Investigation of the relationships of maternal pre-gravid weight and weight gain to birth weight and condition of the infant at birth
by Lanette Haas Moehling

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of MASTER OF NURSING
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Abstract:
The purposes of this study were three-fold: 1) To determine the relationship, if any, between maternal pre-pregnancy weight status and the birth weight of the infant; 2) to determine the relationship, if any, between amount of weight gained during pregnancy and the birth weight of the infant; and 3) to determine the relationship, if any, between amount of weight gained during pregnancy and the condition of the infant at birth.

This investigation was undertaken by means of reviewing existing post-partum medical records. A sample of 324 patients was selected and patients were grouped according to pre-pregnancy weight status and/or weight gained during pregnancy for analysis of the above relationships. A statistical analysis was done using simple correlations and coefficients of determination.

Conclusions reached were that: 1) A significant correlation exists between maternal pre-pregnancy weight status and the birth weight of the infant, especially among underweight pregnant patients; 2) a significant correlation exists between amount of weight gained during pregnancy and birth weight of the infant, but, a large percentage of the variation in infant weight cannot be explained by this relationship; and 3) a significant negative correlation exists between amount of weight gained and the Apgar score of the infant at one minute of life when considered at $r = 0 \leq p.10$.

It must be noted that the conclusions of this study are based on a study of a restricted population and generalizations, therefore, may not be reliable outside of this population.

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INVESTIGATION OF THE RELATIONSHIPS OF MATERNAL PRE-GRAVID WEIGHT AND WEIGHT GAIN TO BIRTH WEIGHT AND CONDITION OF THE INFANT AT BIRTH

by

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A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree

of

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To Coral Collins, who so deeply touched my life with her faith, courage, hope, perseverance, and love of life.

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ABSTRACT

The purposes of this study were three-fold: 1) To determine the relationship, if any, between maternal pre-pregnancy weight status and the birth weight of the infant; 2) to determine the relationship, if any, between amount of weight gained during pregnancy and the birth weight of the infant; and 3) to determine the relationship, if any, between amount of weight gained during pregnancy and the condition of the infant at birth.

This investigation was undertaken by means of reviewing existing post-partum medical records. A sample of 324 patients was selected and patients were grouped according to pre-pregnancy weight status and/or weight gained during pregnancy for analysis of the above relationships. A statistical analysis was done using simple correlations and coefficients of determination.

Conclusions reached were that: 1) A significant correlation exists between maternal pre-pregnancy weight status and the birth weight of the infant, especially among underweight pregnant patients; 2) a significant correlation exists between amount of weight gained during pregnancy and birth weight of the infant, but, a large percentage of the variation in infant weight cannot be explained by this relationship; and 3) a significant negative correlation exists between amount of weight gained and the Apgar score of the infant at one minute of life when considered at $r = 0 \leq p.10$.

It must be noted that the conclusions of this study are based on a study of a restricted population and generalizations, therefore, may not be reliable outside of this population.

CHAPTER I

INTRODUCTION

The restriction of total weight gain during pregnancy has been an emphasis by obstetricians for many years. Past practice has been to limit weight gain to a total of 15 to 20 pounds.[1] However, speculation as to the advisability of such weight restriction began to be raised. In 1963, W. J. McGanity, M.D., posed these questions: "Have we induced a fear complex in our prenatal patient? Will she literally starve herself for the few days before she comes to her obstetrician?"[2] In 1970, this same problem of crash dieting by the pregnant woman before every prenatal checkup was reiterated and led the National Academy of Sciences-National Research Council to issue this warning to obstetricians: "Overemphasis on weight control during pregnancy is not only unnecessary, but quite possibly dangerous."[3]

The tendency now is to avoid the extremes. It is thought that weight gains of under 11 pounds are associated with infants of low-birth-weight and increased perinatal mortality and morbidity,[4] while

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[1]Henry L. Woodward and Bernice Gardner, Obstetric Management and Nursing (Philadelphia: F. A. Davis Company, 1954), p. 103.

[2]William J. McGanity, "Obesity," Journal of the American Medical Association 196:adv. 39, November 9, 1963.

