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There is concern today over the high perinatal mortality rate in the United States and in North Carolina. The analysis of fetal outcome in terms of infant birthweight for respective weeks of gestation is a relatively new approach to assessing the maturity of the newborn and the associated risk of perinatal mortality. The purpose of this study was to analyze the relationship of selected maternal, dietary, and nutrition status variables to categories of birthweight for gestational age, birthweight per se, and perinatal mortality.

A sample of 137 infants born at a hospital that served a mixture of private and public patients was chosen on the basis of infant birthweight for gestational age. Seventeen (12 percent) small for gestational age, eighty-six (63 percent) average for gestational age, and thirty-four (25 percent) large for gestational age infants were selected.

Data were obtained through a review of obstetric and newborn nursery records and maternal postpartum interviews. The variables selected for analysis were maternal age, race, height, height/weight index, pre-pregnant weight, weight gain during pregnancy, smoking habits, reproductive history, special diet instruction, and vitamin/mineral supplementation. The infant variables were birthweight for gestational age, birthweight per se, and perinatal mortality.

The Chi square test of independence and discriminant analysis were the procedures chosen for the statistical analysis. Maternal smoking habits,

race, and pre-pregnant weight were found to be significant with regard to infant birthweight for gestational age ($p < .01$). With regard to infant birthweight per se, maternal smoking habits, race, parity, weight gain, and height had significant relationships ($p < .05$).

Based on simultaneous consideration of all independent variables, the discriminant analyses for birthweight for gestational age and birthweight per se provided formulas by which to predict infant birthweight categories. The accuracy of the formulas was highest in predicting those infants who would be small for gestational age and those who would be low birthweight.

The relationship of maternal race to infant birthweight categories may be confounded by socioeconomic factors, cultural influences, life stresses, and a nutrition component. The consequences of smoking during pregnancy may be manifested in reduced blood oxygen supply to the fetus, curbed appetite of the mother, and decreased nutrient availability to the fetus.

This study did not consider the level of daily maternal calorie intake and its effect on fetal outcome. Although difficult to control in humans, records of caloric consumption would give a more precise indication of the relationship of nutrition to growth and development.

It is recommended that members of the health team educate the general population with regard to nutritional needs during all stages of the life cycle and the adverse effects of smoking during pregnancy. Careful monitoring of the high risk pregnancy in combination with medical care and nutrition counseling may help to reduce the number of newborn who are small for gestational age and/or low birthweight.

THE EFFECT OF SELECTED MATERNAL, DIETARY AND NUTRITION STATUS VARIABLES ON FETAL OUTCOME

by

Claudia Gill Green

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APPROVAL PAGE

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CHAPTER I

INTRODUCTION

There are several categories of mortality that pertain to the infant. Infant mortality, the broadest term, refers to deaths that occur in infants less than one year of age. Perinatal mortality represents the total deaths that occur from twenty weeks of gestation to birth (fetal mortality) plus deaths that occur from the first to the twenty-eighth day of life (neonatal mortality).*

In 1970, the Committee on Maternal Nutrition of the National Research Council (2) stated that the perinatal death rate of the United States ranked thirteenth in comparison with the rates of forty other countries. North Carolina ranked sixth in the nation in the incidence of perinatal deaths in 1973. A higher mortality rate that year was found in only five other states or territories of the United States (3).

A review of the 1968-71 perinatal mortality rates in the three most populous counties of North Carolina indicates that Guilford County had a rate of 32.2/1000 births, as compared with Wake County, 29.2/1000, and Mecklenberg County, 28.1/1000 (4).

A five-year survey of births in the three Greensboro hospitals gives clues to the birth trends in this area. Results have been briefly summarized in

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**Gestation is equal to approximately 280 days or 40 weeks in humans (1).*

Table 1. The data from this five-year survey suggest that both socio-economic background and race may be related to mortality during the perinatal period.

TABLE 1

FETAL OUTCOME IN GREENSBORO HOSPITALS, 1968-72

Fetal Outcome	Hospital A	Hospital B	Hospital C
Perinatal mortality rate (per 1000 births)	35.1	68.7	21.9
Low birthweight (% under 2500 gm.)	10.2	17.5	6.3

Hospital B, a small hospital which primarily served a population that received some form of government support, had a mortality rate of 68.7/1000 births. Hospital A, that served a mixture of private and public patients, had a perinatal mortality rate of 35.1/1000 births. Hospital C, with a population of primarily private patients, had the lowest mortality rate of the three Greensboro hospitals--29.9/1000 births.

With regard to race, the hospital with the lowest perinatal mortality rate served predominantly white patients, while the hospital with the intermediate rate served a mixture of white and non-white patients. The hospital with the highest perinatal mortality rate served a predominantly non-white population.

As is characteristic throughout the country, perinatal statistics in North Carolina reflect a higher mortality rate among non-white infants than among white ones. During 1970-72 the crude perinatal mortality rate in North Carolina for non-white infants was 41.0 as compared to a rate of 25.7 for white infants in North Carolina (5).

In addition to the higher mortality rate, a higher proportion of low birthweight infants (birthweight below 2500 grams) are born to non-white mothers (6). These small babies are considered to be at high risk because of the increased likelihood that perinatal death will occur or that they will have physical and behavioral abnormalities (7).

The five-year survey of Greensboro hospitals showed that low birthweight infants composed 17.5 percent of the total births at Hospital A, 10.2 percent of the births at Hospital B and 6.3 percent of the births at Hospital C.

Usually perinatal death is more prevalent in poor communities which may lack appropriate medical care resources (2). It is puzzling that the state of North Carolina, with its well known medical centers at Bowman Gray School of Medicine, Duke University School of Medicine, and the University of North Carolina Medical School at Chapel Hill, has such a high incidence of perinatal death. Greensboro, a city of relative affluence, is located in the Piedmont region of the state and is within seventy-five miles of all the major medical centers.

In 1972, the Governor of North Carolina appointed a Comprehensive Health Planning Task Force on Maternal-Infant Care. Within the six governmental planning regions in the state of North Carolina, Perinatal Advisory Councils were selected to assist in the development and establishment of regional perinatal care centers. Reduction of morbidity and mortality through adequate medical care was the major objective (3). These regional care sites serve *both rural and urban patients by providing specialized care.*

Although perinatal mortality occurs most frequently in low birthweight infants, the high birthweight infant is also at risk. The arbitrarily defined limit for an infant of high birthweight is 4000 grams. One of the risks of the high birthweight newborn, regardless of gestational age, is birth injuries to the head and neck area that may result in postnatal complications (1).*

Not much is known about the range of factors that lead to infants of high birthweight. Only a small percentage of these large infants are born to diabetic mothers (9). Within the past few years people have begun to examine the precipitating factors other than diabetes to see if these are at the opposite end of the continuum from the precipitating factors of low birthweight, or if they are an entirely different set of factors.

Infant birthweight, once thought to be the index of infant maturity, has been more clearly defined in recent medical research. The criteria now used to evaluate the degree of developmental maturity in infants are length of gestation (pre-term, term, post-term) and infant birthweight for respective weeks of gestation. For example, at the arbitrarily selected low birthweight of 2500 grams, an infant born at thirty-two weeks of gestation would be large for gestational age; at thirty-five weeks the infant would be average for gestational age, and at forty weeks, small for gestational age. Each of these categories of infants carries a different level of risk (1). In an attempt to ascertain

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**Gestational age refers to the weeks of lunar months of intrauterine growth from the beginning of the last menstrual cycle (1, 9).*

the causative factors of high perinatal mortality in Greensboro, this study focused on those factors that might affect infant birthweight for gestational age. Consideration was also given to factors thought to be related to infant birthweight per se.

This study was conducted at Hospital A from July 11 through July 25, 1975 and from February 1 through April 15, 1976. The specific objective of this study was to examine the relationship between selected maternal, dietary, and nutrition status variables and infant birthweight for gestational age, infant birthweight per se, and perinatal mortality.

CHAPTER II

REVIEW OF RELATED LITERATURE

In determining the nutritional status of maternity patients, Aubry et al (10) suggested that any one of the following factors identified a patient at nutritional risk: poverty, adolescence, low pre-pregnant weight for height, high parity, chronic systemic illness (i.e. diabetes), unusual nutritional patterns (i.e. vegetarianism), history of anemia or obesity, and a poor reproductive history. In this review of literature the maternal factors examined were age, race, height, height/weight index, pre-pregnant weight, weight gain during pregnancy, smoking habits, and reproductive history. In addition, several nutrition and dietary variables were reviewed with regard to the mother: nutritional status, special diet instruction, and vitamin/mineral supplementation.

The infant variables examined were birthweight per se, gestational age the gestational age/birthweight relationship, sex of the infant, and multiple births.

Maternal Variables

Maternal Age

Maternal age has been found to have varying influence on fetal outcome. According to Niswander (11), the occurrence of low birthweight is greatest for extremes of age such as the pregnant adolescent who is under seventeen *years old or the woman who is over thirty years old. Pregnant adolescents are at high risk because they have not met their own growth potential (2, 12). Pregnancy places an added stress on the adolescent during her developmental years (12, 13, 14, 15).*

Niswander et al (11) also found that the perinatal death rate increased with increasing age. In primagravidas over thirty years of age, the incidence of perinatal death of the infant is greater than in the younger primagravidas. The infant born to an older white or black primagravida may weigh approximately 200 grams less than the infant of the younger white and 300 grams less than the infant of the younger black primagravida.

Race

A study conducted by Ross (8) at Duke University Hospital during the period 1930-46 revealed that a large part of the high morbidity and mortality rates may be attributed to the non-white and rural populations. It was found that the states with the highest proportion of low birthweight infants were those that had a greater percentage of non-whites in the population. During the period 1950-68, 92.2 percent of the non-white deliveries at Duke University Hospital were black.

In a study of 9289 white and 7605 black obstetric patients, Niswander et al (11) found that the incidence of excessive weight gain or of small weight loss during pregnancy was high. A birthweight distribution analysis showed that black newborns were typically low birthweight. Bergner and Sussner (16) *pointed out that the perinatal mortality for non-whites in New York City was 70 percent higher than for whites. The occurrence of low birthweight infants is especially high for black adolescents.*

Height

A study by Love and Kinch (17) showed a positive relationship between maternal height and the birthweight of the infant. However, the height/birthweight correlation was found to be less significant than the maternal pre-pregnant weight/birthweight relationship.

Baird (18) reported that the incidences of stillbirths and difficult labor were greater in women of short stature. He contended that the reason for the increased unfavorable outcome is that short women often had poor nutrition during childhood and, therefore, failed to reach their own genetic potential.

Height/Weight Index

Love and Kinch (17) stated that maternal pre-pregnant weight to height was an index of maternal body build, which may reflect her status as underweight, overweight, or average weight. A poor weight for height constitutes a nutritional risk in that lack of adequate maternal stores will place stress not only on the mother but also on the fetus during the early developmental period. According to Hunscher and Tompkins (12) the underweight patient has the greatest probability of developing pre-eclampsia and eclampsia and of having premature labor.

