A DESCRIPTIVE SURVEY OF MATERNAL PROTEIN STATUS AND THE COURSE AND OUTCOME OF PREGNANCY

by

Gail Crandall Evans

and

Jane Elizabeth Hasty

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SUPERVISORY COMMITTEE APPROVAL

of a thesis submitted by

Gail Crandall Evans

This thesis has been read by each member of the following supervisory committee and by majority vote has been found to be satisfactory.

[redacted]	[redacted] Yeomans, C.N.M., M.S.
[redacted]	Charles G. Lewis, Ph.D.
14 [redacted] 81	Marcia Strah[redacted], C.N.M., M.S.

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SUPERVISORY COMMITTEE APPROVAL

of a thesis submitted by

Jane Elizabeth Hasty

This thesis has been read by each member of the following supervisory committee and by majority vote has been found to be satisfactory.

C.N.M., M.S.

Charles G. Lewis, Ph.D.

THE UNIVERSITY OF UTAH GRADUATE SCHOOL

FINAL READING APPROVAL

To the Graduate Council of The University of Utah:

I have read the thesis of Gail Crandall Evans, and Jane Elizabeth Hasty in its final form and have found that (1) its format, citations, and bibliographic style are consistent and acceptable; (2) its illustrative materials including figures, tables, and charts are in place; and (3) the final manuscript is satisfactory to the Supervisory Committee and is ready for submission to the Graduate School.

[redacted]

[redacted], M.S.

[redacted]

Approved for the Major Department

[redacted]

Linda K. Amos, Ed.D., F.A.A.N.

Chairman/ Dean

Approved for the Graduate Council

[redacted]

[redacted] Clayton

Dean of The Graduate School

ABSTRACT

A descriptive survey of the nutritional status of 27 pregnant women was conducted at Hill Air Force Base Hospital. Socioeconomic survey, three day diet history and laboratory assessment of blood and urine parameters of protein were used to determine nutritional status and were related to maternal and infant outcome variables. The purpose of the investigation was to answer the following research questions. 1) What is the relationship between reported dietary intake of protein and calories and measurable laboratory parameters of protein during pregnancy? 2) What is the relationship between reported dietary intake of protein and calories and the course and outcome of pregnancy? 3) What is the relationship between measurable laboratory parameters of protein and the course and outcome of pregnancy?

Pearson "r", Chi Square and two tailed "t" tests were used to compare data and answer the research questions.

The findings indicated a significant decrease in protein and calorie intake between the first and second trimesters ($p = .05$). The third trimester reported calorie intake was below the mean in the literature.

The reported dietary intake of protein and calories correlated with the laboratory parameter of total protein level in the second

trimester significant at the .05 level. The other laboratory parameters failed to correlate significantly with reported dietary intakes.

Correlations were found between second trimester reported protein intake and the Ponderal Index of the infant ($p = .05$). Second trimester reported protein intake also correlated with the fetal/placental weight ratio ($p = .05$). Dietary intake failed to correlate significantly with any maternal or infant outcome parameter.

Protein parameters were correlated with infant outcome variables more frequently than with maternal outcome variables. Second trimester blood urea nitrogen correlated with fetal/placental weight ratio ($p = .05$). Third trimester albumin levels correlated significantly with placental weight ($p = .01$), infant weight and occipital-frontal circumference ($p = .05$).

The only maternal outcome variable that correlated with any laboratory parameter was second day postpartum hematocrit to third trimester serum total protein ($p = .01$). This was an inverse correlation, as the third trimester protein increased, postpartum hematocrit decreased.

There were no significant relationships between maternal complications in the antepartum, intrapartum, or postpartum period and any of the nutritional parameters surveyed.

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CHAPTER I

INTRODUCTION

The nutritional status of an individual is a complex construct influenced by many factors. Contributing to an adult's overall nutritional status are: genetic predispositions, nutrients received during growth and development, current dietary intake, activity levels and energy demands, disease states, dietary norms and food availability, personal food preferences, and cooking methods. All of these affect the availability, absorption and utilization of nutrients and ultimately the health of the individual. In the gravid woman the physiologic changes of pregnancy alter this system and make the determination of nutritional status during pregnancy a challenge.

