetus itself. These changes lead to increase in weight of the pregnant woman and a strongly positive association exists with the weight of the infant. Normal pregnancy is associated with a weight gain of 6.75kg to 12.25kg (Dewey et al, 1993). As a goal, the higher figure is best for those underweight while the lower one would be best for those greatly overweight.

Five hundred and twenty-eight consecutive singleton births delivered at the Armed Forces hospital in Saudi Arabia were to identify the relationship between prenatal weight gain, maternal stature, antenatal clinic attendance and low birth weight. Of the total number, 9.5% (50/528) babies were of low birth weight, 56% of which were pattern observed in developed countries rather than developing countries. It was observed in the study that, mothers who delivered low birth weight babies gained significantly less weight in the 3^{rd} trimester. It was suggested that to reduce the low birth weight rate and improve birth weight attention needs to be paid to weight gained in the third trimester and the last four weeks of pregnancy. Antenatal clinic attendance should also be encouraged (Lawoyin, 1997).

Pre-pregnancy weight for height is a determinant of gestational weight gain. On the average, women who are overweight at conception (i.e., women whose BMI exceeds 26.0) gain less weight during pregnancy than do thinner women. However, there is wide a variation in weight gain by women with normal pregnancies within each pre-pregnancy weight-for-height category. The variation is highest among obese women (BMI > 29.0). Some other maternal characteristic associated with an increased risk of low gestational weight gain (less than 7kg or 16lb) occurs in combination, e.g., low family income, black race, young age, unmarried status, and low educational level. These characteristics are also associated with shortened gestational duration. Other factors suggest that black women are more likely to have low weight gain than are white women, but the reason for this difference is not known (Dimperio, 1988).

Some ethnic groups exhibit small average weight gains, but the clinical significance of this has not been established. In studies of groups of women in the United States and elsewhere, energy intake is a determinant of gestational weight gain, but the reported relationship is weak. Large body size and the level of physical activity determine variation in energy intake during pregnancy, not by gestational weight gain. Furthermore, energy intake may erroneously appear to be relatively unimportant for gestational weight gain if women expend less energy by decreasing their physical activity.

Data concerning the effect of changes in maternal body composition on foetal growth are meager and inconclusive. Studies suggest that increases in maternal fat, lean tissue, and body water may each be associated with increased foetal growth. Very high gestational weight gain is associated with an increased rate of high birth weight, which in turn is associated with some increase in the risk of fetopelvic disproportion, operative delivery (forceps or caesarean delivery), birth trauma, and asphyxia and mortality. These associations appear to be more pronounced in short women, i.e., 157cm. A lower ceiling on weight on weight gain may therefore be preferable in short women at any given weight for height (IOM, 1988).

2.8 INFANT BIRTH WEIGHT

Birth weight has been used as a good indicator of pregnancy outcome. It also reflects its importance for child mortality, morbidity, physical performance and mental performance. Small babies are considered unfavourable outcome of pregnancy because they contribute to early infant mortality and as a group, have a high incidence of subsequent physical and behavioural abnormalities.

Low birth weight (LBW) is defined by the World Health Organization as birth weight less than 2.5kg. A short gestational period (gestational age < 37 weeks), or retarded intrauterine growth i.e. an infant small for gestational age (birth weight < 2.5kg and gestational age ≥ 37 weeks) is considered as unfavourable pregnancy outcome. Some babies weigh far in excess of the normal birth weight range (2.51-4.00) kg. Macrosomia has been used to describe babies weighing over 4.0kg (Garner and Kramer, 1992). Such babies increase the risk of mechanical difficulties during labour.

Birth weight is affected by various factors. Pre-pregnancy weight and height of the woman as well as nutrition and weight gained during pregnancy are some of the known factors that effect birth weight. Maternal weight gain and gestation duration are important determinants of infant birth weight (McGregor et al., 1988; Seidman et al., 1989; Sauerborn et al., 1992). It is not known however, that total or third trimester weight gain is most conductive to optimal maternal and foetal outcome. It seems apparent that infants born prior to term will usually weigh less than those who go to term, since much of the foetal weight gain takes place during the third trimester. This is the period when the greatest increase in maternal and foetal tissues occur (Worthington-Roberts et al., 1985). Acceptable birth weight (2.51-4.00) kg is an indication of favourable outcome of pregnancy.

CHAPTER 3

MATERIALS AND METHODS

3.0 THE STUDY LOCATION

The study site was Accra, the capital of Ghana. Accra has a monodal rainy season, lasting from May to October, with most rain falling between June and July tailing off slightly in August. Accra being in the Guinea Savannah zone, the main crops grown are maize and cassava in addition to vegetables like tomatoes, pepper, okro and garden eggs.

3.1 THE STUDY POPULATION

The subjects inhabitants of central Accra and its environs, made up of a mixture of all the tribal groupings in Ghana as can be expected of any metropolis. The mothers were between the ages of 19 to 44 years. Most of the mothers were married, majority were engaged in fish smoking and petty trading. A few were salaried office workers.

3.2 THE STUDY DESIGN

The study employed a longitudinal study design. Eighty-four pregnant women in their second trimester were enrolled and followed-up until they delivered. Forty-two of these women were multiparous (mothers with more than four births), with an interpregnancy interval of less than twenty-one months between the last and the index child. The interpregnancy interval for this study was defined as the elapsed time from the previous delivery to the next conception. The other forty-two women were either nulliparous or mothers who were about to have their second child and with an interpregnancy interval of more than twenty-two months.

3.2.1 SELECTION CRITERIA

Two categories of mothers were selected for the study.

(i) Subjects with short reproductive cycle ($\leq$ 21 months).

(ii) Subjects with long reproductive cycle (> 21 months).

The short reproductive cycle, was defined as birth interval equal or less than 21 months between the date of conception (the first day of the last menstrual period) of the index child and the date of the delivery of the previous child. Mothers were asked to give the birth date of the previous child, this enabled the calculation of the birth interval and for the determination of mothers as exposed. The control group (long reproductive cycle > 21 months) was made up of mothers with either one or two births. Mothers who delivered twins were excluded from the study.

A subject with short reproductive cycle in this study:

Is multiparous and should have more than four children.

A subject with long reproductive cycle had the following characteristics:

Is either nulliparous or has a child.

3.2.2 SAMPLE SIZE CALCULATION

Sample size was calculated based on a pilot study. Births weights and lengths of 20 babies from the following categories: 10 for mothers with short reproductive cycle and the other 10 for mothers with long reproductive cycle were measured. Based on the pilot study, a difference of 1.58cm 49.60 $\pm$ 3.07 for babies of mothers with long reproductive cycle and 48.02 $\pm$ 1.99 for babies of mothers with short reproductive cycle was obtained from the birth lengths between the two groups. Using a level of significance of 0.05, power of 80%, and two-sided test type. The sample size was calculated using the formular below.

$$N = \frac{(\sigma_1^2 + \sigma_2^2)(z_{1-\alpha/2} + z_{1-\beta})^2}{\Delta^2}$$

where

σ_1 = 3.069 (standard deviation for mothers with 1-2 births).

σ_2 = 1 992 (standard deviation for multiparous mothers).

$Z_{1-\alpha/2}$ = 1.960 (obtained from tables).

Power $(80\%)_{\beta}$ = 0.840 (obtained from tables).

Δ^2 = $(\mu_1 - \mu_2)$ (μ_1= 49.60 and μ_2 = 48.02 are the means of birth length for mothers with 1-2 births and multiparous, respectively). Thus the sample size calculated was 42 per group. All mothers who fell into the selection criteria and gave consent were recruited in the study. Once recruited, baseline data on household characteristics, socio-economic status, anthropometry, dietary information and reproductive history were collected by questionnaire.