[3]"Pleasingly Pregnant," Newsweek 76:66, August 10, 1970.

[4]E. Stewart Taylor, Beck's Obstetrical Practice (Baltimore: The Williams and Wilkins Company, 1971), p. 136.

excessive weight gains are associated with increased incidence of complications for both mother and child, such as toxemia and diabetes.[5] Also, women fear that excessive weight gain will cause them to have larger babies, thus increasing the difficulty and pain of labor.[6]

Dr. Howard N. Jacobson believes that there is no correlation between weight gained during pregnancy and the size of the infant at birth, especially when the components of the diet are not known.[7]

There is also an increasing emphasis being placed on the mother's pre-pregnancy weight status as an influencing factor in the birth weight of the infant. Tompkins, in his study of pregravid weight status and its effect on the infant concluded that pre-pregnancy weight and the size of the infant at birth are independent of prenatal weight gain, but the amount of weight gained can affect the ability of the mother to withstand the stresses of pregnancy, thus, reducing the risk of complications.[8]

In light of the controversial nature of the subject, a limited investigation was undertaken to determine the correlation, if any,

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[5]McGanity, *loc. cit.*

[6]"How Much Weight to Gain During Pregnancy," Good Housekeeping 169:149, August, 1969.

[7]*Ibid.*

[8]Winslow T. Tompkins, Dorothy G. Wiehl, and Robert McN. Mitchell, "The Underweight Patient As An Increased Obstetric Hazard," American Journal of Obstetrics and Gynecology 69:114-123, January, 1955.

between pre-pregnancy weight status and birth weight of the infant, and between various amounts of weight gained during pregnancy and the condition of the infant at birth.

Statement of the Problem

The problem of this study is to determine if there is a relationship between the pre-pregnancy weight status of the mother and the weight of the infant at birth; and, to determine if there is a relationship between the amount of weight gained during pregnancy and the condition of the infant at birth.

Purposes of the Study

The purposes of this study were three-fold: 1) To determine the relationship, if any, between the pre-pregnancy weight status of the mother and the weight of the infant at birth; 2) to determine the relationship, if any, between the amount of weight gained during pregnancy and the weight of the infant at birth; and 3) to determine the relationship, if any, between the amount of weight gained during pregnancy and the Apgar score of the infant at birth in order to justify routine restrictions of total weight gain during pregnancy.

Hypotheses

1. There is no relationship between the pre-pregnancy weight status of the mother and the weight of the infant at birth.

2. There is no relationship between the amount of weight gained during pregnancy and the weight of the infant at birth.
3. There is no relationship between the amount of weight gained during pregnancy and the Apgar score of the infant at birth.

Definition of Terms

Amount of weight gained during pregnancy

The number of pounds added by the mother to the pre-pregnancy weight from conception to the time of delivery of the infant.

Pre-pregnancy weight

Normal, non-pregnant weight of the mother.

Pre-pregnancy weight status

Maternal weight in relation to height prior to conception.

Underweight patient

For purposes of this study, considered to be a mother whose weight is less than 90% of the standard weight for her height prior to conception.[9]

Overweight patient

For purposes of this study, considered to be a mother whose weight is over 115% of the standard weight for her height prior to conception.[10]

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[9]Marie V. Krause, Food, Nutrition and Diet Therapy (Philadelphia: W. B. Saunders Company, 1972), p. 434.

[10]Corinne Robinson, Basic Nutrition and Diet Therapy (London: Collier-Macmillan Limited, 1970), p. 219.

Condition of the infant at birth

The birth weight and/or Apgar score at one minute of life given the infant in the immediate period following delivery.

Birth weight

The weight in pounds and ounces of the infant in the immediate post-partal period.