Nutritional advice given during pregnancy has reflected the religious, scientific, and social beliefs of the times, receiving careful scrutiny throughout recorded history. In giving general dietary advice in a treatise on midwifery, Culpepper (1684) counseled that ". . .when the child is bigger, let her diet be more, for it is better for women with child to eat too much than too little, lest the child should want for nourishment." Such positive liberal advice was the norm for biblical times throughout the 16th and 17th centuries. This philosophy changed in 1788 when James

Lucas, a surgeon in Leeds, England, devised a special diet to help overcome the difficulty in labor in contracted pelves. Through restriction of the mothers diet he attempted to reduce the size of the infant. In 1889, Ludwig Prochownick prescribed a restricted intake of carbohydrates and fluids for women to reduce the incidence of cephalopelvic disproportion. His famous diet was accepted and practiced for decades. This trend of starving the mother to diminish the size of the child continued into the early 20th century.

The apparent positive relationship between adequate maternal diet and the well being of the newborn has been empirically recognized by midwives since ancient times (Luke, 1979). Modern nurse-midwives emphasize early antepartum nutritional assessment and continued counseling for improvement of nutritional status throughout pregnancy as essential to the goal of improved pregnancy outcome (Varney, 1980). If it could be established that nutrition, current to and late in, pregnancy has a substantial influence on the outcome of pregnancy there is the potential for a positive impact on outcome by prenatal health care providers (Bergner & Susser,1970). Improving the outcome of pregnancy is of significance in the United States since maternal and infant mortality rates are substantially higher than in many other industrialized nations (U.S. Vital Statistics, 1974).

The purpose of this investigation was to describe a small, convenience sample of clients under nurse-midwifery and obstetrical management, in terms of protein/calorie nutritional status. This information was compared with maternal and infant outcome. Further research in this area may assist nurse-midwives and other health care providers in more readily determining the nutritional status of pregnant women and in identifying the role that nutrition plays in the course and outcome of pregnancy.

Review of Literature

The ideal method of assessment of nutritional status would be relatively non-invasive, broadly applicable, reliable, and cost/time effective. To date, no single instrument for such assessment exists. However, there are various methodologies available within four broad categories; community assessment, dietary surveys, clinical studies, and laboratory investigations (Christakis, 1973). The aforementioned methods have advantages and disadvantages. The limitations of one may often be overcome by utilizing several simultaneously.

Community Assessment

Community assessment provides a background for individual assessment. The nature of the community (urban, suburban, agrarian) may have an effect on the food resources available to the individual. Some geographic factors such as climate, soil characteristics, or the proximity to fishing and hunting areas, will effect types of food and protein sources available to the population. Individual diets can be considered within this framework.

Dietary Surveys

Dietary surveys are used to compare individual nutrient intakes with accepted standards of intake necessary to maintain health. Since individual needs, absorption, utilization and excretion are known for an entire population, these recommendations must be high enough to meet the needs of those well persons with the highest average requirements.

The Recommended Daily Allowances (RDA) of the National Academy of Science (NAS-NRC) were first published in the United States in 1943 and revised at approximately five year intervals thereafter. The purpose of the RDA was originally to facilitate sound nutritional planning for the Armed Services and the general population in the event of wartime shortages. Hence the RDA's are by definition estimates of the amounts of essential nutrients each person in a healthy population must consume in order to provide reasonable assurance that physiologic needs will be met (Harper, 1974). The RDA's do not take into account the amount of nutrients lost during processing or preparing foods, international standards have never been set, and experts within the field of nutrition disagree with the established standards set for various countries. Nonetheless, the RDA's provide a convenient and generally accepted standard against which to measure an individuals dietary intake of essential nutrients.

Dietary studies may be retrospective or prospective. The most commonly used, although the most limited in accuracy, is the twenty four hour recall diet history, a retrospective method. Prospective research may consist of direct observation of the measured and weighed intake of an individual, or the recorded estimates of intake over a defined period of time. These may be 24 hours, three days, five days or longer. Fidanza (1974) reported that optimal correlations of recorded intake occurs with more frequent sampling of moderate duration spread over a period of time. He reported high correlations between three day and seven day diet histories which indicate the relative usefulness of the limited three day diet history. He reported correlations of: r = .86 for protein, r = .79 for fats, and r=.86 for total calories between the three day and seven day diet histories. Fidanza added that the three day diet history will provide the most accurate information if the diet is relatively homogenous and if assessment of the mean dietary intake is the goal.