3.3.□ MATERNAL ANTHROPOMETRIC MEASUREMENT

Maternal height, weight and skin fold were measured using standard procedures.

3.3.1 HEIGHT MEASUREMENT

A stadiometer, calibrated in millimeters was used to measure maternal height. Mothers were made to stand upright with bare foot on a firm level wooden platform. The sliding headpiece of the stadiometer was moved to the level of the crown of the head and the level of the pointer read.

3.3.2 WEIGHT MEASUREMENT

Weights of the pregnant women were measured monthly from 6 to 9 months of pregnancy. The weight measurements enabled the computation of the rate of weight gain over the three-month period. This was determined from the difference in weight first obtained in the 6^{th} month of gestation and that of 9^{th} month. The equipment used was the adult weighing scale with a least count of 0.5kg (Salter). Mothers wore light clothing, and all accessories such as earrings, watches were removed before weighing. They were also bare footed.

3.3.3 MID-UPPER ARM CIRCUMFERENCE

The measurement was taken on the left arm, while hanging freely at the mid-point between the olecranon and the tip of the acromium process. The region is selected in the same way as for the triceps skin fold. The arm circumference is measured to the nearest 0.1 cm with measuring tape, which is placed gently, but firmly around the arm to avoid compression of the soft tissue.

3.3.4 SKIN FOLD MEASUREMENT

Measurement of subcutaneous fat was taken on the left arm at the Triceps. A Harpenden skin fold caliper, calibrated in millimeters was used. Measurement was made to the nearest 0.2mm. As the fat in this region is not uniform in thickness, the site is carefully selected, halfway down the arm. The triceps skin fold measurement was taken at midway between the shoulder and the elbow, between the tip of the acromium process of the scapula and the olecranon process of the ulna at the back of the left arm, held in a relaxed position. The skin fold parallel to the long axis was picked up between the thumb and fore finger of the left hand, pulled gently away from the underlying muscle and measured.

3.4 HAEMOGLOBIN DETERMINATION

Finger prick blood samples from the mothers were analysed to determine the concentration of haemoglobin at the 6th and 9th month using the Hemocue B-haemoglobin photometer (Angelholm, Sweden). The patient was seated comfortably and the hand from which the sample was to be taken was warmed gently by rubbing. The finger was kept straight but not tense, to avoid the stasis effect that occurs when the fingers are bent. The middle finger was used for the sampling. The puncture site was cleaned and wiped dry. Using my thumb in a gentle rocking movement, the finger was pressed lightly from the top knuckle to the tip in order to stimulate the flow of blood to the sampling point. Using the lancet, the side of the finger was pricked. The first drop of blood was wiped away with a dry absorbent pad. This stimulates spontaneous blood flow. The cuvette tip was introduced into the middle of the drop of blood. It was filled in a continuous process. The excess blood on the outside of the cuvette tip was wiped off. The accuracy of the haemoglobin counter was checked daily using reference cuvettes with known haemoglobin concentrations. The filled cuvette was put in the holder of the Hemocue and pushed into till the stop point. After about approximately 45 seconds, the haemoglobin value was displayed.

3.5 CLINICAL OBSERVATION

The schedule employed was to detect the most characteristics signs of nutritional deficiencies and to correlate the findings with thee other indicators of nutritional status. In this study, the eyes, lips and gums were examined for clinical signs.

3.6 DIETARY EVALUATION

The evaluation of individual nutritional status leading to identification of at risk groups requires the study of foods actually consumed by t he individual. A 3-day 24-hour recall was used to determine food intake. The subject recalled all food and amounts eaten over the previous 24 hours. All foods and snacks eaten by the pregnant women on three different occasions were recalled and recorded.

Information on food intake was collected on the 6^{th} and 9^{th} of pregnancy and 3 months after delivery. Food quantities were estimated in ordinary servings (e.g. cupful, ladle) etc. The dietary information obtained was recorded on dietary evaluation forms on the questionnaire (appendix 1). The weights of foods consumed by the mothers were estimated by weighing representative samples on a portable electronic scale. The weights of foods consumed were translated into nutrients and energy by use of Food processor software program (Food processor). For the three occasions, total amounts of each nutrient consumed were computed, after which mean daily intakes were realised.

The average of individual mean daily nutrient intakes were determined and compared with FAO/WHO (1985) recommended nutrient allowances for pregnant women (appendix 3).

3.7 INFANT ANTHROPOMETRY

Pregnancy outcome data, including birth weight, birth length and head circumferences were obtained within the first 24 hours after delivery.

3.7.1 WEIGHT MEASUREMENT OF BABIES

The babies were weighed in the nude, using a beam balance with a least count of 0.01kg (Seca).

3.7.2 LENGTH MEASUREMENT

The length of the babies was taken using an infantometer. Mothers were asked to assist in measuring their babies. The child was laid on the measuring board with the head in contact with the headboard and knees and spine straight. The foot piece was slid to make firm contact with the soles of the feet. The reading was then recorded to the nearest 0.1cm.

3.7.3 HEAD CIRCUMFERENCE

The head circumference is relatively unaffected by malnutrition and therefore it has been proposed that one might relate other anthropometric measurements to head circumference to produce ratios that are relatively age independent. Measurement were taken by placing the tape firmly round the frontal bones, just superior to the supra-orbital ridges, passing it round the head at the same level on each side, and laying it over the maximum occipital prominence at the back.

3.7.4 MATERNAL AND INFANT ANTHROPOMETRIC MEASUREMENT AFTER DELIVERY.

Mothers were asked to assemble at the clinics for postnatal follow-up to take anthropometric measurements of both mother and infant at one and three months after delivery. The breastfeeding frequencies were also recorded at these visits.

3.8 LIMITATIONS OF METHODOLOGY

There were limitations in the following aspects of the research methodology.

1. Estimation of maternal age.
2. Information on their reproductive history.
3. Birth interval.

3.8.1 ESTIMATION OF MATERNAL AGE

Most of the mothers especially the multigravidae were not able to give their exact dates of birth. Thus ages given were rounded off, e.g. 40 years 3 months was considered as 40 years.

3.8.2 INFORMATION ON REPRODUCTIVE HISTORY

Some of the mothers were not able to give the age for menarche. Some also felt embarrassed in revealing the number of pregnancies they have had. This was determined by asking the number of stillbirth, miscarriages they have had and also the number of childr4en that were alive.

3.8.3 BIRTH INTERVAL

Some mothers were not able to give the exact day or month of conception, since some pregnancies occurred concurrently with lactation. In this case the gestational age of the foetus was determined by a trained midwife using fundal height.

3.9 DATA ANALYSIS

All data were entered in Epi-info version 6. Statistical analyses were performed using PC-SAS (SAS Institute Inc., USA). Descriptive statistics included means, frequencies and correlation. Baseline characteristics were compared between the two groups of women using student's t-test. The effect of interpregnancy interval on maternal anthropometric measurement, pregnancy outcome (birth weight, infant weight at 1 and 3 months, birth length, infant length 1 and 3 months, head circumference at 1 and 3 months) and maternal haemoglobin at 6 and 9 months were compared using t-test. A statistical test was considered significant if the p value was ≤ 0.05. Multiple stepwise regression analysis was used to determine factors associated with birth weight. Four categories of independent variables were considered.

i) Maternal characteristics.

ii) Socio-economic indicators.

iii) Biochemical.

iv) Dietary intake.