Low-birth-weight

Infant of full-term gestational age weighing less than 2500 Gms. (5.5 pounds) at birth.[11]

Full-term gestational age

Delivery occurring between 37 and 42 weeks gestation.[12]

Immature

Infant born between 20 and 28 weeks gestation weighing 500 to 999 Gms. (17 oz. to 2.2 pounds) at birth.[13]

Premature

Infant born between 29 and 36 weeks gestation weighing 1000 to 2499 Gms. (2.2 to 5.5 pounds) at birth.[14]

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[11]Clinical Research Advances in Human Growth and Development, How Children Grow General Clinical Research Centers Branch, Division of Research Resources (Bethesda, Md.: National Institutes of Health, June, 1972), pp. 21-29.

[12]Mae M. Bookmiller and George L. Bowen, Textbook of Obstetrics and Obstetric Nursing (Philadelphia: W. B. Saunders Company, 1968), p. 157.

[13]*Ibid.*

[14]*Ibid.*

High-risk pregnancy

"A woman who either has a physical condition which threatens her pregnancy or is faced by life conditions which may adversely affect the course of her pregnancy and its outcome;"[15] includes pregnancy out-of-wedlock, before the age of 17 years, diabetes, Cesarean-section, or a history of toxemia or several miscarriages.

Apgar score

"A scoring system which assigns a numerical index to the degree of newborn's depression or lack of depression at birth ... determined at one and five minutes of life."[16] The infant is rated on the basis of five signs. Each sign can be scored 0, 1, or 2. The total of the five signs is computed; the lower the score, the greater the degree of infant depression with the maximum possible score being 10. (See Appendix A for the index for determining the Apgar score.)

Normal weight gain expected during pregnancy

Eighteen to 25 pounds; the composition of this weight gain is thought to be as follows:[17]

1) Approximately 15.5 pounds are due to the products of conception and increase in breast tissue: infant - 7½ pounds;

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[15]Violet Broadribb and Charlotte Corliss, Maternal-Child Nursing (Philadelphia: J. B. Lippincott Company, 1973), pp. 43-44.

[16]Taylor, *Op. cit.*, p. 582.

[17]Broadribb, *Op. cit.*, pp. 78-79.

placenta - 1 pound; amniotic fluid - 1½ pounds; uterus - 2 to 3 pounds; breasts - 3 pounds.

2) Increase in protein storage outside the uterus - approximately 4 pounds.

3) Increase in blood volume and water retention - approximately 3 pounds.

Limitations

1. The sample size was limited.
2. The population of the sample was drawn from the records of only one hospital.
3. There were a limited number of physicians including a complete prenatal history and record in the hospital medical record.
4. Data available from the records were limited. Only a limited number of physicians in this area kept sufficient prenatal records to provide the data necessary for this investigation.

CHAPTER II

REVIEW OF LITERATURE

The literature dealing with the relationship of maternal weight gain during pregnancy and the condition of the infant at birth seemed to approach the subject from two standpoints: 1) The quantitative weight gain during pregnancy, and 2) the pre-pregnancy weight and quantitative weight gain during pregnancy.

In considering the first standpoint, the relationship between weight gained during pregnancy and the condition of the infant at birth, a major controversy appears to exist: whether or not quantitative weight gain can actually influence the birth weight of the infant. Dr. W. J. McGanity believes there is satisfactory evidence that one cannot influence the birth weight of the infant by controlling the caloric or protein intake of the mother during pregnancy. As an example, he states that a woman who is obese at the onset of pregnancy need not gain additional weight in order to have a satisfactory prenatal course and a healthy infant.[18] Thus, the "old wives' tale" holds true that the fetus has a competitive advantage for the nutrients it needs from the mother. However, there must be an adequate reserve of these nutrients from which the fetus can draw if the mother

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[18]McGanity, *loc. cit.*

is not furnishing them adequately during pregnancy.[19]

Looking at the other side of this controversy, Drs. Nicholson J. Eastman and Ester Jackson studied 12,000 full-term pregnancies and found that some women who gained less than 14 pounds, actually having lost weight during pregnancy, had larger babies than some women who gained more than the average 22.1 pounds. However, further investigation led them to find that this occurred when the women were obese at the onset of pregnancy and the fetus was, therefore, drawing on the mothers' reserves.[20] Eastman and Jackson concluded from this study that with increased weight gain there was a progressive reduction in the percentage of low-birth-weight infants.[21]

In considering the weight gain of the average woman, non-obese at the onset of pregnancy, "most physicians recommend that a woman gain 18-25 pounds during her pregnancy."[22] Weight gains under 11 pounds in pregnancy are associated with low-birth-weight infants and increased perinatal mortality and morbidity.[23]

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[19]Clinical Research Advances in Human Growth and Development, *loc. cit.*

[20]"Weight Gain in Pregnancy--A New View," Briefs, January, 1969, pp. 6-9.