The state of obesity in maternity patients does not indicate good nutrition but does indicate dysfunctional nutrition prior to pregnancy (8, 12). Respiratory, operative and diagnostic problems present hazards to the obese patient (12).

Pre-pregnant Weight

Niswander et al (19) and Mukherjee and Sethna (20) found a strong positive correlation ($p < .001$) between pre-pregnant weight and infant birthweight. Mukherjee and Sethna attributed their observation to the fact that women of higher pre-pregnant weight were in better nutritional status.

Simpson et al (21) reported, however, that the only correlation that exists between pre-pregnant weight and infant birthweight is a negative one in women weighing over 160 pounds since with these women there is often self-imposed or prescribed calorie restriction during pregnancy. They feel that although pre-pregnant weight and weight gain affect the birthweight of the term infant, the variables are independent.

In a Collaborative Perinatal Study of the National Institute of Neurological Diseases and Stroke, Niswander (11) showed there was a steady increase in perinatal mortality for newborns (white and non-white) with increasing maternal pre-pregnant weight. There appear to be different factors that influence the production of a low birthweight infant by a heavy mother and a small mother. Niswander felt that a low birthweight infant born to a heavier mother was more frequently due to a morbid condition such as chronic hyper-

tension. A small mother was more likely to have a low birthweight infant because she, herself, did not reach her genetic potential. The risk of perinatal death is greater in small infants of heavy mothers than small infants of small mothers.

Weight Gain During Pregnancy

Historically, advice on the optimal weight gain during pregnancy has been based on much folklore and unscientific thought. Obstetricians often advocated restricted weight gain in the belief that it facilitated easy delivery and prevented eclampsia (21).

Some of the fallacious reasons given for the positive effects of limited weight gain were that excess weight gain caused breastfeeding to be unsuccessful, resulted in a complicated labor, increased the incidence of infection, and caused toxicity within the mother. Simpson et al (21) cite a 1917 editorial in the Journal of the American Medical Association that concluded that restricted intake of fat and meat during pregnancy tended to ward off eclampsia.

Eastman (22) found no scientific evidence that weight restriction prevented the development of eclampsia in a study of 6675 white and 5236 non-white pregnancies. The reduction of the incidence of pre-eclampsia in the United States is due to better nutrition and increased protein intake according to Hester (23). Pomerance (24), Love and Kinch (17), Tompkins (25), and O'Sullivan (26) found a positive correlation between the mother's weight gain in pregnancy and the birthweight of the infant. The lowest perinatal mortality rate reported *by Niswander in his study was achieved when maternal weight gain was twenty to twenty-nine pounds. Increased perinatal mortality occurred with gains of thirty or more pounds. A gain of thirty or more pounds exceeded the physiological needs of pregnancy and lactation (11).*

A problem that faces many obstetricians is the management of the grossly overweight and grossly underweight obstetric patient. Low weight gain during pregnancy by the obese patient does not cause reduced size of the baby, nor does high weight gain in underweight patients cause an increase in the size of the baby (12, 25).

According to Shank (27), the effect of dietary restriction on fetal outcome is impaired fetal growth and development, reduced birthweight, and increased threat to survival. Severe caloric restriction limits supplies of protein, a nutrient necessary for growth, repair, and maintenance. Restricted total calories in animal studies resulted in increased numbers of offspring with decreased size and increased mortality (28). It is agreed that even the obese obstetric patient should not be encouraged to lose weight during her pregnancy. She should eat an adequate diet, increase activity, and gain approximately twenty-four pounds (29). The underweight obstetric patiend should gain enough weight to be the proper weight for her height plus approximately twenty-four pounds.

According to Jacobson (30), the overall goal in the management of the obstetric patient is to encourage the patient to gain enough weight during pregnancy in order to facilitate the preservation of critical stores and to allow the *fetus to reach its full growth potential.*

In 1970 the Committee on Maternal Nutrition of the National Research Council presented the results of a three-year study of literature on pregnancy. It was the conclusion of the Committee that the optimal weight gain for the pregnant female was approximately twenty-four pounds (2, 28, 30, 31).

The components of a weight gain of twenty-four pounds at forty weeks gestation may be broken down as shown in Table 2.

TABLE 2

CONSTITUTENTS OF MATERNAL WEIGHT GAIN DURING PREGNANCY

	Weight	
Tissue or Fluid	*gm.*	*lb.*
Fetus	*3500*	*7.7*
Placenta	*650*	*1.4*
Amniotic fluid	*800*	*1.8*
Uterus	*900*	*2.0*
Breasts	*405*	*0.9*
Interstitial fluid	*1200*	*2.7*
Maternal blood	*1800*	*4.0*
TOTAL	*9255*	*20.5*
Total weight gained during average pregnancy	*10896*	*24.0*
Weight gained but not accounted for	*1621*	*3.5**

**The extra 3.5 pounds is considered to be a margin of safety (10).*

Inadequate weight gain is detrimental to the fetus and to the mother (32, 33, 34, 35). Waisman (32) and Winick (33), through studies on the DNA/RNA content of cells in the brain and placenta of both normal and low birthweight infants, indicated that the fetus is not a parasite taking priority on maternal stores. Analysis of brains and placenta reflect that growth of the fetus occurs in three stages: hyperplasia (increase in cell number), hyperplasia and hypertrophy (increase in cell number and cell size), and hypertrophy (increase in cell size). If nutrients are not available during the early developmental stages, irreparable damage may occur.

Smoking Habits

Women who smoke ten or more cigarettes per day during pregnancy risk having an infant small for gestational age and infant mortality (36). Studies have shown that if mothers smoke during pregnancy, the birthweight of the infant is reduced by 200 grams (37, 38). A recent report on smoking during the thirty-second to thirty-eighth weeks of pregnancy indicated that fetal breathing movements might be diminished among mothers who smoke (37). As many as thirty-three references support the observation that smoking during pregnancy results in infants of low birthweight (9). In addition to adversely affecting the blood flow to the uterus, smoking may also serve to curb the appetite of the mother.

Reproductive History

A reproductive history is predictive of future pregnancy outcomes. If a previous infant had a birthweight that exceeded 2500 grams, the incidence of fetal malnutrition during the current pregnancy may be expected to be 7.3 percent. If a previous infant was of low birthweight, a current pregnancy has a 13.7 percent chance of producing a low birthweight child. Young females have an increased tendency to deliver low birthweight infants, whereas females over forty-five have an increased tendency to produce higher birthweight infants with each succeeding pregnancy (16).

Niswander et al (11) found a racial differential with regard to history of previous pregnancies. In white patients, if the last child weighed less than 2501 grams at birth, the chance that the current pregnancy would yield an infant less than 2501 grams was one in four. For non-white infants, the chance was one in three. Generally speaking, the greatest proportions of low birthweight infants were found with birth orders of one or over six. The occurrence of low birthweight increased with increasing pregnancies in whites and decreased with increasing pregnancies in non-whites.

Nutrition and Dietary Variables

Nutritional Status

The nutrition of the mother exerts a limiting effect on the fetus during growth and development, and also has a bearing on the occurrence of complications during pregnancy (12). The nutritional status of the mother, the efficiency of blood flow to the fetus, and the maturation of intrinsic fetal regulatory processes are three factors that determine the intrauterine nutritional status of the fetus (10, 35).

Information pertaining to the effect of poor nutrition on fetal outcome has been provided from studies on animals consuming experimentally deficient diets *and from studies on infant birthweights during famine (34). Animal studies have revealed that impaired nutrition during pregnancy may result in congenital anomalies, intrauterine death, and reduced birthweight (28, 39). Human studies done during periods of famine show that fertility was lower in those women who subsisted on inadequate supplies of food. An example of acute deprivation of food came from studies in Holland where good nutrition preceeded a short period of deprivation (9).*

Acute poor nutrition during the first half of pregnancy resulted in infants with normal birthweight. Poor nutrition during the second half of pregnancy may result in a ten percent reduction in the average birthweight. An example of chronic deprivation can be observed in the Stalingrad studies where extreme deprivation existed prior to and during a long war and famine. The effect on fetal outcome was profound in that the average maternal weight gain fell from twenty-five pounds during the pre-famine period to five pounds during the famine. The resulting newborn birthweight dropped 7 per cent (9).

Flowers (40) reported that pre-term deliveries were associated with poor nutrition among women of lower socio-economic status in North Carolina. He also stated that these women had the additional stress of insecure living conditions. Prenatal care must begin early with the mother to assure that she has adequate nutrition and nutritional stores, and has met her genetic potential.

Although the Committee on Nutrition has recommended a weight gain of twenty-four to thirty pounds, the Committee also suggests that the content of the diet of the pregnant woman be carefully monitored (2, 30). A varied diet providing essential nutrients should be consumed.

Low protein intake was associated with poor postnatal health for the mother and infant, the birth of low birthweight infants, toxemias of pregnancy, anemia, and decreased mental development (23). Protein must be supplied (approximately sixty-five grams per day), and enough carbohydrate should be available to exert a protein sparing effect.

Special Diet Instruction

With regard to diet during pregnancy, three areas that need consideration are weight reduction diets or calorie restriction, low sodium diets, and vitamin/mineral supplementation (2). The rationale behind the use of these three forms of diet modification is weak and based on little substantial evidence. According to Oakes (41), these three measures are examples of unnecessary treatment in most cases.

Weight Reduction or Calorie Restrictions

Calorie restriction during pregnancy may be initiated by the obstetrician in an effort to prevent toxemia or by the mother who desires to return quickly to her pre-pregnant weight (21, 28). Historically, it was thought that a sign of toxemia was rapid weight gain which was supposedly attributed to over-eating. Reid (42) encouraged limiting of pregnancy weight gain to fifteen to eighteen pounds in order to prevent toxemia and to ensure return to pre-pregnant weight.

Studies (12, 28) have shown a positive correlation between poor fetal *outcome, in terms of birthweight and mortality, and diets containing less than 1500 calories or less than fifty grams of protein. Diets under 1500 calories will not supply essential nutrients to the mother and fetus; diets consisting of 3500 calories or more will exceed the needs of the patient (12).*

There is no scientific evidence that proves restriction of calories during pregnancy prevents pre-eclampsia. The National Research Council does not support caloric restriction because of its potential hazard in fetal outcome (2).

In the dietary management of the pregnant patient, obstetricians often prescribe severe restriction of calories, especially for the obese patient. The rationale often used is that the patient will metabolize fat stores to meet the additional calories needed for energy. This may be true for a short period of time, but becomes hazardous treatment for extended periods (12, 28).