To avoid problems of colinearity, independent variable that were highly correlated ($r \geq 0.7$) with each other were not entered in the model at the same time. Maternal height, maternal weight gains (i.e. weight at 9th month – weight at 6th month), were included in the models, but not parity because it was highly correlated with maternal age (r > 0.8). Maternal weight at 9th month was not used in the models because it highly correlated with weight at 6th month (r > 0.9. Mid-upper arm circumference and triceps skin fold at 9th month were used in the regression analysis instead of mid-upper arm circumference and triceps skin fold at 6th month because they were also highly correlated (r > 0.90) with 9 month values. Maternal haemoglobin concentrations at 6th and 9th month gestational ages of the index child were also included in the models. Dietary factors included in the models were mean energy protein, iron and calcium intake at 6th and 9th month.

Table 3: Variables included in the regression models

Dependent variables	Birth weight
Independent variables	
Maternal factors	Maternal height (m)
	Maternal weight at 6th month
	Maternal weight at 9th month
	Maternal weight gain (9th – 6th)
	Mid-upper arm circumference at 6th month
	Triceps skin fold at 6th month
	Gestational age of index child
Demographic factors	Maternal age (years)
	Maternal education (years)
Biochemical variable	Maternal haemoglobin level at 6th month
	Maternal haemoglobin level at 9th month
Dietary factors[1]	Energy at 6th month
	Energy at 9th month
	Protein at 6th month
	Protein at 9th month
	Iron at 6th month
	Iron at 9th month
	Calcium at 6th month
	Calcium at 9th month

[1] Dietary factors (maternal nutrient intake)

CHAPTER 4

RESULTS

4.0: BASELINE CHARACTERISTICS OF STUDY MOTHERS

In this study eighty-four Ghanaian women who reside in the Greater Accra Region, were enrolled. Mothers with long interpregnancy interval (> 21 months) were younger (19-30) years and had a lower parity as compared with mothers with short interpregnancy interval (≤ 21 months) Table 4.

No maternal death was recorded during the period of the study. None of the mothers was in the high socio-economic class. Only 15% of the mothers lived in their own house. The rest were living either in rented or family houses. It was observed that irrespective of the family size, only one or two rooms were available for a family. None of the mothers had higher education (tertiary), and majority (70%) were traders.

Table 4 shows the demographic and obstetrical characteristics of the mothers (n=84)

Table 4: Baseline characteristics of subject mothers

Variable	Mothers (1-2 births) n=42	Multiparous (> 4 births) n=42	P value
Maternal age (years)	23.76 ± 3.67	34.81± 5.34	< 0.001
Previous still birth (19)	0	19	
* Current still birth (11)	0	11	
Parity	1.55 ± 0.05	6.86 ± 1.57	< 0.001
Previous number of miscarriages(s)	6	13	
Age at menarche (y)	14.45 ± 1.60	14.43 ± 1.76	0.948
Gestational age of index child	37.83 ± 1.29	37.28 ± 3.28	0.317
Asthma (3)	0	3	
Hypertension (2)	0	2	
Sickle cell (2)	1	1	
Maternal haemoglobin at 6 mo of preg. (g/dl)	10.52 ± 1.41	9.69 ± 1.38	<0.001
Maternal haemoglobin at 9 mo of preg. (g/dl)	11.19 ± 1.04	11.31 ± 1.18	0.618
** Birth interval (months)	23-97	5-18	

No. of stillbirth recorded in the study.
** The interval between the last delivery and present conception.

As expected women (multiparous) with interbirth interval of less than twenty-one months were older than the women with longer intervals. The age difference was significant (p<0.001). Most of the mothers (68%) were between the ages of 20-34 years, 29% were above 35 years and 6% were below 19 years. Although the data was collected in Greater Accra region, mothers were from six major regions in Ghana. Fantes from the central region were the majority (42%) (Fig 1). Within the groups the percentage of unmarried women was 22%. Majority of the mothers were Christians (94%) and the remaining (6%) were of other religions (Fig 2).

The obstetrical factor that was more frequent among women with short reproductive cycle than among those with long reproductive cycle was the prevalence of stillbirth. The rate of stillbirth both previous and current was higher (26.2%) in the multiparous women (Table 4). Mothers with (1-2 birth) had fewer previous miscarriages (14.3%) compared to the multiparous women (31%). Gestational age of the index child for both groups was not significantly different (p=0.317). Age at menarche for both groups was also not significantly different (p=0.948).

Maternal haemoglobin concentration at the 6th month of pregnancy varied significantly ($p<0.001$) among the two groups being 9.69 ± 1.38 and 10.52 ± 1.41 g/dl for multiparous women and mothers with 1-2 births were respectively. At the 9th month, haemoglobin concentration was not significantly different p=0.618 for both groups. The birth interval (i.e. interval between the birth of the previous child and the conception of the index baby) was 5-18 months for multiparous women and 23-97 months for mothers with 1-2 births.

Fig. 1 Distribution of mothers according to region of origin

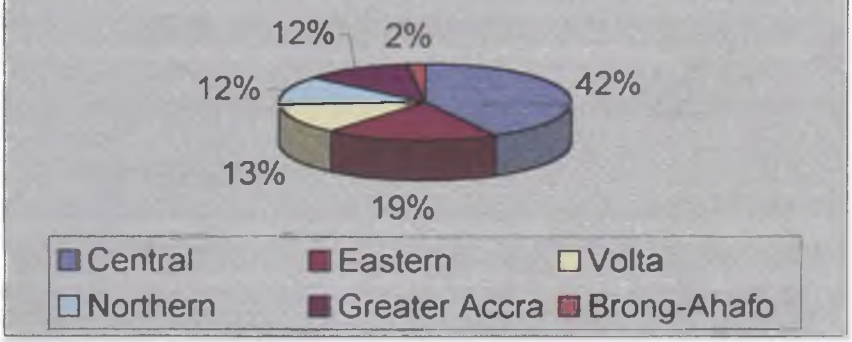
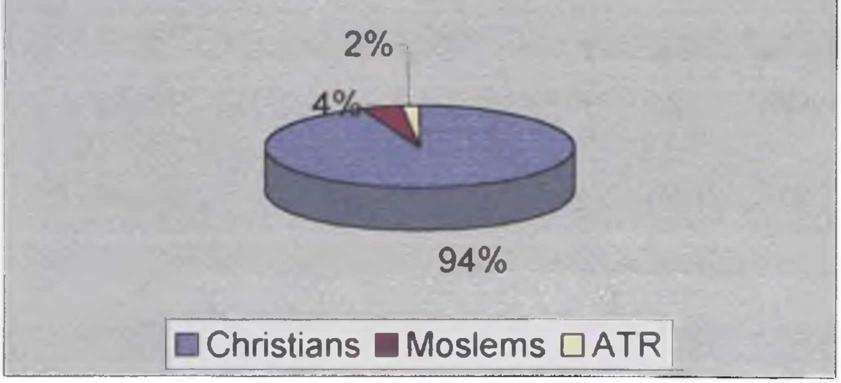


Fig. 2 Distribution of mothers by religion



4.1: SOCIO-ECONOMIC STATUS OF MOTHERS

Based on data on socio-economic status collected, a socio-economic score was calculated using the scoring system. Mothers were classified as low, middle and high socio-economic status.

Table 5: Distribution of mothers into the various socio-economic socio-economic classes.

Socio-economic status	Mothers (1-2 births) n=42	Multiparous (>4 births) n=42
Low	26 (62%)	39 (93%)
Middle	16 (38%)	3 (7%)
High	0 (0%)	0 (0%)

In this system, a mean grade point was used to assess the socio-economic status of the mothers. The variables used were as follows.