[21]*Ibid.*

[22]Broadribb, *Op. cit.*, p. 78.

[23]Taylor, *Op. cit.*, p. 136.

In considering the second standpoint, the relationship between pre-pregnancy weight and birth weight of the infant, the original controversy seems to be explained. This standpoint looks at the relationship of weight gain to infant condition at birth from the aspect of pre-pregnancy weight and subsequent weight gain during pregnancy. Tompkins, Wiehl and Mitchell, in a study of 2,076 pregnancies, stated:

> We believe that too much attention has been given to weight as a number, rather than to the objective evidence which an individual's weight at any specified time indicates relative to nutritional status.[24]

The above authors found in their study that average or greater weight gains by underweight patients (referring to pregravid weight) were consistent with a reduction in the percentage of infants of low-birth-weight.[25] However, this is not meant to suggest that weight gain influences the size of the infant at birth. They believe that the underweight patient, by gaining more weight during pregnancy, is adding to her own body increments and not to the weight of the infant.

> Consequently, there is no indication that a relatively high rate of gain by underweight mothers does increase the size of the baby. The increase in her own tissue mass may afford greater protection to meet the stresses of pregnancy.[26]

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[24]Tompkins, Wiehl, and Mitchell, *loc. cit.*

[25]*Ibid.*, p. 121.

[26]*Ibid.*, p. 123.

Tompkins, Wiehl and Mitchell conclude that pregravid weight status and size of the infant are independent of prenatal weight gain. The relationship of weight gain in pregnancy and size of infant is, therefore, influenced only by the fact that a greater gain reduces the risk of premature labor for the mother and prematurity for the infant, especially in those patients who are underweight prior to pregnancy.[27]

> Failure to gain an average amount, especially during the first two trimesters, increases the likelihood of premature labor, but greater gain has little, if any, effect on the size of the baby.[28]

Another study, along these same lines, by Schram and Raji, found results consistent with the study just cited. They, too, were concerned with pregravid weight status and its effects on the mother and fetus. Consequently, it was found that approximately 85% of the infants born to mothers in the underweight group (referring again to pregravid weight status) were of low-birth-weight.[29]

Thus far, in considering the effect of pregravid weight on the birth weight of the infant, mention has only been made of the underweight patient. However, Love and Kinch, in their study of various factors influencing the birth weight of the infant, found that the

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[27] *Ibid.*

[28] *Ibid.*

[29] Maxwell Schram and Manssour Raji, "The Problem of Underweight Pregnant Patients," American Journal of Obstetrics and Gynecology 94:595-596, February 15, 1966.

heavier the mother before pregnancy, the heavier the infant.[30] They also found that the heavier the woman prior to pregnancy, the less weight she tended to gain during her pregnancy.[31] Thus, these findings would also appear to be consistent with the belief cited previously: that the fetus draws on maternal stores available.

In light of this evidence, experts are now proposing that routine weight gains or weight restrictions should not be advocated for all pregnant women without considering their pre-pregnancy weight status. The trend seems to be to look more at the individual needs of the pregnant woman and adjust advice concerning weight restrictions to her particular circumstances.[32]

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[30]E. J. Love and R. A. H. Kinch, "Factors Influencing the Birth Weight in Normal Pregnancy," American Journal of Obstetrics and Gynecology 91:342-349, February 1, 1965.

[31]*Ibid.*

[32]Broadribb, *Op. cit.*p. 79.