The prescription of calorie restricted diets is an example of a poor conception of the effect of nutrition on fetal outcome. If maternal intake is reduced to a point where maternal fat stores are metabolized, ketosis and acetonuria may result. Acetonuria has been associated with intellectually retarded development in the offspring (12, 28).

Sodium Restriction

Sodium intake and its relationship to toxemia during pregnancy has been a controversial topic for many years. Stone et al (43) have found a higher incidence of toxemia among pregnant patients suspected of having a deficiency of folic acid. Some have shown that deprivation of salt during the antepartum *period resulted in a threefold higher incidence of toxemia than the consumption of salt in food (8). A number of studies give evidence of the point that the value of sodium restriction is absent in normal and toxemic pregnancies (8, 10, 41). Oakes et al (38) pointed out that physiological edema is often an inevitable consequence of pregnancy. Attempts to control edema by diet or diuretics does little but upset the normal renin-angiotensin-aldosterone balance to insure positive sodium balance.*

<u>Vitamin/Mineral Supplementation</u>

Nutrition education is a neglected subject in medical, nursing, and dental schools (28). An especially weak area is knowledge of the nutritional needs of the pregnant woman. Due to this lack of knowledge, many obstetricians rely heavily on vitamin/mineral supplements to assure proper nutrition during pregnancy.

Multivitamins

Supplementation with multivitamin/mineral tablets is a prevailing practice today in the management of the obstetric patient. Evidence available at the present time does not indicate that vitamin supplementation has a beneficial effect (28). A disadvantage of the routine supplementation is the false sense of security given to the patient or the physician in lieu of a concern for development of good dietary practices.

Ross (8) stated that there is no need to prescribe vitamins except for folic acid. The Committee on Maternal Nutrition also stated that arbitrary supplementation may result in hypervitaminosis and may have teratogenic consequences, however, it did recommend folic acid supplementation (2).

Iron and Folic Acid

Iron and folic acid are two nutrients that have been found to be of primary importance in prenatal care due to the increased need during this period (10). A deficiency of either of these micronutrients may result in anemia and may affect the fetal outcome. Levels of iron and folic acid in the pre-pregnant female give an indication as to her nutritional status.

Iron. Anemia may be defined as a reduced concentration of hemoglobin per 100 milliliters of blood, reduced volume of packed red cells per 100 milliliters of blood (hematocrit), or reduced number of erythrocytes per cubic millimeter of blood (2). The normal range for hematocrit in a non-pregnant female is 38 to 45. The normal range for hemoglobin in the non-pregnant female is 12.0 to 15.4 per 100 milliliters. If the hemoglobin level is below 11 late in pregnancy, anemia should be suspected (2, 10).

The pregnant female has an increased need for iron due to the increased hematopoiesis (manufacture of red blood cells). Iron is the limiting factor for the formation of hemoglobin. The total amount of iron needed for the development of the fetus is 300 milligrams. The amount needed to prevent anemia due to the increased maternal blood volume is 500 milligrams. Due to the fact that the usual diet of a pregnant female contains 10 to 15 milligrams of iron per day and only ten to twenty percent of that (or 1 to 2 milligrams) is absorbed, it is *recommended that all pregnant women receive 30 to 60 milligrams of ferrous iron daily. Supplementation should be continued postpartum to replenish body stores (28).*

Folic Acid. Lack of appropriate amounts of folic acid may result in megaloblastic anemia. The deficiency is usually evident in cells that have a rapid turnover, such as red blood cells. Data on folic acid supplementation report conflicting recommendations. It has been suggested that there may be a relationship between folic acid deficiency and abruptio placentae, abortion, and fetal malformations (2). A subsequent report fails to support these data (44).

A hazard supplementation with folic acid is that pernicious anemia may go unrealized. The risk, however, is low because supplementation of 200 to 400 micrograms per day will not mask neurologic complications (28).

Infant Variables

In an effort to determine what characteristics are peculiar to infants who suffer perinatal death, one must consider birthweight (low, average, or high), length of intrauterine life (gestation), sex of the infant, and multiple births.

Birthweight

The World Health Organization has defined a low birthweight infant as one who weighs less than 2500 grams. A low birthweight or high birthweight infant may be term, pre-term, or post-term. A pre-term infant is one who is *born before the thirty-seventh week of gestation. A term infant is one born between the thirty-eighth and forty-first weeks of gestation, whereas a post-term infant is one born from the forty-second week and thereafter.*

The infant birthweight usually increases up to forty weeks. A general decline in birthweight begins between forty and forty-two weeks of gestation, with a definite decrease at forty-three weeks, when the infant starts to lose weight in utero and the effect of length of gestation on birthweight diminishes (1,9).

Gestational Age

The belief that birthweight is the only index of infant maturity is a fallacy. Length of gestation has the greatest single effect on birthweight according to O'Sullivan et al (26). Within the past ten years research reports have shown that gestational age (or intrauterine life) is a better indication of maturity.

Gestational age is calculated from the first day of the last menstrual period, which is often inaccurately reported by the mother (9, 11). Gestational age also may be determined by a neurological examination of the newborn, called a Dubowitz exam (45).

Gestational Age/Birthweight Relationship

Gestational age and birthweight are two variables that, taken together, give predictability with regard to perinatal mortality. A graph used to assess birthweight for gestational age has been developed at the University of Colorado Medical Center (Appendix E). It plots the weights of the newborn in grams vertically and the weeks of gestation of the newborn horizontally. Those infants whose age and birthweight put them at the ninetieth percentile or above are considered large for gestational age, between the tenth and ninetieth percentile are average for gestational age, and below the tenth percentile are small for gestational age. Infants large for gestational age have grown at an accelerated pace. The small infant for gestational age has grown at a retarded pace (46).

At the University of Tennessee, researchers (9) found that 40 percent of the low birthweight infants were born at or near term, which would make them not only low birthweight, but also small for gestational age. A low birthweight infant may also be born pre-term and be an average weight for his gestational age. The rate of mortality decreases for any birthweight as gestational age increases and also decreases for any gestational age as weight increases.

Sex of the Infant

According to Love and Kinch (17), male infants tend to have a larger birthweight than female infants. For this reason the sexes should be analyzed separately.

Multiple Births

The perinatal mortality rate of twins is four times greater than of singletons. Typically, twins are at high risk because they are usually born preterm, with the average length of gestation being thirty-seven weeks (9). Because length of gestation has the greatest effect on birthweight, the *pre-term infant is often low birthweight. Heavier twins (over 3000 grams) also have a higher mortality rate than singletons due to mechanical-obstetrical factors.*

For any length of gestation, however, twins are usually smaller in birthweight than singletons. A subnormal rate of growth occurs at approximately thirty weeks in twins, as compared to thirty-six to thirty-eight weeks in normal singletons. A progressive decrease in efficient nutrient transfer across the placenta results in decreased fetal growth (1, 9).

A race differential has been observed in multiple births in the population. One out of seventy non-white births is a multiple birth, whereas one out of eighty white births is multiple (1).

Summary

This review of literature on selected maternal, dietary, nutrition status and infant variables includes discussion of areas where there is general agreement and areas in which there is lack of consensus. There is a need to analyze the factors related to infant birthweight for gestational age, a comparatively new concept, since most previous work has been done on birthweight per se.

CHAPTER III

METHOD

In light of the high perinatal mortality rate in North Carolina, a retrospective study was designed to study the relationship between selected maternal, dietary, and nutrition status variables and birthweight for gestational age, birthweight per se, and perinatal mortality.

Selection of Hospital

This study was conducted at Hospital A in Greensboro, North Carolina, for a variety of reasons:

1. the availability of an accessible mixed patient population of private and public assistance patients,

2. the existence of the most sophisticated perinatal care facility in the area,

3. the presence on the hospital staff at that time of the only pediatric neonatologist in Greensboro,

4. the cooperation of the obstetricians with regard to access to the medical records of patients and permission to conduct a postpartum interview with each obstetric patient, and

5. the willingness of the nursing staff to weigh the obstetric patients as they were admitted to the hospital to be delivered.

Selection of Independent Variables

A careful perusal of thirty maternity patient medical records on July 1, 1975 indicated the type of information that was available for analysis. The specific independent variables were designated following a pilot study in which one hundred obstetric records, consisting of four small for gestational age infants, seventy-one average for gestational age infants, and twenty-five large for gestational age infants were reviewed. Postpartum interviews also were conducted to determine data accessibility.

The variables examined with regard to the mother were age, race, height, height/weight index, pre-pregnant weight, weight gain during pregnancy, smoking habits, reproductive history, special diet instruction, vitamin/mineral intake, and hemoglobin and hematocrit levels during pregnancy. The infant variables studied were birthweight, gestational age, gestational age/birthweight relationship, sex of the infant, and occurrence of multiple births.

Data Collection

Maternal data were obtained from obstetrical records and a postpartum interview with maternity patients. Infant data were collected from birth records available in the Newborn Nursery. Both the data collection and coding instruments may be found in Appendix B.

Selection of Sample

The sample consisted of 137 deliveries selected on the basis of infant birthweight for gestational age. Newborn medical charts were reviewed to determine the birthweight of infants. Infants weighing less than 2500 grams (low birth-

weight infants) were given a Dubowitz examination* to clinically assess the gestational age of the infant. Determination of the gestational age of infants weighing in excess of 2500 grams was based on calculation from the first day of the last menstrual period as reported by the maternity patient.

Newborn Classification and Neonatal Mortality Risk, a graph designed at the University of Colorado Medical Center (Appendix E), was used to plot the birthweight and gestational age of the infant. Infants falling above the ninetieth percentile were large for gestational age; those falling between the tenth and the ninetieth percentiles were average; and those falling below the tenth percentile were small (46). Data from newborn records also included sex of the infant and notations on multiple births.

Sample Size

A survey of approximately 2,200 births at Hospital A during eight consecutive months in 1974 and 1975 revealed that 3.6 percent of all births at the hospital were small birthweight for gestational age (47). A similar figure was not available for infants of large birthweight for gestational age.

During the pilot study, information was collected on all maternity patients and all infants born during the period July 11 to July 25, 1975. The intent during the second period of data collection, February 1 to April 15, 1976, was to obtain additional data on infants at the extremes of the continuum--the newborn which

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*Dubowitz examination is an objective and reproducible scoring system for determination of gestational age based on ten neurologic and eleven external criteria (45).

were small or large for gestational age. Since one of the major emphases of this study was to determine relationships between high risk pregnancies and perinatal outcome, it was agreed that it would not be necessary to collect additional data on all average births during the second data collection period. Upon each visit to the hospital to get additional data on infants at the extremes, one additional infant of average birthweight for gestational age was added to the sample.

Within the time limits of this study, seventeen infants small for gestational age and thirty-four infants large for gestational age were born at Hospital A. The remainder of the total sample of 137 deliveries consisted of eighty-six infants of average birthweight for their weeks of gestation.