1. Level of education.
2. No. of rooms available to a family.
3. Types of furniture.
4. Bathroom facility.
5. Toilet facility.
6. Means of transport.
7. Income.
8. Tenancy.
9. Occupation
10. Possession of items indicative indicative of wealth.

The highest score given for each of the variables mentioned above was 2.5 and the least was 0.0.

E.g <u>The level of education</u>		<u>Grade point</u>
i.	No. School	0.0
ii.	Primary/JSS	0.5

iii.	Secondary/SSS	1.0
iv.	Post secondary (6th form, polytechnic etc.)	1.5
v.	University (graduate)	2.0
vi.	Post-graduate	2.5

No. of rooms available to a family	Grade point
1	0.5
2	1.0
3	1.5
4	2.0
More	2.5

The range was obtained from the mean of the variables in the formular indicated below. The figures represent the variables mentioned above. E.g. !. Level of education and 2 number of rooms available to a family etc. See (appendix 2 for details of the scoring system).

$$\textbf{Mean Grade Point} = \frac{1+2+3+4+5+6+7+8+9+10}{10}$$

DEFINITION OF SOCIO-ECONOMIC CLASSES

RANGE	SOCIO-ECONOMIC CLASS
0.2-0.9	Low
1.0-2.0	Middle
2.1-2.5	High

4.2: MATERNAL ANTHROPOMETRIC MEASUREMENT

Table 6 gives a summary of the maternal anthropometric characteristics.

TABLE 6: MATERNAL ANTHROPOMETRIC CHARACTERISTICS

Variable	Mothers (1-2 births) n=42	Multiparous (>4 births) n=42	p-value
Maternal weight at 6mo (kg)	61.96 ± 11.60	66.96 ± 7.27	0.02
Maternal height (m)	1.58 ± 0.05	1.55 ± 0.05	<0.001
Triceps skinfold thickness at 6mo (mm)	17.27 ± 6.69	19.87 ± 5.51	0.06
MUAC at 6mo (cm)	24.57 ± 6.34	29.47 ± 3.51	<0.001
Maternal weight at 9mo (kg)	66.15 ± 11.39	71.41 ± 7.51	0.01
Triceps skinfold thickness at 9mo (mm)	18.30 ± 6.85	20.49 ± 5.38	0.11
MUAC at 9mo (cm)	25.49 ± 6.26	30.22 ± 3.44	<0.001
Maternai weight gain (6-9mo) (kg)	4.19 ± 1.25	4.45 ± 1.11	0.31
Change in triceps skinfold (6-9mo) mm	1.03 ± 2.12	0.63 ± 0.55	0.23
Change in MUAC (6-9mo) (mm)	0.92 ± 0.97	0.75 ± 0.57	0.33
Maternal weight 3mo postpartum (kg)	60.50 ± 11.13	64.10 ±8.26	0.09
Triceps skinfold thickness 3mo postpartum	17.37 ± 7.01	19.45 ± 5.53	0.13
MUAC at 3 months postpartum (cm)	24.70 ± 6.34	28.72 ± 3.51	<0.001

Table 6 shows that the multiparous women were heavier (66.96 ± 7.27 kg) than mothers with 1-2 births (61.96 ± 11.60 kg) at 6th month of their pregnancy (p=0.02). Maternal weight gain from 6th to the 9th month was not significantly different between the two groups (4.45kg vs. 4.19kg; p=0.311 for multiparous and mothers with 1-2 births respectively).

The weekly weight gain between the second and third trimesters was 0.37kg and 0.35kg for multiparous and mothers with 1-2 births respectively. Maternal weight at 3 months postpartum was not significantly different between the two groups; p=0.09.

Maternal height was significantly different between the two groups $p<0.001$. Mothers with 1-2 births were taller (1.58 ± 0.05m) than the multiparous women (1.55 ± 0.05m).

4.3: DIETARY INTAKE DATA

Dietary intakes were assessed using 24-hour dietary recall on three different occasions (6^{th} month, 9^{th} month of pregnancy and 3 months after delivery). The data were analysed for energy, protein, iron, calcium, fat, vitamin A, vitamin B1 and vitamin C intakes. Table 7and 8 show the means and standard deviations for the above-mentioned nutrient intakes of the pregnant women.

TABLE 7: Dietary energy, protein and fat intake estimated by 24-hour recall.

NUTREINT	Mothers (1-2 births) n=42	Multiparous (>4 births) n=42	p-value
Energy at 6mo (kcal)	1614.17± 572.50	1485.86 ±563.56	0.30
Energy at 9mo (kcal)	1558.86± 473.70	1473.55± 520.60	0.43
Energy at 3mo postpartum (kcal)	1775.21± 450.07	1636.02± 568.90	0.22
Protein at 6mo (g)	55.21± 22.52	46.40 ± 17.76	0.04
Protein at 9mo (g)	50.05 ± 24.75	49.55 ± 20.59	0.92
Protein at 3mo postpartum (g)	55.55± 18.17	53.19 ± 22.43	0.59
Fat at 6mo (g)	52.38 ± 40.30	50.86 ± 33.55	0.85
Fat at 9mo (g)	44.83± 26.49	44.98 ± 25.73	0.98
Fat at 3mo postpartum (g)	63.26 ± 32.56	56.38 ± 37.39	0.37

Energy intake of mothers with 1-2 births at 6th, 9th month of gestation and 3 months after delivery were not significantly different from the intakes of multiparous mothers. Protein intake of mothers with 1-2 births at 6th month was significantly higher than that for multiparous women (p=0.04), while at the 9th month of pregnancy and 3 months after delivery protein intakes were similar for the two groups. Fat intake at corresponding times was not significantly different between the two groups.

TABLE 8: Dietary vitamin and mineral intake estimated by 24-hour recall.

NUTRIENT	Mothers (1-2 births) n=42	Multiparous (>4 births) n=42	p-value
Vitamin A at 6mo (µg RE)	1061.41±1477.68	1607.79±1486.50	0.09
Vitamin A at 9mo ((µg RE)	687.81±949.55	1421.81±1212.13	0.01
Vitamin A at 3mo postpartum	1166.48±1358.17	1707.17±1517.14	0.09
Vitamin B1 at 6mo (mg)	0.71 ± 0.37	0.57 ± 0.32	0.06
Vitamin B1 at 9mo (mg)	0.61 ± 0.28	0.52 ± 0.36	0.23
Vitamin B1 at 3mo postpartum	0.87 ± 0.50	0.75 ± 0.50	0.30
Vitamin C at 6mo (mg)	103.07 ± 85.45	88.67 ± 59.13	0.37
Vitamin C at 9mo (mg)	107.57 ± 83.02	75.38 ± 40.48	0.02
Vitamin C at 3mo postpartum	101.33 ±50.02	88.93 ± 56.80	0.29
Iron at 6mo (mg)	15.40 ± 7.82	15.38 ± 6.78	0.98
Iron at 9mo (mg)	17.55 ± 11.10	16.60 ± 9.32	0.68
Iron at 3mo postpartum (mg)	18.29 ± 9.29	17.40 ± 7.92	0.64
Calcium at 6mo (mg)	577.07 ± 394.34	577.74± 370.50	0.99
Calcium at 9mo (mg)	594.86 ± 365.56	648.86±454.82	0.37
Calcium at 3mo postpartum (mg)	561.74±382.87	684.55±457.08	0.19

With the exception of Vitamin A intake at the 9th month, which was significantly higher for multiparous mothers and vitamin C, which was significantly higher for mothers with 1-2 births, none of the nutrient intakes shown on Table 8 was significantly different between the two groups.

4.4: HAEMOGLOBIN DATA

Maternal haemoglobin concentrations were determined at 6th and 9th months of pregnancy. Table 9 shows the percentages of mothers who were severely, moderately or mildly anaemic and also those who had normal haemoglobin concentration.