Limitations in the use of any dietary survey were reported. Errors in measurement, recording, evaluation of nutrient content, and limited sampling time may produce bias and not accurately reflect the actual intake. Similarly, variations may occur in the absorption and utilization of nutrients. Distortions may occur due to the artificial setting of weighing and recording all items consumed which may significantly alter recorded intake. This dietary survey, while clinically available, is limited in providing specific information about dietary deficiency or adequacy. However, an awareness of the limitations associated with diet history surveys will encourage researchers to utilize other parameters in the analysis of nutritional status.

Clinical Studies

The next modality under consideration is clinical assessment observable physical deficiency states as indices of overall nutritional status. Physical parameters are varied, tend to be relatively non-specific, are frequently last manifestations of nutritional deficiency, and tend to provide poor screening techniques for borderline conditions. Christakis (1973) cited the low general prevalence and the poor interrater reliability as drawbacks in the use of physical signs and symptoms as a single indicator of nutritional status. Pregnancy itself further confuses these physical signs. For example, gingivitis is usually a sign of vitamin C deficiency but is a common finding in pregnant women even in the presence of adequate vitamin C intake (Christakis, 1973).

Physical anthropometric data such as maternal height, weight, newborn head circumference, and skin fold thicknesses are reliable indices of long term nutritional status when genetic predispositions are taken into account. They are easily and accurately obtained and have been used in numerous studies. Burke, Harding and Stuart (1943), Fort (1971), and Naeye, Blane and Paul (1973), using these indices, reported correlations between overall maternal nutrition and the outcome of pregnancy.

Laboratory Investigations

The fourth assessment method is laboratory analysis of blood and urine for nutrients and metabolites. Laboratory measures have the advantage of objectivity in the detection of a deficiency state.

However, definition of parameters of normal and interpretation of high and low level is an inexact science and normal laboratory values may not always assure adequacy of intake (NAS-NRC, 1970). Furthermore, deficient blood levels have not always correlated with clinical observations or dietary findings. The differences in individual needs, metabolism, and utilization are unclear, therefore, laboratory values show their worth only in the extremes and in conjunction with other parameters.

The Committee on Procedures for Appraisal of Protein-Calorie Malnutrition of the International Union of Nutritional Sciences (1970) reported that the assessment of protein status in pregnancy has been a difficult task due to the physiologic changes in protein metabolism and to the lack of reliable, practical indicators of protein status. Generally, pregnancy has been noted to be an anabolic state, a time of positive nitrogen balance (absorption of nitrogen exceeds excretion); this positive balance is acknowledged as a factor necessary for the growth of the fetus and the establishment of maternal protein stores (Macy & Huncher, 1934; NAS-NRC, 1970; Pitkin, 1977). The maintenance of a positive nitrogen balance is partially achieved by alterations in maternal absorption and excretion of protein and its metabolites. King, Calloway, and Margen (1973) stated than an additional 30 grams of protein intake is necessary in pregnancy to achieve nitrogen balance. The glomerular filtration rate increases in pregnancy to approximately one and one half times the non-pregnant level, though this change has no effect on the serum levels of protein and albumin (NAS-NRC, 1970; Hytten &

Leitch, 1963, Hytten & Lind, 1975). Serum protein, and serum albumin levels are generally present with chronic severe malnutrition states such as kwashiorkor, but may remain in the normal range during moderate protein restriction or short term fasting (Zlatnick, 1979). The blood urea nitrogen level (BUN) has also been used as an indicator of protein intake and will evidence changes in short term intake. However, the affects of hydration and the glomerular filtration rate on the BUN make it a poor independent indicator in pregnancy.

These four basic approaches to nutritional assessment were reported either singularly or in various combinations throughout the literature in an attempt to determine the effect of maternal nutrition upon pregnancy outcome.

Following World War II, using community assessment techniques, a retrospective analysis was made of naturally occuring famine in Holland (Smith, 1946) and Liningrad (Antonov, 1947) relating the widespread malnutrition to an increased incidence of amenorrhea, miscarriage, and maternal/infant morbidity and mortality. Although it is difficult to determine the effect of hostile environment, high stress, and poor living conditions, the effects of famine are thought to have played a major role in increasing reproductive casualties.