The groups of infants small, average, and large for gestational age represented 12 percent, 63 percent, and 25 percent of the sample. It was felt that these proportions were large enough to submit for statistical analysis and to allow one to postulate relationships between maternal variables and fetal outcome.

Characteristics of the Sample

The collection of data on the study sample provided a demographic profile of participating infants and mothers.

Infant Characteristics

Infant birthweight for gestational age was the criteria used to select the sample under study. The final sample consisted of seventeen (12 percent) small, eighty-six (63 percent) average, and thirty-four (25 percent) large infants for gestational age.

An evaluation of the sample in terms of birthweight per se showed twenty-one (16) percent low birthweight, ninety-nine (72 percent) average birthweight, and seventeen (12 percent) high birthweight infants. The range of birthweights was 550 grams to 4730 grams, with the average birthweight being 3186 grams.

Using the definition of full term as those neonates born between the thirty-eighth and forty-second weeks of gestation, one hundred and three (83 percent) were term infants, seventeen (12 percent) were pre-term, and seven (5 percent) were post-term. Because length of gestation per se has the most profound effect on infant birthweight, inclusion of this variable in the analysis would preclude observation of the significance of any other factors.

Six (94 percent) of the pregnancies resulted in perinatal death. Four of the deaths were neonatal (within the first twenty-eight days of life) and two were fetal (between twenty weeks of gestation and birth). The data available on perinatal deaths in this sample were considered inadequate for further interpretation.

Fifty percent of the sample of newborn were female and fifty percent were male.

Three (2 percent) of the 137 deliveries resulted in the birth of twins.

Maternal Characteristics

The final sample of maternity patients consisted of eighty-nine (65 percent) white mothers and forty-eight (35 percent) non-white mothers.

The ages of the women ranged from fourteen to thirty-eight, with eighteen (13 percent) of the subjects aged seventeen or younger and fifteen (11 percent) *aged thirty or older. Data in Table 3, arranged in those age intervals used by Niswander (11), indicated that eighty-six (62 percent) of the subjects were between twenty and twenty-nine years of age. The average age of the subjects was twenty-three.*

TABLE 3

DISTRIBUTION OF MATERNAL AGE IN THE SAMPLE

Maternal Age	*Frequency*
14-15	*6 (5%)*
16-17	*12 (8%)*
18-19	*18 (14%)*
20-24	*42 (30%)*
25-29	*44 (32%)*
30-34	*12 (9%)*
35-38	*3 (2%)*
TOTAL	*137 (100%)*

Maternal heights ranged from four feet, eleven inches to five feet, eleven inches, with the average height being five feet, four inches. The range of pre-pregnant weights was ninety-four pounds to two hundred sixty-four pounds. The average maternal pre-pregnant weight was one hundred thirty-three pounds (Appendix B).

With regard to reproductive history, sixty-two (45 percent) of the cases were primaparas (first delivery). The remaining seventy-five (55 percent) had one to five previous deliveries.

Sixteen (12 percent) of the mothers had a previous abortion. Of these, four (25 percent) were reportedly therapeutic and twelve (75 percent) were reportedly spontaneous. Because these data were obtained through report of the mother in her medical record, there was no method to determine reliability of this information, and it was, therefore, omitted from analysis.

Information on the birthweights of previous newborns was also obtained by maternal report from memory and was likewise omitted from analysis.

Ninety-seven (70 percent) of the mothers were non-smokers. Of those who did smoke during pregnancy, twenty-two (16 percent) smoked from ten cigarettes to more than a pack per day and eighteen (13 percent) smoked less than ten cigarettes per day.

Hemoglobin and hematocrit levels taken throughout pregnancy were not consistently available on the total sample and were omitted from analysis.

One hundred twenty-three (90 percent) of the patients reported that they took vitamin/mineral supplements during pregnancy as prescribed by the obstetrician. Of the remaining fourteen, three (21 percent) stated that their obstetrician did not prescribe vitamin/mineral supplements and eleven (78 percent) said they never or rarely took the prescribed supplements.

Twenty-eight of the maternity patients were given special diets to follow during pregnancy by the attending obstetrician. Sixteen of the special diets were low sodium, eight were low calorie (1500 calories per day or less), and four were miscellaneous diets for patients with complicating medical conditions such as diabetes, hiateal hernia, and high blood pressure. Because only twenty percent of the maternity patients were given special diets during pregnancy, further interpretation was not possible.

Selection of Statistical Procedures for Analysis

The Chi square test of independence was chosen as the statistical method to test the significant relationships between maternal and nutrition-related variables and those of infant birthweight for gestational age and infant birthweight per se. Discriminant analysis was used to consider all maternal, dietary, and nutrition status variables simultaneously. The result of this analysis was the derivation of two prediction formulas that assigned infants to (1) three categories of birthweight for gestational age, and (2) three categories of birthweight per se by designating a relative weight to each variable in the formula.

For certain maternal variables such as age, smoking habits, weight gain, height, and pre-pregnant weight, grouped data were used to facilitate statistical analysis. An extensive study of the National Institute of Health on 16,894 pregnancies (11) provided a framework for the grouping of data on age, smoking habits, weight gain, and height. Grouping of the maternal pre-pregnant weight was based arbitrarily on intervals of nineteen pounds.

The weight for height index was based on the table prepared by Hathaway and Foord on heights and weights of adults in the United States (Appendix C).

Maternal parity was not grouped as such, but for the purposes of this study, low parity was defined as having none or one previous pregnancy. High parity was defined as having two or more previous pregnancies. Following the collection of data, information was coded for computer analysis (Appendix B).

Data were collected at Hospital A from July 11 to July 25, 1975 and February 1 to April 15, 1976 and were analyzed to ascertain the relationship between selected maternal, nutrition, and dietary variables and infant birthweight for gestational age, infant birthweight per se, and perinatal mortality.

CHAPTER IV

RESULTS

In this chapter data on the influence of maternal, nutrition, and dietary variables on the infant variables have been displayed in two sections. The first section was based on factors related to infant birthweight for gestational age, and the second section was based on factors related to infant birthweight per se. The arrangement within each section is: (1) factors found to be significant, (2) factors found to be insignificant, and (3) the prediction formula derived.

Data on special diet instruction, birthweights of previous newborn, history of abortions and miscarriages, multiple births, and perinatal mortality were not available on a large enough sample to submit for statistical analysis. In addition, values recorded on hemoglobin and hematocrit of the maternity patients was not consistently available. For the group of twenty-eight patients on which blood work was consistently available, it was not a significant factor.

Infant Birthweight for Gestational Age

Nine maternal, nutrition, and dietary variables were studied to determine their relationship to categories of infant birthweight for gestational age. Maternal smoking habits, race, and pre-pregnant weight were found to be significantly related to birthweight for gestational age according to the Chi square test of independence. Maternal age, height, vitamin/mineral intake, weight for height index, weight gain during pregnancy, and parity were found to be not significant.

Significant Factors

Maternal Smoking Habits

Sixty-one (71 percent) of the infants who were of average birthweight for gestational age and thirty (88 percent) who were large for gestational age were born to women who did not smoke during pregnancy as seen in Table 4. Eleven (65 percent) of the infants who were small for gestational age were born to mothers who smoked during pregnancy. Maternal smoking habits were significant at the $p < .001$ level.

TABLE 4

EFFECT OF DAILY MATERNAL SMOKING HABITS ON INFANT BIRTHWEIGHT FOR GESTATIONAL AGE

Maternal Smoking Habits	Birthweight for Gestational Age		
	Small (n=17)	Average (n=86)	Large (n=34)
Non-smokers	6 (35%)	61 (71%)	30 (88%)
Smokers			
10	7 (41%)	9 (10%)	2 (6%)
10	4 (24%)	16 (19%)	2 (6%)
TOTAL	17 (100%)	86 (100%)	34 (100%)

Chi square = 19.6 Degrees of Freedom = 4 $p < .001$

The results of this study indicated that the fact that the mother smoked or did not smoke during pregnancy had an effect on category of infant birthweight for gestational age. Number of cigarettes smoked per day did not appear to have an impact on size of the infant for respective weeks of gestation in the sample used in this study.

Maternal Race

Data in Table 5 shows that fifty-seven (66 percent) of the infants who were average birthweight for gestational age and twenty-six (76 percent) of the infants who were large for gestational age were born to white mothers.

TABLE 5

EFFECT OF MATERNAL RACE ON INFANT BIRTHWEIGHT FOR GESTATIONAL AGE

Maternal Race	Birthweight for Gestational Age: Small (n=17)	Average (n=86)	Large (n=34)
White	6 (35%)	57 (66%)	26 (76%)
Non-white	11 (65%)	29 (34%)	8 (24%)
TOTAL	17 (100%)	86 (100%)	34 (100%)

Chi square = 8.63 Degrees of Freedom = 2 $p < .01$

Non-white mothers in this study bore eleven (65 percent) of the infants small for gestational age. Maternal race was found to be significant at the $p < .01$ level.

Maternal Pre-pregnant Weight

A summary of data in Table 6 indicates that seventy-two (84 percent) of the infants who were average birthweight for gestational age and twenty (59 percent) of those infants who were large for gestational age were born to women with a pre-pregnant weight of 149 pounds or less. Women in this pre-pregnant weight category also had sixteen (94 percent) of the infants who were small for gestational age, which had been anticipated.

TABLE 6

RELATIONSHIP BETWEEN MATERNAL PRE-PREGNANT WEIGHT AND INFANT BIRTHWEIGHT FOR GESTATIONAL AGE

Maternal Pre-pregnant Weight (pounds)	Birthweight for Gestational Age		
	Small (n=17)	Average (n=86)	Large (n=34)
110	2 (12%)	18 (21%)	3 (9%)
100-129	8 (47%)	42 (49%)	10 (29%)
130-149	6 (35%)	12 (14%)	7 (21%)
150-169	1 (6%)	8 (9%)	6 (18%)
170-189	--	4 (5%)	2 (6%)
190 and up	--	2 (2%)	6 (17%)
TOTAL	17 (100%)	86 (100%)	34 (100%)

Chi square = 22.11 Degrees of Freedom = 10 $p < .01$

The fact that women with a pre-pregnant weight of 149 pounds or less had the largest percentage of small, average, and large infants for gestational age is not surprising because 108 (78 percent) of the women in the sample fell into this weight category. Pre-pregnant weight was found to be significant at the $p < .01$ level.

Insignificant Variables

Several variables examined did not have a significant effect on infant birthweight for gestational age. Data on these variables may be found in Appendix D.

Women aged seventeen or younger and thirty or older were not found to have a higher proportion of small, average, or large for gestational age infants. The index of height to weight, indicating maternal pre-pregnant condition as underweight, average weight, or overweight, was not found to be significant.

Vitamin/mineral intake was not found to be significant with infant birthweight for gestational age or infant birthweight per se. Although 123 (90 percent) of the patients reported that they took supplements, this information was based on self report and was considered to be unreliable.