TABLE 9: Maternal haemoglobin concentrations at 6th and 9th month.

Haemoglobin conc. (g\dl)[1] and type of anaemia	Mothers (1-2 births) n=42	Multiparous (>4births) n=42
Haemoglobin concentration (g\dl)[1] at 6th month		
Severe (Hb < 7)	0 (0.0%)	0 (0.0%)
Moderate (Hb=7.0-9.0)	4 (9.6%)	12 (28.6%)
Mild (Hb=9.0-11.0)	24(57.1%)	26 (61.9%)
Normal (Hb ≥11.0)	14(33.3%)	4 (9.5%)
Haemoglobin concentration (g\dl) at 9th month		
Severe (Hb < 7)	0 (0.0%)	0 (0.0%)
Moderate (Hb=7.0-9.0)	4 (2.4%)	2 (4.8%)
Mild (Hb=9.0-11.0)	15 (35.7%)	13 (31.0%)
Normal (Hb ≥11.0)	26 (61.9%)	27 (64.2%)

[1]Cutoff based on WHO cutoffs below which a subject is classified as anaemic.

The mean haemoglobin values at 6th month of gestation differed significantly ($p<0.001$) between the two groups of mothers (10.52 ± 1.41g\dl and 9.69 ± 1.38g\dl). However, the haemoglobin values in the 9th month of gestation were similar ($p=0.618$) for the two groups (11.19 ± 1.04g\dl and

11.31±1.18g\dl for mothers with 1-2 births and multiparous women, respectively). None of the mothers were severely anaemic (<7.0g\dl). Twenty-eight percent of the multiparous women were moderately anaemic (7.0-9.0g\dl) at 6th month of gestation, compared to 9.6% of mothers with 1-2 births were moderately anaemic.

At the 6th month of gestation, 33.3% of mothers with 1-2 births had haemoglobin concentrations in the normal range (≥ 11.0 g\dl). Compared to 9.3% of the multiparous mothers. At the 9th month, 4.8% of the multiparous women were moderately anaemic (7.0-9.0g\dl), compared to 2.4% for the other group. Haemoglobin concentration appeared to have improved towards the 9th month of gestation because 61.9% of mothers with 1-2 births had haemoglobin concentrations in the normal range (≥ 11.0g\dl).

4.5: ANTHROPOMETRIC MEASUREMENT OF PREGNANCY OUTCOME

Anthropometric measurement (birth weight, birth length and head circumference) of the infants were taken within 24 hours of delivery. Table 10 shows the various measurements made at birth, one and three-months. Breast-feeding episodes at one and three-month were also recorded.

TABLE 10: Anthropometric measurement of infants and breast feeding episodes.

Variable	Mothers (1-2 births) n=42	Multiparous (> 4 births) n=31[1]	p-value
Birth weight (kg)	3.05± 0.49	3.11± 0.36	0.56
Infant weight (kg) 1mo	3.65± 0.66	3.75± 0.44	0.46
Infant weight (kg) 3mo	5.62± 0.99	5.46 ± 0.57	0.43
Birth length (cm)	48.99± 2.91	46.00±3.42	<0.001
Infant length (cm) 1mo	51.17± 3.13	48.67±3.80	<0.001
Infant length (cm) 3mo	65.86±2.64	64.95±3.53	0.21
Head circumference (cm)	33.09± 1.70	32.65±3.53	0.21
Head circumference (cm) 1mo	33.09±1.70	34.53±1.36	0.19
Head circumference (cm) 3mo	35.05 ± 1.87	41.63±0.96	0.98
Total breastfeeding episodes at 1mo	10.26 ± 1.33	9.81±1.28	0.14
Total breastfeeding episodes at 3mo	11.21 ± 1.46	11.61±1.54	0.27

[1]n=31 (11 values missing)

The mean birthweight were 3.05 (±0.49kg) and 3.11 (± 0.36kg) for mothers with 1-2 births and multiparous women respectively. The difference was not significant (p=0.56), but the babies of the multiparous women were slightly heavier than babies of mothers with 1-2 births. Infant weight at one and three months was also not significantly different (p=0.47,0.43). It was observed that the infants of mothers with 1-2 births at 3months were slightly heavier but not significant different from infants of the multiparous women (5.62± 0.99kg and 5.46±0.57kg; p=0.43). Birth length and infant length at one month were significantly higher in the mothers with 1-2 births than the mothers in the other group. The difference remained significant ($p<0.01$, 0.02) after controlling for maternal height. The head circumference were not significantly different at any time point at birth, one and three months were not significantly different (p=021,0.19.0.98). All infants were breast-fed. Total breastfeeding episodes at one and three months were also not significantly different (p=0.14,0.27) between the two groups. The mean breast-feeding frequency was about 10 feeds/d in the first month for mothers with 1-2 births and 9 feeds/d for the multiparous women. This increased to about 11 feeds/d in the third month for both groups.

Weight, length and head circumference of the infants from birth to 3 months after delivery is shown in Table 11.

TABLE 11

Weight, length and head circumference gains of infants from 0 to 3 months.

Variable	Mothers (1-2 births) n=42	Multiparous (>4 births) n=31[1]	p-value
Weight gain (kg)	2.57±0.69	2.35±0.48	0.1356
Length gain (cm)	16.87±3.24	18.95±3.05	0.0069
Head circumference (cm)	8.55±2.13	8.98±1.11	0.3039

[1]n=31 (11 value missing as stillbirth recorded)

Only length gain between 0-3 months was significantly different between the two groups. All other measurements were not significantly different.

TABLE 12

Birth weight, birth length, head circumference and gestational age at delivery of study infants.

	Number of infants		
Variable	**Mothers (1-2 births) n=42**	**Multiparous (>4births) n=31[1]**	
Birth weight (kg)			
<2.5	5	1	
2.51-4.00	37	29	
4.10-6.00	0	1	
Birth length (cm)			
<45	4	12	
45-50	25	16	
>50	13	3	
Head circumference (cm)			
<32	10	8	
32-38	32	23	
>38	0	0	
Gestational age (weeks)			
<37	6	3	
37-40	36	25	
>40	0	3	
Sex of the babies			
Male	18	19	
Female	24	12	p-value
Birth weight (male)	3.19±0.48	3.12±0.27	0.57
Birth weight (female)	2.94±0.48	3.10±0.48	0.37
Birth length (male)	50.54±2.73	47.83±2.52	0.01
Birth length (female)	47.83±2.52	44.48±3.82	0.01
Head circumference (male)	33.57±1.53	32.73±1.76	0.15
Head circumference (female)	32.73±1.76	32.18±1.16	0.33

[1]n=31 (11 values missing)

The prevalence of low birth weight (<2.5kg) in the study was 8%. Most of these low birth weight infants were from the primiparous mothers. Four 9% of the babies of mothers with 1-2 births had birth length less than 45 cm, while (13) 31% had birth length than 50 cm. Thirty-nine percent of the babies of multiparous women had birth length less than 45 cm, while (3) 10% had birth length greater than 50 cm. Paternal height was not included in the study.

Pre-term delivery (<37 weeks) for mothers with 1-2 births was 14% (6) and 10% (3) for the multiparous women. Ten percent (3) of the babies of the multiparous women were delivered after 40 weeks. Gestational age was positively and significantly correlated with infant birth weight (r=0.31, p< 0.007). Fifty-eight percent of the infants were boys and 42% girls.

In the bivariate analyses, seven variables were found to be significantly associated with birth weight. The variables are shown in Table 13.

TABLE 13: Variables significantly associated with birth weight.