CHAPTER III

METHODOLOGY

Collection of Data

To most effectively facilitate the determination of the relationship, if any, between weight gained during pregnancy and the condition of the infant at birth, the investigative method of research was chosen for this study. It was decided that the greatest sample size could be obtained through review of existing medical records for collection of data pertaining to the problems of this study. A data sheet (Appendix B) was developed to facilitate collection of the information from the records.

To determine the relationship, if any, between weight gained during pregnancy and the condition of the infant at birth, a total of 324 post-partum medical records of patients delivered at Bozeman Deaconess Hospital was reviewed for the patient's past medical history, history of previous pregnancies, if any, present physical condition and course of labor and delivery. The prenatal history and physical data for the most recent pregnancy were recorded for control of variables in this study.

The sample for determining the relationship, if any, between weight gained during pregnancy and the weight of the infant at birth consisted of 313 patients. The patients were assigned to one of three groups according to the amount of weight gained during pregnancy.

Group I consisted of those patients having gained 0-15 pounds; Group II consisted of those patients having gained a total of 16-26 pounds; and, Group III consisted of those patients having gained 27 or more pounds during their pregnancy. The group sizes were 104, 102 and 107, respectively.

Data applicable to the third aspect of this study, dealing with the relationship, if any, between pre-pregnancy weight status and the birth weight of the infant, were derived from the same sample population. Out of the original 313 patients, 240 patients were found to be acceptable for this aspect of the investigation. These patients were divided into three weight groups according to their pre-pregnancy weight status. Group A, consisting of 35 patients, was composed of those patients considered to be underweight prior to conception; Group B, consisting of 171 patients, was composed of those patients considered to be of standard weight for their height prior to conception; and, Group C, consisting of 34 patients, was composed of those patients considered to be overweight prior to conception. (Consult Appendix C for the Table of Standard Weight for Height, Underweight and Overweight.)

The records reviewed ranged over a time span of from 1965 to 1973. The majority of the records were from the years 1971 to 1973 with the remaining years containing only those occasional complete past post-partum records discovered in the patient's file with the most recent post-partum medical record being examined.

Selecting the Sample

The 324 patients constituting the total sample were selected for study on the basis of whether or not their record contained the information necessary for this study, and whether or not they then met the following criteria:

1. Age limit of 18-29 for primiparas; 18-40 for multiparas.
2. No limitation on parity of the patient.
3. No history of diabetes mellitus in either the patient or her husband.
4. Prenatal medications prescribed by the physician restricted to the following: vitamins, iron, folic acid, calcium, anti-nauseants, and diuretics.
5. No history of repeated miscarriages.
6. No family or personal history of congenital defects in either the patient or her husband.
7. No hereditary defects in either the patient or her husband.
8. Vaginal delivery of the infant following a normal labor pattern without the complication of toxemia and/or fetal distress.
9. No history of pre-eclampsia in the pregnancy being studied.

The above criteria pertained to the mothers selected, but certain criteria were also established for the infants that resulted from their pregnancies. The criteria were as follows:

1. No congenital deformities.
2. Product of a single pregnancy. No multiple pregnancies were included in this study.
3. Born past the age of viability. This was considered to be after 20 weeks gestation as this is the lower limit of what is considered to be an immature birth.[33]

The 240 patients selected for the study of pre-pregnancy weight status and its relationship, if any, to birth weight of the infant were drawn from the same sample used to study weight gained and condition of the infant at birth, thus meeting the same criteria.

Variables

There were certain independent variables within this study that the investigator was unable to control due to the nature of the investigation. These variables, however, were not discounted entirely when considering the findings of this study. The variables were as follows:

1. Smoking: Research findings indicate that infants born to mothers who smoked one pack of cigarettes or more per day during pregnancy are more likely to weigh 3/4 of a pound less on the average than infants of non-smokers.[34] Still, this lesser weight does not seem

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[33]Bookmiller, *Op. cit.*, p. 157.