Maternal height, weight gain, and parity were not found to have significant relationships with birthweight for gestational age; however, significant relationships with birthweight per se can be noted on pages 43-45.

Prediction Formula

Discriminant analysis was applied to selected maternal and nutrition status variables to derive a formula by which to predict categories of infant birthweight for gestational age (small, average, or large). The independent maternal and nutrition status variables were weighted by the assignment of standardized discriminant coefficients. Based on these coefficients, the prediction formula derived in this study was

*Standardized Discriminant Function Score = 0.28 Age +0.32 Race +0.09 Height +0.66 Pre-pregnant Weight -1.28 Delivery Weight of Mother -0.41 Smoking**

The strongest factors in predicting birthweight category for gestational age were, respectively: weight of the mother at delivery, smoking habits, and race.

When the prediction formula yielded a value below -0.469, a large infant birthweight for gestational age was predicted. Values greater than +0.419 predicted an infant small for gestational age. Values from +0.419 to -0.469 predicted an infant within the average range.

According to data in Table 7, the accuracy of the formula was 58 percent, with the highest accuracy of prediction for small (77 percent) and large (62 percent) for gestational age infants.

**Race and smoking were coded as follows: 1=white, 2=non-white, 1=smoker, and 2=non-smoker. For maternal age, height, pre-pregnant weight and delivery weight, the actual numerical values were used.*

TABLE 7

ACCURACY OF PREDICTION FORMULA FOR CATEGORY OF INFANT BIRTHWEIGHT FOR GESTATIONAL AGE

Actual Group	Group Predicted Small	Average	Large
Small (n=17)	13 (77%)	4 (24%)	0 (0%)
Average (n=86)	24 (28%)	45 (52%)	17 (20%)
Large (n=34)	3 (9%)	10 (29%)	21 (62%)

TOTAL PERCENT CORRECTLY CLASSIFIED: 57.66

The prediction formula derived for categories of infant birthweight for gestational age may be used to make a rough estimation of fetal outcome if data on maternal age, race, height, pre-pregnant weight, delivery weight, and smoking habits are available.

Data in Table 8 displays the characteristics of a mother in the study sample who was eighteen years old and five feet, eleven inches tall, with a pre-pregnant weight of 112 pounds and a weight at delivery of 120 pounds. This mother reported that she smoked less than one pack of cigarettes per day during her pregnancy. Based on this data, her computed standardized discriminant function score was 2.62. With respect to the cutoff points established, the score was well within the limits of the category of small for gestational age infants, which proved to be the actual category of the infant at time of delivery.

TABLE 8

USE OF FORMULA TO PREDICT CATEGORY OF INFANT BIRTHWEIGHT FOR GESTATIONAL AGE

Variable	Data	z Score	Standardized Discriminant Function Coefficient	Standardized Discriminant Function Score
Age	18	-1.08	-0.28	0.30
Race	2	1.36	0.32	0.43
Height	5'11"	2.53	0.09	0.20
Pre-pregnant Weight	112	-0.63	0.66	-1.41
Weight at delivery	120	-1.14	-1.28	1.46
Smoking habits	1	-1.55	-0.41	0.64
TOTAL DISCRIMINANT FUNCTION SCORE				2.62

In Table 8, the standardized discriminant score is obtained by converting the raw data to z scores and multiplying by the standardized discriminant function coefficients.

Infant Birthweight Per Se

Nine maternal, nutrition, and dietary variables were studied to determine the relationship to categories of infant birthweight per se. Maternal smoking habits, race, parity, weight gain, and height were found to be significant ($p < .01$). Maternal pre-pregnant weight, vitamin/mineral intake, weight for height index, and age were termed not significant by Chi square tests of independence.

Significant Factors

Maternal Smoking Habits

Seventy-two (73 percent) of the infants of average birthweight and fifteen (94 percent) of the high birthweight infants were born to mothers who did not smoke during pregnancy. Twelve (55 percent) of the mothers who smoked during pregnancy had low birthweight infants. Mothers who smoke at all during pregnancy run a greater risk of having a low birthweight infant.

TABLE 9

EFFECT OF DAILY MATERNAL SMOKING HABITS ON INFANT BIRTHWEIGHT PER SE

Maternal Smoking Habits	Birthweight Per Se Low (n=22)	Average (n=99)	High (n=16)
Non-smokers	10 (46%)	72 (73%)	15 (94%)
Smokers			
10	7 (32%)	11 (11%0	--
10	5 (22%)	16 (16%)	1 (6%)
TOTAL	22 (100%)	99 (100%)	16 (100%)

Chi square = 13.06 Degrees of Freedom = 4 $p < .01$

According to the data displayed in Table 9, there is no clear breakdown between mothers who smoked less than or more than ten cigarettes per day Maternal smoking habits were significant at the $p < .01$ level.

Maternal Race

Data on the effect of maternal race on infant birthweight per se are given in Table 10. Seventy (71 percent) of the average birthweight infants and ten (63 percent) of the high birthweight infants were born to white parents.

TABLE 10

EFFECT OF MATERNAL RACE ON INFANT BIRTHWEIGHT PER SE

Maternal Race	Birthweight Per Se Low (n=22)	Average (n=99)	High (n=16)
White	9 (41%)	70 (71%)	10 (63%)
Non-white	13 (59%)	29 (29%)	6 (37%)
TOTAL	22 (100%)	99 (100%)	16 (100%)
Chi square = 24.08	Degrees of Freedom = 14		$p < .05$

Non-white patients had thirteen (59 percent) of the low birthweight infants. Maternal race was significant at the $p < .05$ level.

Maternal Parity

With regard to infant birthweight, there was a distinction as seen in Table 11 between mothers who had no previous pregnancy or one previous pregnancy and mothers who had two or more pregnancies.

TABLE 11

RELATIONSHIP BETWEEN PARITY AND INFANT BIRTHWEIGHT PER SE

Number of Previous Pregnancies	Infant Birthweight Per Se Low (n=22)	Average (n=99)	High (n=16)
None	8 (36%)	47 (48%)	7 (44%)
One	13 (59%)	28 (28%)	3 (19%)
Two	--	10 (10%)	1 (6%)
Three or more	1 (5%)	14 (14%)	5 (31%)
TOTAL	22 (100%)	99 (100%)	16 (100%)

Chi square = 13.76 Degrees of Freedom = 6 $p < .05$

Twenty-one (95 percent) of the low birthweight infants were born to mothers with a parity of none or one. Parity was significant at the $p < .05$ level.

Maternal Weight Gain

Women who gained twenty pounds or more during pregnancy had seventy-nine (79 percent) of the average and thirteen (91 percent) of the high birthweight infants according to data in Table 12.

TABLE 12

EFFECT OF MATERNAL WEIGHT GAIN ON INFANT BIRTHWEIGHT PER SE

Maternal Weight Gain (pounds)	Infant Birthweight Per Se Low (n=22)	Average (n=99)	High (n=16)
Less than 9	2 (9%)	5 (5%)	--
10-14	3 (14%)	4 (4%)	2 (13%)
15-19	8 (36%)	12 (12%)	1 (6%)
20-24	3 (14%)	26 (26%)	4 (25%)
25-29	3 (14%)	22 (22%)	1 (6%)
30-34	2 (9%)	10 (10%)	1 (6%)
35-39	--	13 (13%)	4 (25%)
40 or more	1 (4%)	7 (7%)	3 (19%)
TOTAL	22 (100%)	99 (100%)	16 (100%)

Chi square = 24.08 Degrees of Freedom = 14 $p < .05$

Thirteen (59 percent) of the low birthweight infants were born to women who gained nineteen pounds or less during pregnancy. Weight gain was significant at the $p < .05$ level.

<u>Maternal Height</u>

In interpreting the effect of maternal height on infant birthweight per se, Table 13 shows that only fifty-three (53 percent) of the average birthweight *infants and nine (56 percent) of the high birthweight infants were born to women five feet, four inches and over. On the other hand, sixteen (73 percent) of the low birthweight infants were born to women five feet, three inches or less. Maternal height was significant at the $p < .001$ level.*

TABLE 13

EFFECT OF MATERNAL HEIGHT ON INFANT BIRTHWEIGHT PER SE

Maternal Height	Infant Birthweight Per Se Low (n=22)	Average (n=99)	High (n=16)
Less than 5'	5 (23%)	1 (1%)	--
5' to 5'3"	11 (50%)	45 (46%)	7 (44%)
5'4" to 5'6"	2 (9%)	30 (30%)	4 (25%)
5'7" and up	4 (18%)	23 (23%)	5 (31%)
TOTAL	22 (100%)	99 (100%)	16 (100%)

Chi square = 24.05 Degrees of Freedom = 6 $p < .001$

The categories were divided by criteria established in a previous comprehensive study (11).

Non-significant Variables

Three of the variables examined did not have a significant effect on infant birthweight per se. The pre-pregnant weight and age of the mother had no bearing on the outcome of the infant in terms of birthweight per se. There was no relationship between maternal weight for height index, vitamin/mineral *intake and infant birthweight per se. Data on these variables may be found in Appendix D.*

Prediction Formula

Discriminant analysis was applied to the selected maternal and nutrition status variables to derive a formula by which to predict categories of birthweight per se (low, average, or high). The independent maternal and nutrition status variables were weighted by the assignment of standardized discriminant function coefficients. Based on these coefficients, the prediction formula derived was

*Standardized Discriminant Function = –0.23 Age + 0.21 Race – 0.29 Height + 1.58 Pre-pregnant weight – 1.88 Delivery Weight of Mother – 0.47 Smoking**

The strongest factors in predicting birthweight category per se were, respectively: weight of the mother at delivery, pre-pregnant weight, and smoking habits.

When the prediction formula yielded a value below –1.61, a large infant birthweight was predicted. Values greater than +0.500 predicted low birthweight. Values from –1.61 to +0.500 predicted an infant within the average range.

An examination of data in Table 14 shows that the formula best predicted the category of low birthweight infants with an accuracy of 77 percent.

**Race and smoking were coded as follows: 1 = white, 2 = non-white, 1 = smoker, and 2 = non-smoker. For maternal age, race, height, pre-pregnant weight, delivery weight, and smoking habits, the actual numerical values were used.*

TABLE 14

ACCURACY OF PREDICTION FORMULA FOR CATEGORY OF INFANT BIRTHWEIGHT PER SE

Actual Group	Group Predicted		
	Low	Average	High
Low (n=22)	17 (77%)	5 (19%)	1 (5%)
Average (n=99)	28 (28%)	50 (51%)	21 (21%)
High (n=16)	2 (13%)	5 (31%)	9 (56%)

TOTAL PERCENT CORRECTLY CLASSIFIED: 56.00

The prediction formula derived for categories of infant birthweight per se may be used to make a rough estimation of fetal outcome if data on maternal age, race, height, pre-pregnant weight, weight at delivery, and smoking habits are available.