Variables	Regression coefficient	p-value
Maternal haemoglobin at 6th month	0.27	0.020
Maternal haemoglobin at 9th month	0.24	0.035
Maternal weight at 6th month	0.32	0.006
Maternal weight at 9th month	0.34	0.003
Mid-upper arm circumference at 6th month	0.22	0.050
Triceps skin fold at 6ht month	0.34	0.003
Gestational age of index child	0.31	0.007

Regression analysis indicated that maternal weight at 6th month; maternal haemoglobin concentration at 6th month and the gestational age of the index child were significantly associated with birth weight (Table 14). Infant birth weight was significantly correlated with both maternal weights at 6th month of gestation (r=o0.32, p=0.006) and at 9th month (r=0.34, p=0.003).

The results of the multiple regression analyses for factors associated with birth weight are shown in Table 14.

TABLE 14: Factors associated with birth weight.

Variable	Regression coefficient	p-value	R^2
Haemoglobin at 6th month	0.27	0.020	26
Maternal weight at 9th month	0.34	0.003	
Gestational age of index child	0.31	0.007	

Maternal haemoglobin level at 6th month, maternal weight at 9th month and gestational age of the index child were the main predictors of birth weight in this study. These three variables accounted for 26% of the variation in birth weight. There were other 74% variations in birth weight such as pre-pregnancy weight for height, gestational weight gain etc, which my data could not capture. This therefore suggests that interventions to improve infant birth weight should aim at improving maternal haemoglobin concentration and maternal weight, thus emphasizing the importance of maternal nutrition in pregnancy.

CHAPTER 5

DISCUSSION

5.0: BACKGROUND

Many investigators have proposed an unfavourable epidemiological link between short interpregnancy intervals and pregnancy outcomes. The majority have reported an increased prevalence of low birth weight, preterrm delivery and intrauterine growth retardation (Idem, 1991; Mavalankar and Gray, 1991; Huttly et al, 1992). Increased perinatal mortality has been linked to short interpregnancy intervals (Hebert et al, 1986). The leading theory involves the incomplete restoration of physiological critical nutrient reserves in the mother that are depleted in the course of the preceding pregnancy (Rasmussen, 1992). Winkvist et al (1992), proposed a hypothetical "critical" interpregnancy interval, indicating the threshold for significant increases in the prevalence of unfavourable outcomes. This critical interpregnancy interval varied among published reports, ranging from 6 months for developed industrialized nations to 18 months or longer in developing countries.

Several investigators have noted that short interpregnancy interval is linked to some obstetrical risk factors, such as unfavourable outcomes of previous pregnancies, young maternal age, poverty and the use of tobacco during pregnancy (Klebanoff 1988 and Hathout et. al 1982). Lang et al (1990) and Santelli et al (1990) their studies have shown no linkage between short interpregnancy intervals and unfavourable pregnancy outcomes when mothers were selected according to criteria designed to control for the following confounding variables stillbirth, miscarriages, young maternal age, a history of low birth weight and the use of tobacco.

5.1: OUTCOMES ASSOCAITED WITH LONG AND SHORT PREGNANCY INTERVALS.

In this study, the mean birth weight of children born to study mothers was 3.05 (±0.49 kg and 3.11(±0.36 kg), for mothers with 1-2 children and multiparous women, respectively. This value is higher than values reported for some African populations (Rip et al, 1988; Downes et al, 1991), but slightly below the value of 3.3 kg reported for developed countries (FAO/WHO, 1985), although this value falls within the favourable birth weight range (2.51-4.00 kg). One baby from the multiparous group weighed more than 4.0kg. Garner and Kramer (1992) described babies weighing more than 4.0kg as having macrosomia. Such babies increase the risk of mechanical difficulties during labour. Mothers who have had more than four births had infants of slightly higher birth weight than mothers with 1-2 births. Only twenty two percent of primiparous mothers gave birth to bigger babies while most of them gave birth to slightly smaller infants. This result is similar to that observed by Lee et al, (1988).

The rate of low birth weight observed for the whole study was 8%. This is lower than the value of 11.8% reported for mothers in Birmingham, by Kerman et al, (1998). However, birth weight was not obtained for 11 multiparous mothers whose pregnancy either ended in stillbirth or miscarriages.

The rate of stillbirth, both previous and current, in the study was relatively high among the multiparous women (13%) to mothers with 1-2 births (0%). As expected, mothers with 1-2 births had fewer previous miscarriages (14%) compared to 31% for multiparous women. A similar observation was reported by other workers (Mavalankar et al, 1991). The increased risk of stillbirth with shorter intervals between pregnancies was evident primarily among mothers whose preceding pregnancies had resulted in the delivery of stillbirth. This finding observed in this study remains obscure. A reverse causality stillbirth may play a part here, in that mothers who have had previous stillbirth or miscarriages are more likely to have more children.

Our findings reveal a clear association between the gestational age of the index child and birth weight. The observed positive and significant association ($r=0.31$, $p=0.007$) between gestational age and birth weight is consistent with results from other studies (Seidman et al, 1989, Sauerborn et al, 1992). It seems apparent that infants born prior to term will usually weigh less than those born at term, since much of the foetal weight will gain takes place during the third trimester, the period when the greatest increase in maternal and foetal tissues occur (Worthing to-Roberts et al, 1985).

The differences in finding between this study and earlier studies are probably due to differences in interpregnancy interval used in this study of ≤ 21 months. This could have resulted in the lack of effect since 21 months between pregnancy is enough for mothers to recuperate. The population and methods used may also contribute to this. This study population included more of older mothers than in other studies. The inclusion of women with a wider range of socio-economic characteristics in the other studies may have hidden the associations found in this study, which included the populations mostly at risk for adverse pregnancy outcomes. Many experts have long believed that short interpregnancy is potentially more harmful among poor women, who are often less well nourished and are under more physical and social stress, than among middle and high-income women.

5.2: MATERNAL HAEMOGLOBIN STATUS AND PREGNANCY OUTCOME

In this study a positive and significant correlation between haemoglobin concentrations and infant birth weight at 6 ($r=0.27$, $p=0.02$) and 9 month ($r=0.25$, $p=0.03$) of pregnancy was observed. This is similar to results from other studies (Duthie, 1991; Lu et al, 1991; Sarin, 1985). The multiple stepwise regression analysis indicated that maternal haemoglobin concentration at 6^{th} month was predictive of infant birth weight than haemoglobin concentration at 9^{th} month. Women who had normal mean haemoglobin values (i.e. $\geq$ 11.0g/dl) at 6 months delivered infants with higher birth weights than did those who were anaemic at 6^{th} month of gestation.

5.3: MATERNAL SOCIO-ECONOMIC STATUS AND PREGNANCY OUTCOME

In our study, the effects of the socio-economic factors were partly diminished, because the mothers were chosen only from public polyclinics that cater for the low and middle class clientele. Socio-economic status appears not to have had significant independent effects on the pregnancy outcome possibly because the subjects had relatively homogenous socio-economic background. Peters et al, (1983) found that socio-economic class did not remain an important determinant of birth weight once maternal height and parity had been taken into account.

5.4: PARITY AND PREGNANCY OUTCOME

The increase in infant birth weight with rising parity up to the fourth, fifth and sixth pregnancy is in agreement with earlier reports by Shah (1981) and Grover (1982). In this study, parity was positively and significantly associated with maternal weight at 6th and 9th month of gestation ($r=0.20$, $p=0.05$ and $r=0.22$, $p=0.03$ respectively). Several, but not all, reports suggest that on the average each successive birth adds 1kg of postpartum maternal body weight above that normally gained with age. It was evident in the study that the multiparous women were heavier than mothers with 1-2 births though the mean gestational weight gain by the two groups of mothers was almost the same. In our study, it was observed that parity greater than four, a history of stillbirth, premature birth and short interpregnancy interval had an adverse effect on the index child of some of multiparous mothers. The index child either resulted in a miscarriage or it was still born.