[34]Alan F. Guttmacher, Pregnancy, Birth and Family Planning (New York: The Viking Press, 1973), p. 61.

to affect the infants' chances of survival, unless the infant is also premature.[35] A team of Air Force physicians, in a study of 7,740 mothers and their infants, found no significant difference in the condition at birth of the infants of smokers and non-smokers. Apgar scores were calculated on all babies and no significant difference in occurrence of low Apgar scores was found among infants of smokers and non-smokers.[36]

A controversy still exists as to the possibility of prematurity being increased among smoking mothers. One authority states: "The infants of heavy smokers [more than one pack of cigarettes per day] have no tendency to be born prematurely; they simply weigh less at term,"[37] while another states: "Underwood, *et al.*, have shown that infants of mothers who smoke during pregnancy are smaller, and the incidence of prematurity is increased."[38]

In light of the above findings, the possibility of the mother having smoked during pregnancy was taken into consideration in cases of infants of low-birth-weight where data were available. For average or above average birth weight infants, the effects of smoking were not

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[35] *Ibid.*

[36] "Smoking and Prematurity," Briefs, March, 1966, pp. 36, 45.

[37] Guttmacher, *loc. cit.*

[38] Taylor, *Op. cit.*, p. 138.

considered because of inadequate data available.

2. Edema: Edema is considered to be one of the symptoms of toxemia of pregnancy. "Persistent edema of the hands and the face" is the criteria established for definition of "mild pre-eclampsia" in reference to this symptom.[39] Moderate edema of the feet and ankles is common and it was found that a majority of the patients in this study experienced some pretibial edema. "Mild edema unassociated with other symptoms, such as severe headache, stubborn constipation, excessive gain in weight and proteinuria, is of no special significance."[40] On these bases and for purposes of this investigation, edema of the feet and ankles alone was not considered a symptom of toxemia, unless accompanied by edema of the hands and/or face, elevated blood pressure, or albuminuria, in which case the patient was eliminated from the study.

3. Analgesia and anesthesia during labor and delivery: Control of the use of analgesics and anesthetics could not be done by the mere fact that this study was done from a review of existing post-partum records. However, control of the effects of these agents used during labor and delivery on the condition of the infant had to be made since one aspect of this study deals specifically with the condition of the

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[39]Elise Fitzpatrick, Maternity Nursing (Philadelphia: J. B. Lippincott Company, 1966), p. 445.

[40]J. P. Greenhill, Obstetrics (Philadelphia: W. B. Saunders Company, 1966), p. 498.

infant as evidenced by the Apgar score at one minute of life.

The agents used for analgesia and anesthesia among the sample studied fell into five categories: Inhalation anesthetics; local anesthetics for regional blocks; narcotics; tranquilizers; and sedatives. The inhalation anesthetics (nitrous oxide with oxygen, penthrane and trilene) are known to rapidly cross the placental barrier and cause the same depressant effects in the fetus as they do in the mother. However, in small concentrations and/or intermittent use during parturition they have no appreciable affect on the infant.[41] Therefore, use of these agents was evaluated accordingly for length of administration in conjunction with the Apgar score of the infant.

The local anesthetics are thought at times to be the cause of fetal bradycardia. However, patients exhibiting fetal distress, which would include bradycardia, have already been eliminated from the study according to the original criteria. Therefore, use of these agents did not appear to have an effect on the Apgar score in the patients selected for this study.

The narcotic analgesics are known to cause fetal depression (respiratory) when used in the later stages of labor.[42] Therefore,

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[41]Greenhill, *Op. cit.*, p. 387.

[42]*Ibid.*, p. 380.

a low Apgar score was evaluated for use of narcotics, which may have been the causative factor, before the patient was included in the sample. The same holds true for the use of sedatives.[43] Tranquilizers appear to cross the placental barrier, but are not considered to be harmful to the fetus.[44] (Consult Appendix D for a complete listing of analgesics and anesthetics used in the sample.)

5. Heredity: There was no possible means in this investigation for control of genetic factors as they affect body build and weight of the infant. Therefore, it may have to be considered as a possible bias on the findings of this study.

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[43] *Ibid.*, p. 382.