Based on data from the same case study used to illustrate the use of the prediction formula for infant birthweight for gestational age (page 39), Table 15 gives a standardized discriminant function score of 1.69 in the prediction of the category of birthweight per se. This infant was low birthweight at the time of delivery.

TABLE 15

USE OF FORMULA TO PREDICT CATEGORY OF INFANT BIRTHWEIGHT PER SE

Variable	Data	z Score	Standardized Discriminant Function Coefficient	Standardized Discriminant Function Score
Age	118	-1.08	-0.23	0.25
Race	2	1.36	0.21	0.29
Height	5'11"	2.53	-0.29	-0.73
Pre-pregnant weight	112	-0.63	1.58	1.00
Weight at delivery	120	-1.14	-1.88	2.15
Smoking habits	2	-1.55	-0.47	0.73
TOTAL DISCRIMINANT FUNCTION SCORE				1.69

Based on the cutoff point established, the score fell well within the limits of the category of low birthweight.

Summary

Maternal smoking habits, race, and pre-pregnant weight were found to be significant with regard to infant birthweight for gestational age. In addition to maternal smoking habits and race, the variables found to be significant for birthweight per se were parity, weight gain, and height.

The formulas derived for predicting categories of infant birthweight for *gestational age and birthweight per se had accuracies of 58 percent and 56 percent respectively. The highest accuracy of prediction (77 percent) was found in infants who were small for gestational age and low birthweight per se.*

CHAPTER V

DISCUSSION

In this section, consideration will be given to possible reasons for the effect of the independent variables on infant birthweight for gestational age, infant birthweight per se, and perinatal mortality. Emphasis also will be given to additional findings that, although not available in sufficient quantities for statistical analysis, may provide some clues with regard to future obstetrical management and research.

Birthweight for Gestational Age

A trend in current medical practice is to evaluate development maturity of the infant on the basis of two parameters--infant birthweight per se and length of intrauterine life (gestation). Because this is a relatively new approach to assessing maturity, research on birthweight for gestational age is limited. On the other hand, literature of the factors related to infant birthweight per se is vast.

In this study, the variables found to have a significant relationship with infant birthweight for gestational age were maternal smoking habits, race, and pre-pregnant weight.

Maternal Smoking Habits

Maternal smoking habits were found to have a relationship with both infant birthweight for gestational age and birthweight per se. The relationship with birthweight per se is well documented in the literature (36, 37). The effect on both birthweight parameters is negative in that mothers who smoked during pregnancy were more likely to have infants of low birthweight, as was the case in this study.

The possible explanation for the relationship is twofold. First, the transfer of carbon monoxide may serve to reduce the oxygen carrying capacity of fetal blood. Secondly, smoking may be used as a method of weight control in that it can curb appetite. This is especially detrimental during pregnancy when the quality and quantity of food consumed play an integral part in the well-being of the mother and of the fetus.

Race

Race of the mother was found to have a significant relationship with both infant birthweight for gestational age and infant birthweight per se. There is much literature to document the effect on birthweight per se, but little exists on the relationship with infant birthweight for gestational age.

Studies on fetal outcome in New York and North Carolina indicate that the target population for reducing the incidence of perinatal mortality should be non-white women (6). Non-white mothers have a greater chance of bearing low birthweight infants than their white sisters. Knowledge of the race differential has been called to the attention of physicians, nurses, dietitians, and allied health professionals in North Carolina (5). The result has been a direct effort to reach the non-white urban and rural populations with medical care, including a nutritional component, through regionalized perinatal care centers (3).

The relationships with race may not be as clear-cut as they seem in that socioeconomic components work simultaneously with race. According to Ross, mothers of lower socioeconomic status not only may have poor diets, but also may be under greater life stress than middle class mothers (8). If stresses in life are associated with reduced uterine blood flow, this may eventually be manifested in decreased flow of nutrients to the fetus via the placenta.

Pre-pregnant Weight

The pre-pregnant weight of the mother was found to have a significant positive relationship with infant birthweight for gestational age only. Women with poor nutrition prior to pregnancy fall into two categories: the underweight patients and the overweight patients. With the exception of the overweight patient, the higher the pre-pregnant weight, the taller the mother will be. Women of low pre-pregnant weight and short stature may be those who have not met their own genetic potential due to poor nutrition. These women are less able to carry a pregnancy to term due to structural features.

Infant Birthweight Per Se

In addition to having significant relationships with maternal smoking habits and race, infant birthweight per se was also correlated with parity, weight gain during pregnancy, and height.

Parity

Reproductive history of the mother in terms of number of previous pregnancies (parity) was significant in that mothers of high parity had infants with higher birthweights. The finding may be related to the fact that the first pregnancy is considered to be the one at highest risk. There is less risk of having low birthweight deliveries in mothers of high parity partly because these women have proven their ability to carry a pregnancy to term.

When considering parity of the mother, there is a nutritional component that should not be ignored, although it was not included in this study. Poor prenatal nutrition may not be evident in first pregnancies, but may become obvious in subsequent pregnancies if nutrient reserves have been drained. It is important to stress good nutrition to mothers of all parities.

Maternal Weight Gain

Studies on the effect of maternal weight gain on infant birthweight have shown diverse results. Pomerance (24), Love and Kinch (17), Hunscher and Tompkins (12), and O'Sullivan (26) found a positive relationship between infant birthweight and maternal weight gain.

Niswander et al (19) added a third factor, pre-pregnant weight, in the analysis of the relationship of maternal weight gain to infant birthweight. They reported that both pre-pregnant weight and weight gain must be considered. In their study of 9289 white and 7605 non-white pregnancies, they found that the positive correlation of birthweight to maternal weight gain diminished as pre-pregnant weight increased. In the analysis of 137 pregnancies in this study sample, maternal weight gain was considered to be significant at the $p < .01$ level without giving simultaneous consideration to the pre-pregnant weight of the mother.

Maternal weight gain is directly related to caloric intake. The weight gain should be gradual and based on a program of sound nutrition to ensure a diet balanced in all essential nutrients.

Restricted weight gain during pregnancy can be detrimental to the mother and to the fetus. Even the obese patient should avoid low calorie diets. If not enough calories are provided to meet the basic metabolic needs of the mother in addition to the growth needs of the fetus, fat stores are metabolized and the result may be ketosis and acetonuria. The consequence of this condition may be retarded development in the offspring. A second hazard of restricted weight gain during pregnancy is failure to develop the fat stores necessary for successful breastfeeding postpartum.

Maternal Height

Love and Kinch (17) and Murjerkee and Sethna (20) report that maternal height has a significant positive relationship with infant birthweight. This *finding was supported in the study sample population in that sixteen of the mothers less than five feet, three inches in height had low birthweight infants, whereas only six of the mothers five feet, four inches and over had low birthweight infants.*

Maternal height may be a function of early nutrition. People of short stature may be those who are genetically destined to be short or those, who by poor nutrition, did not meet their genetic potential. It is for this reason that principles of good nutrition should be stressed throughout the life cycle, as well as during the reproductive years.

Prediction Formula for Categories of Infant Birthweight for Gestational Age and Infant Birthweight Per Se

In this study the variables found to be most predictive of categories of infant birthweight for gestational age were: weight of the mother at delivery, smoking habits, and race.

The variables found to be most predictive of birthweight per se were weight of the mother at delivery, pre-pregnant weight, and smoking habits.

The prediction formulas (pages 38, 46) may be used to obtain a rough estimation of the pregnancy outcome with regard to birthweight categories and their attendant risks. In addition, they will provide clues as to the areas to which special medical attention and diet counseling may be directed.

Perinatal Mortality

Even though the group of infants who suffered perinatal mortality was too small to submit for statistical analysis, an observation of the raw data showed *that the prevailing characteristics of the mothers conform with the factors found to be significant with regard to infant birthweight. Four of the five mothers smoked during pregnancy; all of the mothers were of low parity (none or one previous pregnancy); three were non-white; all had low weight gain during pregnancy (nineteen pounds or less); and three were five feet, six inches or shorter in height.*

Additional Findings

Certain selected independent variables were not available in large enough quantities to submit for statistical analysis. The implications of the effects of these variables on management of the obstetric patient may be important.

Special Diet Instruction

Only a small percentage of the sample received special diet instruction during pregnancy. The two most commonly prescribed diets were low sodium and low calorie. According to the Committee on Maternal Nutrition of the National Research Council, it is possible that these restrictions are unnecessary (2).

Sodium Restriction

Within the group of patients on special diets, sixteen were on low sodium diets. A current practice of some obstetricians is the prescription of low sodium diets for patients who begin to show evidence of toxemia or edema. Unwarranted restriction of sodium can create a hazardous situation. Some *fluid retention is a natural phenomena in the normal pregnancy. The normal renin-angiotensin-aldosterone balance causes fluid to be retained and insures positive sodium balance during pregnancy (41).*

The Toxemic Patient

Toxemia of pregnancy which involves acute pre-eclampsia/eclampsia has been a problem in the management of obstetric patients for many years. Because the etiology of toxemia is unknown, it has been the victim of a multitude of dietary and therapeutic treatments (41).

Toxemia is typically associated with increased sodium retention and edema, and has, therefore, been erroneously linked closely with sodium. There is a lack of support from the routine restriction of sodium in the toxemic patient. Dieckman (49) reported improvement of the toxemic condition with sodium administration. Another study involved the administration of high and low levels of sodium to toxemic obstetric patients with no ill effects (25).

The Edemic Patient

In evaluating the relationship between sodium and edema, consideration must be given to the two types of edema--generalized and dependent (28). The former may occur in the toxemic patient or the non-toxemic patient as an exaggerated physiological process. Dependent edema is usually characterized by pitting edema of the legs and feet, which may occur late in the day. This type of edema is said to be due to the pressure of the uterus on the pelvic veins and the inferior vena cava.

Caloric Restriction

Low calorie diets were prescribed to nine of the obstetric patients. The consumption of diets restricted to 1500 calories or less has been known to cause some pregnancy casualty and has been detrimental to the mother and to the fetus (8).

The aim of the nutrition advice during pregnancy should be to ensure that the pregnancy will not be at the expense of the lean body stores of the mother, nor will it hamper the growth and development of the fetus (30).

The suggested calorie intake for the patient of average pre-pregnant weight is 2400 calories. This should be adjusted with regard to activity of the patient and with regard to the later stages of pregnancy. The overweight patient is encouraged to gain approximately twenty-four pounds and to increase activity. The underweight patient is encouraged to gain to her proper weight for height plus approximately twenty-four pounds (29, 30).

Multiple Births

Although the occurrence of multiple births in the sample did not supply sufficient data for analysis, representation of the data in Table 16 reinforces the significance of certain variables in the relationship of fetal outcome.