Lobel (1994) and Lockwood (1994) also observed that short interpregnancy intervals (<6months) might also be associated with increase level of stress among mothers who are caring for other infants. In turn, stress during pregnancy has been shown to be related to increase risk of adverse outcomes such as foetal death (Lobel, 1994).

5.5: MATERNAL ANTHROPOMETRIC MEASUREMENT AND BIRTH WEIGHT

Maternal weight gains, mid upper arm circumference and triceps skin fold were used as a measure of nutritional status. Measurement of pre-pregnancy weight would have been desirable since it indicates the exact nutritional status of the mothers before pregnancy, since the study started with mothers in their third trimester, it was not possible to obtain such data reliably. A relationship between anthropometric characteristics and infant anthropometric values has been reported by others (Neggers et al, 1997). Mid-upper arm circumference and triceps skin fold at the 6th month of gestation were positively and significantly associated with infant birth weight (MUAC; r=0.22, p=0.05 and triceps skin fold; r=0.34, p=0.003). In this study, maternal MUAC was found to be significant predictor of birth weight.

The positive association of maternal weight at both 6 and 9 months of gestation with birth weight is in agreement with observation from Moller et al (1989). The average weight gain in our subjects was 4.3kg over the last trimester period. Jackson, et al and Yu, (1993) observed that a maternal weight gain of 6.64kg over the last trimester was consistent with a favourable or optimal birth weight (2.50-3.80kg) for their Liberian subjects.

5.6: MATERNAL DIETARY INTAKES AND INFANT BIRTH WEIGHT

The mean intakes of energy, calcium, iron and thiamin at 6 and 9 months of gestation were below the recommended allowances set by FAO/WHO (1985), for pregnant women (appendix 3). In this study, mothers were able to meet 62% of the required energy intake, 485 of calcium, 75% of iron and 47% of thiamine at the 6th month of gestation. However, protein, vitamin A and vitamin C allowances were met at both 6th and 9th month. There was no significant relationship between the intakes of these nutrients and pregnancy outcome. The negative correlation reported between maternal intakes of calories, protein, calcium and infant birth weight (Beal, 1971) was not observed in this study. The relationship between dietary intake and pregnancy outcome has been reported with inconsistent results. Worthington-Roberts et al, (1985) reported that the inconsistencies may be due to methodological problems either in evaluating dietary intake accurately or to variations in daily nutrient intake among women in many populations studied. Also, the interactions between nutrition, biological and environmental factors may interfere with the interpretation of the results.

5.7: BREAST FEEDING PATTERN AND INFANT WEIGHT GAIN

All the infants were exclusively breast fed within the period of study and the total breastfeeding episodes at 0-3 months were not significantly different between the two groups. Infants' weights at one month and three months for both groups were also not significantly different. The interpregnancy interval of $\leq$ 21 months in this study seems to have little effects on the pregnancy outcome. It is reasonable at this time to advise mothers about the importance of interconception care and to delay the next pregnancy for at least twenty-one months. Mothers should be advised of the importance of planning their pregnancies and the potential harm to their infants of short intervals of < 6 months between pregnancies.

CONCLUSION

The mean birth weights of infants in this study were 3.05 ±(0.49kg) and 3.11± (0.36kg) for mothers with 1-2 births and multiparous women respectively, which falls in the favourable birth weight range (2.51-4.00 kg). Although interpregnancy interval had no significant effect on birth weight and infant weight at 1 and 3 months, there was a significant decrease in the birth length and length at 1 month in infants of mothers with short interpregnancy interval. Mothers with short reproductive cycle tended to have low haemoglobin concentration at 6 months.

Maximum stepwise regression analysis suggests that maternal haemoglobin concentration at 6th month, maternal weight at 9 months and gestational age were significant determinants of birth weight indicating the importance of maternal nutrition in pregnancy. These three variables accounted for 26% of the variation in birth weight. There were other 74% variation in birth weight such pre-pregnancy weight for height, gestational weight gain over the whole period etc. that my data could not capture. Also the food frequency approach, which indicates long-term food intake, may have been helpful in addition to the 24-hour recall method in assessing the maternal nutritional status.

Women, particularly those who are old (over 35 years), should be advised of the potential harm to their infants of short interpregnancy intervals. Breastfeeding frequency was not affected by interpregnancy interval. Both groups breastfed equally well.

This and other studies of interpregnancy intervals offer a clear message about the importance of interconception care and family planning after a pregnancy. Thus, this study supports other findings (Nyirjesy and Nyirjesy, 1991) that in addition to encouraging higher formal education among women, public health officials should concentrate on alleviating anaemia and ensuring an adequate weight gain during the last trimester of pregnancy to increase the chances for a successful outcome of pregnancy.

RECOMMENDATIONS

From this study, it is recommended that:

1. All pregnant women should be encouraged to report early for antenatal care and follow-up.
2. All pregnant women should have haemoglobin estimation at their first antenatal visit and be given iron and folic acid supplements in pregnancy. They should also have a repeat haemoglobin estimation at 30-36 weeks gestation o check their response to treatment.
3. Further work is needed to determine the effect of short interpregnancy interval of 6 to 9 months on pregnancy outcome on younger Ghanaian mothers (less than 35 years old).
4. Longitudinal studies should be conducted to cover the period before pregnancy to parturition to relate food and nutrient intake of individual women to maternal nutritional status and pregnancy outcome.
5. Access to family planning services and strong encouragement to use them can help improve the outcomes of pregnancy.

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Consent to participate in a research study

University of Ghana, Department of Nutrition and Food Science

Title: The impact of frequent reproductive cycling on pregnancy maternai nutritional status.

Investigators: Dr. Anna Lartey
Ms. Gloria Adu-Aboagye

INFORMED CONSENT FORM

The department of Nutrition and Food Science is carrying out a study on the effect of frequent reproductive cycle on pregnancy outcome and maternal nutritional status.

Purpose: In this study we hope to find out the effect of frequent pregnancies on the mother's nutritional status and on the health of her infant. It is important to collect this information since it will help us understand the ability of the mother's body o recover fully to her non-regnant state. You are being asked to participate in this study. Participation is voluntary.

Procedure: If you decide to participate, we would ask you questions about your household, and your pregnancy history. We would ask questions about your normal diet. Your weight, height and skin fold measurements will be taken periodically. After you have delivered, your bay's weight, length and head circumference will be measured for 3 months. This is to determine your baby's growth. We will ask you questions about the way you plan to feed your baby. There is no financial cost to you if you agree to participate in the study, although answering questions will take some time from you.

Benefits: Your infant will be followed regularly for the first 2-3 months to assess growth. Nutrition advice will be available to you. By participating in this study you will help increase knowledge on the effect of frequent pregnancy on the nutrition of the mother and infant and come up with possible intervention to help mothers at risk.

Confidentiality: The results from other volunteers will be combined into one group. The confidentiality of your records will be maintained. No name would be mentioned in any report from this study.

If you have any questions please ask us.