[44] *Ibid.*

CHAPTER IV

ANALYSIS OF DATA

The data collected were tabulated according to the groupings as described in Chapter III. A statistical analysis using simple correlations and coefficients of determination was performed. The *t-test* was then used as the test of significance of the calculated r over the groups individually and over all groups as a whole within the relationships being examined. All tests of significance are two-tailed, $p = .05$ *t-tests* unless otherwise indicated.

The relationships examined statistically were as follows: 1) Pre-pregnancy weight to infant birth weight (grouped according to weight gained during pregnancy); 2) pre-pregnancy weight to infant birth weight (grouped according to pre-gravid weight status of the mother); 3) pre-pregnancy weight to weight gain during pregnancy; 4) weight gained during pregnancy to infant birth weight; and, 5) weight gained during pregnancy to condition of the infant at birth as evidenced by the Apgar score at one minute of life. (The raw data are given in Appendix E.) The statistical analysis of these relationships revealed the following:

The statistical relationships of the pre-pregnancy weight of the mother to the birth weight of the infant are summarized in Tables I and II. (Recall that Groups I, II, and III are groupings according to

TABLE I. RELATIONSHIP OF PRE-PREGNANCY WEIGHT TO INFANT BIRTH WEIGHT.

Group	N	r	r^2	t calc	$t = .05$
I	104	0.51	.2601	5.98*	1.99
II	102	0.16	.0256	1.62	1.99
III	107	0.21	.0441	2.20*	1.99
Total	313	0.29	.0841	5.34*	1.96

*Indicates $r = 0 \leq p.05$.

the amount of weight gained during pregnancy and Groups A, B, and C are groupings according to pre-pregnancy weight status of the mother.)

The data in Table I indicate an unquestionable positive association between the pre-gravid weight of the mother and the birth weight of the infant over the total of all three groups, but only 8.4% (r^2 x 100) of the variation in infant birth weight can be attributed to differences in the maternal pre-pregnancy weight summed over all groups. Examining the groups individually, Groups I and III show a definite positive association between maternal pre-pregnancy weight and infant birth weight. In Group I, women who gained less weight than recommended during pregnancy, 26% of the variation in infant weight can be attributed to differences in maternal weight prior to conception, while in Group III, women who gained excessive amounts of weight during pregnancy, only 4% of the variation in infant weight can be attributed to differences in maternal pre-pregnancy weight. These findings seem

to agree with previous studies done.[45] [46]

Secondly, a further examination of the data for the relationship being studied in Table I revealed group means as follows:

TABLE Ia. GROUP MEANS OF PRE-PREGNANCY WEIGHT FOR GROUPS I, II, AND III.

Group	Mean Pre-pregnancy Weight (in pounds)
I	136.26
II	127.79
III	130.06
Total	131.38

Although there does not appear to be wide variation among the group means, an analysis of variance for a completely random design with unequal sample size was performed to determine if the variation was significant.

TABLE Ib. ANALYSIS OF VARIANCE OF GROUP MEANS OF PRE-PREGNANCY WEIGHT FOR GROUPS I, II, AND III.

Source of Variation	Sum of Squares	*DF*	Mean Square	F	F=.05
Total	151695.23	312			
Among Group Means	3977.70	2	1988.85	4.17	3.00
Error	147717.53	310	476.51		

[45]Tompkins, Wiehl and Mitchell, *Op. cit.*, pp. 114-123.

[46]L. Jean Bogert, Nutrition and Physical Fitness (Philadelphia: W. B. Saunders Company, 1968), p. 409.

The data in Table Ib indicate that there is a significant variation among the means of the maternal pre-pregnancy weight for Groups I, II, and III based on the analysis of variance. This suggests the possibility of a slight bias due to differences in weights of the three groups. The correlations reported in Table I suggest, however, that the bias would not be severe, because even with significant correlations only 26% of the variation in infant weight of Group I can be attributed to differences in the pre-pregnancy weight of the mother, and only 4% of the variation in infant weight of Group III can be attributed to differences in the maternal pre-pregnancy weight. Furthermore, the slight difference among means demonstrated to be statistically significant is of questionable biological meaning due to the large sample size. All data could be adjusted using covariance techniques, but, based on the above logic, assumptions underlying data adjustment could introduce as much bias as may be introduced to the correlations as a result of the differences in group means. Finally, because much of the interpretation is based on the correlation summed over the total of the three groups, the weight bias then becomes non-existent due to the fact that the individual group means are not considered when dealing with the total of the groups.