TABLE 16

CHARACTERISTICS OF MULTIPLE BIRTH NEWBORN
IN THE SAMPLE

	Race		Weeks of	Birthweight for	Birthweight		Mortality	
	W	NW	Gestation	Gestational Age	1st	2nd	Fetal	Neonatal
Case A		x	33	small	457	560	x	x
Case B	x		37	average	1600	2610	--	--
Case C		x	32	average	1500	1260	--	--

Despite the fact that this study did not analyze for the effect of length of gestation, it is agreed in the medical community that this variable has the greatest single effect on infant birthweight (26). All multiple birth infants in the sample were premature, with the average length of gestation being thirty-four weeks.

The effects of race may also be seen in that two of the three sets of twins were born to non-white mothers. Non-white mothers are more likely to have multiple births than white mothers (1). According to Berger (5) and Chase (6), perinatal casualty is greater for non-white infants than for white infants. The infants born to Case A suffered mortality in the neonatal and fetal periods.

The effect of infant birthweight for weeks of gestation may also be observed in Case A where both infants were small for gestational age and both suffered mortality.

Summary

The variables found to be significant with regard to infant birthweight for gestational age were maternal smoking habits, race, and pre-pregnant weight. In addition, birthweight per se had a positive relationship with maternal smoking habits, race, parity, weight gain, and height. It becomes apparent, however, that each variable does not represent a simple entity, but is composed of many factors. The impact of maternal race on fetal outcome may be confounded by socioeconomic status, cultural influences, life stresses, and a nutrition component. Results of this study reinforce the need for involvement of nutritionists and dietitians on the medical team in obstetric and perinatal care.

The use of the prediction formulas for categories of infant birthweight may help reduce the incidence of high risk neonates through a more directive approach to preventive nutrition counseling and medical care.

In this study the infant who was small for gestational age or low birthweight was affected by the same factors as the infant who was large for gestational age or high birthweight. These two infant categories are affected in opposite ways by the same variables and may, therefore, be found at opposite ends of the continuum. One caution must be noted--the positive relationship between weight gain during pregnancy and infant birthweight per se diminishes when weight gain exceeds thirty pounds.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The analysis of fetal outcome in terms of infant birthweight for respective weeks of gestation is a relatively new approach to assessing the maturity of the newborn and the associated risk of perinatal mortality. Concern for the high perinatal mortality rate in North Carolina and other states has led to an interest in the detection and monitoring of high risk pregnancies. In an effort to identify the relationship between selected maternal, dietary, and nutrition status variables and the infants of high risk pregnancies in terms of categories of infant birthweight for gestational age, birthweight per se, and perinatal mortality, a study was undertaken at Hospital A in Greensboro, North Carolina.

Data was collected on 137 deliveries selected on the basis of infant birthweight for gestational age (small, average, or large). The maternal variables selected for analysis were age, race, height, height/weight index, pre-pregnant weight, weight gain during pregnancy, smoking habits, reproductive history, special diet instruction, vitamin/mineral intake, and hemoglobin and hematocrit levels. The infant variables considered were birthweight for gestational age, birthweight per se, sex of the infant, multiple births, and perinatal mortality.

Information on selected maternal and infant variables was collected from maternity and Newborn Nursery records. The information was further supplemented by a postpartum interview with the maternity patients.

Data from the study was coded and submitted for computer analysis. The statistical methods employed were Chi square test of independence and discriminant analysis.

Infant birthweight for gestational age was found to have significant relationships with maternal smoking habits, race, and pre-pregnant weight. Discriminant analysis ranked maternal smoking habits, race, and weight of the mother at delivery as the variables of greatest predictive value. The formula derived predicted with an accuracy of 58 percent (Table 7). The accuracy of the formula was highest in predicting the infants in the category of small for gestational age (77 percent).

Infant birthweight per se was found to be significantly related to maternal smoking habits, race, parity, weight gain, and height. Discriminant analysis ranked maternal smoking habits, weight of the mother at delivery, and pre-pregnant weight as the variables of greatest predictive value. The prediction formula derived had an accuracy of 56 percent (Table 14). The highest degree of accuracy was found in the prediction of infants in the low birthweight category (78 percent).

One may conclude that maternal smoking during pregnancy and race were the significant factors with relation to fetal outcome. This conclusion must be made with due consideration given to the confounding factors. With regard to smoking habits, one must recognize that the relationship to fetal outcome may be reduced blood oxygen supply to the fetus or reduced maternal appetite, which may decrease the nutrients available to the fetus. Maternal race may be confounded by socioeconomic status, cultural influences, life stress, and a nutrition component.

Although this study did not analyze the caloric consumption as a variable, food intake during pregnancy is reflected in maternal weight gain, which in turn has a strong relationship with infant birthweight. In assessing the nutritional status of the maternity patient, a record of food intake can provide information with regard to food preferences, allergies, and cultural food habits, and can give clues to possible deficiencies of calories or of specific nutrients.

The prediction formulas may be useful as a tool in obstetric clinics to detect the high risk pregnancies. The formulas provide a rough estimation of the perinatal risks with regard to the factors analyzed in this study and with regard to the sample selected. Based on these guidelines, the health care team may more effectively direct attention to those patients in greatest need of specialized care.

CHAPTER VII

RECOMMENDATIONS

Perinatal mortality occurs most frequently in infants of low birthweight (under 2500 grams). Those infants who are low birthweight and small for gestational age are at an even higher risk. The prevention of this high risk category of neonates will do much to reduce perinatal mortality and prevent the intellectual and developmental stunting that so often occurs in infants in this category (50).

A variety of recommendations may be made. A large part of the responsibility for reducing the perinatal mortality rate may be vested in the physician, nurse, dietitian, and nurse practitioner. In their contact with the public, it should be the responsibility of the health professional:

1. to educate the population on nutritional needs during all stages of life,

2. to educate the population on the adverse effects of smoking during pregnancy to the mother and to the fetus,

3. to carefully monitor the pregnancies of high risk mothers (non-white patients of a low pre-pregnant weight), and

4. to emphasize the value of medical care and nutrition counseling early during pregnancy.

Continued research on infant birthweight for gestational age and its precipitating factors will do much to clarify the areas where nutritional and medical attention should be directed. The target population in this study has been defined as the non-white mother who smokes during pregnancy. Future studies should control for these two variables to get more descriptive information about the other factors that contribute to the high risk pregnancy.

Many studies have been conducted on laboratory animals receiving controlled diets during pregnancy. There are limitations in controlling the diets of pregnant humans, however. It is feasible to get a more accurate assessment of the nutritional status of the pregnant woman by reinforcing the clinical examination with laboratory tests and diet histories. Future studies may be based on determination of the correlation between clinical assessment, laboratory tests, and the dietary intake of the mother throughout pregnancy.

Obstetritians and nurses may not receive training with regard to the nutritional needs of the woman during pregnancy, nor be trained to translate these needs to suit the preferences or economic limitations of the individual patient. There is a need for studies on the effects of diet counseling by nutritionists or other trained personnel as an adjunct to medical care. Well designed and controlled studies in this area will do much to support the need for a strong nutrition component in the management of the pregnant female and of the infant during the perinatal period.

APPENDIX A

SAMPLE DESCRIPTION

TABLE 17

DISTRIBUTION OF MATERNAL HEIGHTS IN THE SAMPLE POPULATION

Height (inches)	Frequency	Percent
Less than 5'	6	4.3
5' to 5'3"	63	46.0
5'4" to 5'6"	36	26.3
5'7" and up	32	23.4
TOTAL	137	100.0

TABLE 18

DISTRIBUTION OF MATERNAL WEIGHTS IN THE SAMPLE POPULATION

Weight (pounds)	Frequency	Percent
Less than 110	23	16.8
110-129	60	43.8
130-149	25	18.2
150-169	15	10.9
170-189	6	4.4
190 and up	8	5.8
TOTAL	137	100.0

APPENDIX B

DATA COLLECTION AND CODING INSTRUMENTS

DATA SHEET

Patient Name ______________________________ *Date Recorded* __________

MATERNAL VARIABLES

Age _____ *Height* _________ *Race* ___________

Number of previous pregnancies ____ *(Term* ____ *Pre-term* ____ *Other* ____*)*

Weights of previous newborn ______________________________

Daily smoking habits:

More than one pack *Approximately one pack* *Less than 10* *Never*

LMP ______________________ *EDC* ______________________

NUTRITION STATUS VARIABLES

Pre-pregnant weight _________

Weight prior to delivery ______________ *Total gain* ____________

Hemoglobin levels ______________________________

Hematocrit levels ______________________________

Vitamin/mineral supplements prescribed? *Yes* *No*

Taken? *Never* *Rarely* *Most of the time* *Absolutely always*

INFANT VARIABLES

Male _________ *Female* _________

Normal birth ______ *Neonatal death* _______ *Fetal death* ________

Birthdate ____________________ *Hospital number* __________________

____________________ *grams* ______________ *Weeks of gestation*

Estimated age of newborn _________________

Size for gestational age:

LGA	*above 90%*
AGA	*10-90%*
SGA	*below 10%*

MATERNAL POSTPARTUM INTERVIEW

1. *What was your weight prior to pregnancy?* ______________________

2. *Did your physician prescribe vitamin/mineral supplements to you during pregnancy?* *Yes* *No*

   If yes, which of the following described your intake of the supplements?

   Never *Rarely* *Most of the time* *Absolutely always*

3. *Did you smoke cigarettes during your pregnancy?* *Yes* *No*

   If yes, which of the following described your daily smoking habits?

   More than one pack *Approximately one pack* *Less than 10*

4. *Were you given any special diet to follow during pregnancy?*

   Yes *No*

   If yes, what type of diet?