Appendix (1) DEPARTMENT OF NUTRITION AND FOOD SCIENCE

UNIVERSITY OF GHANA

IMPACT OF FREQUENT REPRODUCTIVE CYCLING ON PREGNANCY OUTCOME AND MATERNAL NUTRITIONAL STATUS

SECTION A: Background Information DATE……….(Int Date)

1. Name of mother…………………………………………………………………
2. ID Number………………………………………………………………….(ID)
3. Area of residence…………………………………………….(AREA-RES)
4. House number………………………………………………………..(HSE-#)
5. Age………………………………………………………………………..(MO-AGE)
6. Religion (tick the appropriate answer) (RELGN)

1. Christian	2. Islam	3. ATR	4.Other (specify)

7 Marital status (tick appropriate answer)

1. Married	2. Single	3. Divorced	4. Separated

SECTION B: SOCIO-ECONOMIC STATUS OF MOTHER

8. How many years have you been in school?…………………..(EDUC)
9. What is your ethnic origin……………………………………….(ETHNC)
10. Main Occupation……………………………………………….(OCCUP)

    Where?…………………………………………………………………………
11. Subsidiary occupation…………………………………………………….

    Where?………………………………………………………………… …
12. How much do you earn in a month? (in thousands)………(INCOME)

DWELLING

13. Type of residence (Tick correct box) (RES-T)

    Own [ ] Rented [ ] Family house [ ] Other specify…………………

14. How many rooms are available to your family (HH size)

    1 [ ] 2 [ ] 3 [ ] 4 [ ] More than 4 [ ]

15. Bathing facility (tick correct box) (RES-B)

    Bucket [ ] Shower [ ] Shower+ Bathing tub [ ] Other specify………

16. Toilet facility (TOIL-F)

    Pan latrine [ ] Water closet [ ] Public Toilet [ ] KVIP [ ] None [ ]

17. Do you share bathroom facility with other household(s) Yes[ ] No [ ]

18. Do you owe any of the following (Tick correct box) (RES-G)

    i. Wireless\Radio Yes [ ] No [ ]

    ii. Television (black and white) Yes [ ] No [ ]

    iii. Television (coloured) Yes [ ] No [ ]

    iv. Video Yes [ ] No [ ]

    v. Refrigerator\ Deep freezer Yes [ ] No [ ]

    vi. Car Yes [ ] No [ ]

    vii. Lorry\ Bus\ Tractor etc Yes [ ] No [ ]

    If yes, how many?…………………………………………………………

    viii. Bicycle Yes [ ] No [ ]

    ix. Motor bike Yes [ ] No [ ]

SECTION C: REPRODUCTIVE HISTORY

19. At what age did you have your first menstruation?............(AGE-MENS)

20. Number of pregnancies..(PREG-#)

21. Number of live births...(LIVE-BHT)

22. Any miscarriages? Yes [ ] No [ ] (MISCAR-#)

If yes how many (tick appropriate box)

1	2	3	Other (specify)

23. Number of still births...(STILL-BTH)

24. The gestational age of your (GEST-AGE)

a. Previous child...weeks

SECTION D: CLINICAL OBSERVATION (tick box if symptom is present)

25.	EYES	Bitot's spots	[ ]	(EYE)
		Keratomalacia	[ ]	
26.	LIPS	Angular stomatitis	[ ]	(LIP)
		Cheilosis	[ ]	
27	Gums	Swollen, red bleeding	[ ]	(GUM)

28. Any other ailments..(OTHER-AIL)

BIOCHEMICAL EVALUATION

29. Hb......................................g/L (6^{th} month)

30. Hb......................................g/L (9^{th} month)

SECTION E: MATERNAL ANTHROPOMETRY

31. The # of months pregnant……………………………………………………………

32. The date of last menstrual period…………………………………………………

33. Height of mother……………………………………………………………………m

	Weight (kgs)	Skin fold measurement (cm)		
		Mid-arm cir.	Biceps	Triceps
At 6 months				
At 9 months				
After 3 months of delivery				

SECTION F: INFANT ANTHROPOMETRY

34. Date of birth……………………………………………………….(DATE-BTH)

INDEX CHILD

	Weight (kgs)	Height (cm)	Head circumference (cm)
At birth			
1 month			
3 months			

FEEDING FREQUENCY

35. How many times do you breast-feed your child in the day?………………

36. How many times do you breast-feed your child in the evening?…………..

(PREVIOU CHILD)

37 Date of birth……………………………

38. Duration of lactation……………………….mths (DURA-LAC)

SECTION G: DIETARY INFORMATION

DIETARY EVALUATION BY 24-HOUR RECALL

DAY	BK.FAST	SNACK	LUNCH	SNACK	SUPPER	SNACK
1						
2						
3						

APPENDIX 2: SCORING FOR SOCIO-ECONOMIC STATUS.

A mean grade point system was used to measure the socio-economic status of the mothers. The variables used were as follows:

1. Level of education.
2. Number of rooms available to a family.
3. Types of furniture.
4. Bathroom facility.
5. Toilet facility.
6. Means of transport.
7. Income.
8. Tenancy.
9. Possession of items or property indicative of wealth.
10. Occupation.

$$\text{Mean Grade Point} = \frac{1+2+3+4+5+6+7+8+9+10}{10}$$

DEFINITION OF SOCIO-ECONOMIC CLASSES

RANGE	SOCIO-ECONOMIC CLASS
0.2-0.9	Low
1.0-2.0	Middle
2.1-2.5	High

LEVEL OF EDUCATION	**GRADE POINT**

a. No school (0yrs)	0.0
b. Primary / J.S.S (1-9yrs)	0.5
c. SSS/Secondary School (10-12yrs)	1.0
d. Post Secondary (13-15yrs)	1.5
e. University	2.5

NO. OF ROOMS AVAILABLE TO A FAMILY	**GRADE POINT**
1	0.5
2	1.0
3	1.5
4	2.0
More	2.5

TYPES OF FURNITURE	**GRADE POINT**
Benches	1.0
Arm chairs (cushioned)	1.5
Stuffed chairs	2.5

BATHROOM FACILITY	**GRADE POINT**
Bucket	0.5
Shower	1.5
Bathing tub	2.5

TOILET FACILITY	**GRADE POINT**
Public toilet / KVIP	0.5

Pan latrine	1.0
Water closet	2.5

MEANS OF TRANSPORT	**GRADE POINT**
Nil	0.0
Bicycle	1.0
Car\Bus	2.5

INCOME PER MONTH	**GRADE POINT**
< C 50 000	0.0
C 50 000-100 000	1.0
C 100 000-150 000	1.5
> C 150 000	2.0

TENANCY	**GRADE POINT**
Rented	0.5
Family house	1.5
Owner	2.5

POSSESSION OF ITEMS	**GRADE POINT**
Radio	0.5
Radio & Television (black and white)	1.0
Radio & Television (colour)	1.5
Radio & Television (colour) & Refrigerator	2.0
Radio & Television (colour) & Deck & Refrigerator	2.5

OCCUPATION	GRADE POINT
Trader	1.0
Vocational	1.5
Office Worker	2.0
Professional	2.5

APPENDIX 3

Extra daily nutrient allowance for pregnant women

Nutrient	Non-pregnant	Pregnant
Energy	2235 kcal	+ 160kcal (1st trimester)[1] + 350 kcal (2nd and 3rd trimesters)
Protein (g)	41	+6[2]
Retinol (μg)	800	1000
Vitamin D (μg)	7.5	12.5
Vitamin E (mg)	8	10
Vitamin C (mg)	60	80
Riboflavin (mg)	1.3	1.6
Nicotinamide (mg)	14	16
Vitamin B6 (mg)	2.0	2.6
Folate (μg)	400	800
Thiamine (mg)	1.1	1.5
Calcium (mg)	800	1200
Iron (mg)	18	5+

1,2: Allowance set by FAO/WHO, 1985

5+ the increased requirement cannot be obtained from the diet and thus supplemental iron was recommended.