Continuing the original analysis of the relationship of maternal pre-pregnancy weight to the infant birth weight, Table II is derived from correlations run over Groups A, B, and C (groupings according to

pre-pregnancy weight status).

TABLE II. RELATIONSHIP OF PRE-PREGNANCY WEIGHT STATUS TO INFANT BIRTH WEIGHT.

Group	N	r	r^2	t calc	$t = .05$
A	35	0.37	.1369	2.29*	2.03
B	171	0.11	.0121	1.44	1.96
C	34	0.19	.0361	1.09	2.03
Total	240	0.21	.0441	3.31*	1.96

*Indicates $r = 0 \leq p.05$.

Again, looking first at the overall correlation summed over Groups A, B, and C, there is a definite positive correlation between pre-pregnancy weight of the mother and birth weight of the infant. However, when broken down by groups, Group A, those mothers who were underweight prior to conception, shows the only significant correlation. Thus, predictive power for infant birth weight from maternal pre-pregnancy weight comes only within this group. However, it must be noted that only 13.6% of the variation in infant weight can be attributed to differences in maternal weight prior to conception. Therefore, the predictive power would be limited.

The second purpose of this investigation was to determine the relationship, if any, between the amount of weight gained during pregnancy and the birth weight of the infant. The analyses are summarized in Table III.

TABLE III. RELATIONSHIP OF WEIGHT GAIN TO INFANT BIRTH WEIGHT.

Group	N	r	r^2	t calc	$t = .05$
I	104	-0.06	.0036	0.61	1.99
II	102	0.25	.0625	2.58*	1.99
III	107	0.11	.0121	1.13	1.99
Total	313	0.20	.0400	3.60*	1.96

*Indicates $r = 0 \leq p.05$.

The data in Table III show that there is a significant positive correlation when the relationship is considered over the total sample. However, only 4% of the variation in infant weight can be explained by the maternal weight gain during pregnancy. Thus, biologically, this is not a highly meaningful correlation. Many other factors must influence infant birth weight. Within the individual groups, a significant correlation is found only in Group II, mothers with recommended weight gain during pregnancy, but this is of minor biological significance because only 6.25% of the variation in infant birth weight can be attributed to differences in maternal weight gain. This leaves 93.75% of the variation in infant weight unexplained.

Thus far, the relationships of pre-pregnancy weight to infant birth weight and amount of weight gain to infant birth weight have been considered. However, a third, possibly intervening relationship, the relationship of pre-pregnancy weight to amount of weight gained during pregnancy, has been suggested by previous studies. Love and

Kinch believe that the heavier the mother prior to pregnancy, the less weight she gained during pregnancy.[47] Tompkins, Wiehl, and Mitchell, on the other hand, believe the size of the baby and pre-gravid weight status to be independent of weight gain during pregnancy.[48] Table IV reveals the analyses of the relationship of pre-pregnancy weight to weight gain during pregnancy.

TABLE IV. RELATIONSHIP OF PRE-PREGNANCY WEIGHT TO WEIGHT GAIN DURING PREGNANCY.

Group	N	r	r^2	t calc	$t = .05$
I	104	-0.15	.0225	1.53	1.99
II	102	0.12	.0144	1.21	1.99
III	107	0.18	.0324	1.86	1.99
Total	313	-0.07	.0049	1.24	1.96

The data show there to be no significant correlation between these two factors. Thus, weight gain during pregnancy cannot be estimated from pre-pregnancy weight for this sample. It must be remembered that grouping of this sample was done in hindsight, after the fact, and may not be completely reliable. Therefore, definite statements about this relationship, within these groupings, cannot be made. Yet, summed over all three groups, r is still non-significant.

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[47]Love and Kinch, *loc. cit.*

[48]Tompkins, Wiehl, and Mitchell, *loc. cit.*