DATA CODE SHEET

Line	Information	
1, 2, 3	Patient number	
4, 5	Age	
6	Race 1 white 2 black	
7	Number of previous pregnancies	
8, 9, 10, 11	First pregnancy -	weight of infant in grams weight of infant not given - 9
12	State of pregnancy 1 premature 3 abortion 4 stillborn 5 term 6 neonatal death	
12, 13, 15, 16	Second pregnancy -	weight of infant in grams weight of infant not given - 9
17	State of second pregnancy 1 premature 3 abortion 4 stillborn 5 term 6 neonatal death	
18, 19, 20, 21	Third pregnancy -	weight of infant in grams weight of infant not given - 9
22	State of third pregnancy 1 premature 3 abortion 4 stillborn 5 term 6 neonatal death	

23, 24, 25, 26	Fourth pregnancy -	weight of infant in grams weight of infant not given - 9

27 State of fourth pregnancy

1 premature
3 abortion
4 stillborn
5 term
6 neonatal death

28, 29, 30, 31	Fifth pregnancy -	weight of infant in grams weight of infant not given - 9

32 State of fifth pregnancy

1 premature
3 abortion
4 stillborn
5 term
6 neonatal death

33, 34, 35, 36 Maternal height

37, 38, 39 Pre-pregnant weight

40, 41, 42 Weight before delivery

43 Smoking habits

1 smoked
2 did not smoke

44 Vitamin intake

1 yes
2 no

45 Frequency of intake

1 never
2 rarely
3 most of the time
4 some of the time
5 always

46 Sex of infant

1 male
2 female

47	*State of infant*	
		1 *premature*
		2 *post-term*
		3 *perinatal death*
		4 *stillborn*
		5 *term*
48, 49	*Weeks of gestation*	
50	*Diet*	
		1 *1000 calories last 3 months*
		2 *1200 calories last 2 months*
		3 *salt restriction*
		4 *fruit diet*
		5 *diabetic*
		6 *only eggs and skim milk last 2 months*
		7 *1500 calories last 7 months*
		8 *hiatal hernia at 7 months (bland diet encourage protein)*
		9 *high protein diet (had high blood pressure)*
51, 52, 53, 54	*Weight of infant in grams*	
55	*Size of infant*	
		1 *small for gestational age*
		2 *average for gestational age*
		3 *large for gestational age*
56	*Mortality*	
		3 *neonatal*
		4 *fetal*
57	*Previous abortion*	
		1 *therapeutic*
		2 *spontaneous*
58	*Sex of second of twins*	
59, 60, 61, 62	*Weight of second twin*	

63 *Weight for height index*
1 underweight
2 average weight
3 overweight

64 *Mortality of second twin*
3 neonatal
4 fetal

APPENDIX C

MATERNAL WEIGHT FOR HEIGHT STATUS

TABLE 19

RANGES OF NORMAL WEIGHT FOR HEIGHT*

Height	Weight Range
4'11"	97-115
5'0"	100-118
5'1"	103-121
5'2"	106-124
5'3"	109-129
5'4"	112-132
5'5"	116-136
5'6"	119-139
5'7"	123-143
5'8"	126-146
5'9"	129-151
5'10"	132-156
5'11"	136-150

*Extrapolated from Hathaway and Foord (48).

TABLE 20

WEIGHT FOR HEIGHT INDEX FOR STUDY SAMPLE

Weight for Height Status	Frequency	Percent
Underweight	25	18
Average weight	64	47
Overweight	48	35
TOTAL	137	100

APPENDIX D

DATA ON NON-SIGNIFICANT VARIABLES

TABLE 21

RELATIONSHIP BETWEEN MATERNAL HEIGHT AND INFANT BIRTHWEIGHT FOR GESTATIONAL AGE

Maternal Height	Birthweight for Gestational Age: Small n=17	Average n=86	Large n=34
Less than 5'	3 (18%)	2 (2%)	1 (3%)
5' - 5'3"	8 (47%)	41 (48%)	14 (41%)
5'4" - 5'6"	2 (12%)	24 (28%)	10 (29%)
5'7" and up	4 (24%)	19 (22%)	9 (27%)
TOTAL	17 (100%)	86 (100%)	34 (100%)

Chi square = 9.82 Degrees of Freedom = 6 $p < .1$

TABLE 22

RELATIONSHIP BETWEEN MATERNAL AGE AND INFANT BIRTHWEIGHT FOR GESTATIONAL AGE

Maternal Age	Birthweight for Gestational Age: Small n=17	Average n=86	Large n=34
14-17	4 (24%)	12 (14%)	2 (6%)
18-20	5 (29%)	16 (19%)	4 (12%)
21-24	3 (18%)	25 (29%)	7 (21%)
25-29	4 (24%)	23 (27%)	17 (50%)
30-38	1 (6%)	10 (12%)	4 (12%)
TOTAL	17 (100%)	86 (100%)	34 (100%)

Chi square = 10.92 Degree of Freedom = 8 $p \angle .5$

TABLE 23

EFFECT OF MATERNAL WEIGHT GAIN ON INFANT BIRTHWEIGHT FOR GESTATIONAL AGE

	Birthweight for Gestational Age		
Maternal Weight Gain	Small n=17	Average n=86	Large n=34
Less than 9	1 (6%)	5 (6%)	1 (3%)
10-14	2 (12%)	4 (5%)	3 (8%)
15-19	6 (35%)	11 (13%)	4 (12%)
20-24	2 (12%)	23 (27%)	8 (24%)
25-29	3 (18%)	17 (19%)	6 (18%)
30-34	2 (12%)	9 (10%)	2 (6%)
35-39	-	12 (14%)	5 (15%)
40 and up	1 (6%)	5 (6%)	5 (15%)
TOTAL	17 (100%)	86 (100%)	34 (100%)

Chi square = 13.90 Degrees of Freedom = 14 $p < .5$

TABLE 24

RELATIONSHIP BETWEEN PARITY AND INFANT BIRTHWEIGHT FOR GESTATIONAL AGE

Previous Pregnancies	Birthweight for Gestational Age: Small n=17	Average n=86	Large n=34
None	7 (41%)	41 (48%)	14 (41%)
One	8 (47%)	27 (31%)	9 (27%)
Two	1 (6%)	7 (8%)	3 (9%)
Three or more	1 (6%)	11 (13%)	8 (24%)
TOTAL	17 (100%)	86 (100%)	34 (100%)

Chi square = 4.89 Degrees of Freedom = 6 $p < .5$

TABLE 25

RELATIONSHIP BETWEEN MATERNAL PRE-PREGNANT WEIGHT AND INFANT BIRTHWEIGHT PER SE

Maternal Pre-pregnant Weight	Infant Birthweight Low n=22	Average n=99	High n=16
Less than 110	5 (23%)	17 (17%)	1 (6%)
110-129	9 (41%)	44 (44%)	7 (43%)
130-149	5 (23%)	19 (19%)	1 (6%)
150-169	2 (9%)	10 (10%)	3 (19%)
170-189	1 (5%)	4 (4%)	1 (6%)
190 and up	--	5 (5%)	3 (19%)
TOTAL	22 (100%)	99 (100%)	16 (100%)

Chi square = 6.27 Degrees of Freedom = 10 $p < .5$

TABLE 26

RELATIONSHIP BETWEEN MATERNAL AGE AND INFANT BIRTHWEIGHT

Maternal Age	Infant Birthweight Low n=22	 Average n=99	 High n=16
14-17	3 (14%)	14 (14%)	1 (6%)
18-20	6 (27%)	17 (17%)	2 (13%)
21-24	6 (27%)	27 (27%)	2 (13%)
25-29	5 (23%)	31 (31%)	8 (50%)
30-38	2 (9%)	10 (10%)	3 (19%)
TOTAL	22 (100%)	99 (100%)	16 (100%)

Chi square = 6.44 Degrees of Freedom = 8 $p < .5$

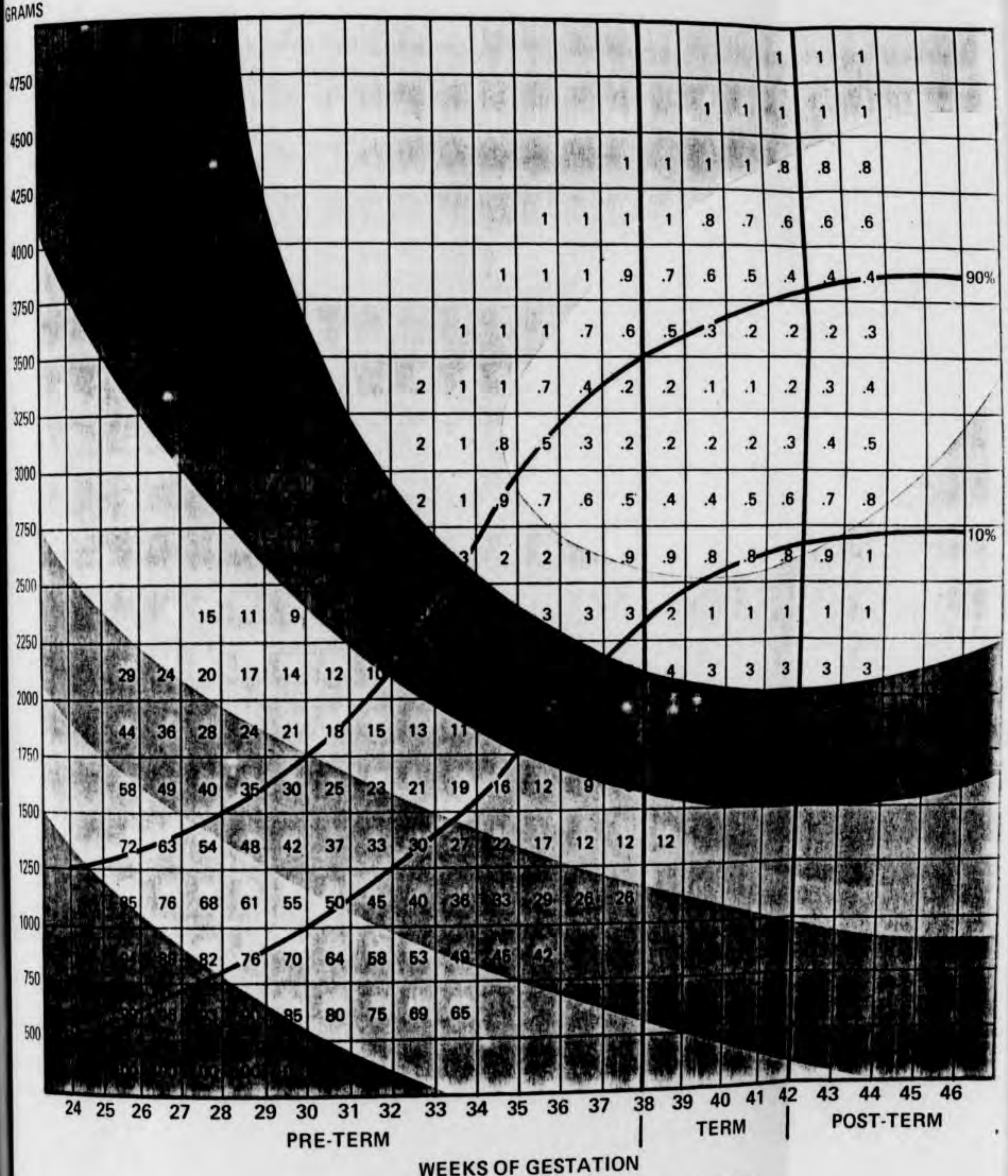
APPENDIX E

NEWBORN CLASSIFICATION AND NEONATAL MORTALITY RISK

Patient Identification:

NEWBORN CLASSIFICATION AND NEONATAL MORTALITY RISK

BY BIRTH WEIGHT AND GESTATIONAL AGE



Interpolated data based on mathematical fit from original data University of Colorado Medical Center newborns. 7/1/58 - 7/1/69

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