Burke, Beal, Kirkwood, and Stuart (1943), utilizing a 24-hour diet recall to gather information about the protein intake of gravid women, categorized subjects according to the percent of the RDA for protein in their diets. If the average protein intake equaled or or exceeded the RDA the diet was called "excellent" for protein, if the intake was less than the RDA but 80% or more it was considered "good"; the diet was "fair" when intake was 60-79% of the RDA; less than 60% was "poor"; and if the average intake was less than 50% of the RDA for protein it was labelled "very poor". They reported a greater incidence of complications during pregnancy among the women with a "poor to very poor" diet, which was largely due to a high (44%) incidence of pre-eclampsia. There was no incidence of pre-eclampsia in the "excellent" or "good" dietary groups, and an 8% incidence in the "fair" group. They also reported that while there was a statistically significant relationship between the mother's dietary rating for protein intake, and the course of pregnancy it was evident that this relationship was not as marked as that existing between the mother's dietary rating and the condition of the infant at birth. This indicates that the fetus will show the signs of inadequate protein supply to a greater degree than will the mother during the course of her pregnancy.

Higgins (1976) at the Montreal Diet Dispensary designed a program for the supplementation of low income, high risk, gravid women to improve pregnancy outcome. Her goal was to increase birthweight and lower infant morbidity/mortality rates. She individualized each woman's caloric and protein needs by using the Canadian RDA's as a base and adding 500 K/calories and 25 grams of protein after 20 weeks gestation. Additional corrective allowances were added if the woman was under weight for her height, if she had evidence of undernutrition (for example, if her protein/calorie intake was below the RDA when she entered the program), or if she had other chronic stress factors such as disease or emotional upsets. Mothers were assessed by 24 hour recall diet histories repeatedly throughout the pregnancy and counseled to improve their intakes of essential nutrients. Mothers whose incomes were below the poverty level received a food supplement of milk, eggs, and oranges to make up the nutritional deficit.

In the initial investigation over nine years, 1,736 women completed the program. Mean calorie intake increased from 2249 K/cal to 2778 K/cal while the mean protein intake increased from 68 grams to 101 grams. Only 5% of the subjects entered the program in what was termed good nutritional status (appropriate weight/height relationship, diet equal to or greater than the RDA, with no disease or emotional stress). The remaining 95% had one or more of the aforementioned conditions. At the completion of the program the mean birthweight of infants of mothers who entered undernourished was 3418 grams, only ten grams less than infants of mothers who entered well nourished. The percentage of low birthweight babies fell with the length of time in the program from 9.8% for infants of mothers with 1 to 12 weeks service, to 4.07% for those who received over 20 weeks service. Perinatal mortality also fell from 26.6 to 8.3 deaths/1000 with the same service ranges.

Higgins also reported a direct positive relationship between birth weight and the percentage of protein requirement consumed by the mother. She concluded that the RDA was perhaps too low in many cases and should be increased to meet the individual needs in the manner already described, and recommended that this increase should be routine to achieve the goal of increased birth weight and decreased infant mortality.

Other maternal complications, besides pre-eclampsia, have been reported. Higgins (1976) noted a decreased incidence of abruptio placentae among a group of high risk women who had received supplementation in protein, calcium, and vitamin C. Deficiencies in iron stores and intake as well as inadequate protein/calorie intake which resulted in anemia during pregnancy has also been correlated with an increased incidence of infection in the antepartum and postpartum periods (Pritchard & MacDonald, 1975).

Of infant outcome factors, birth weight has been the most investigated. Numerous authors have reported positive correlations between decreased maternal protein/calorie nutrition and decreased infant birth weight (Burke, Harding & Stuart, 1943; Fort, 1971, Naeye et al., 1973). Optimal birth weight has additionally been identified as the best single indicator of future optimal physical and mental development (Knobloch, Pasamanik & Shepard, 1952; Singer, Westphal & Niswander, 1968; Winick, Brasel, Velasco & Rosso, 1974). In clinically controlled animal studies, decreased protein consumption has been implicated as the critical factor in retarded brain growth, impaired development, and ultimately survival (Brazel, 1972).

High correlations have been shown between diet history of protein intake and infant outcome (Shanklin & Hoden, 1975) such that there was less than one in one billion chance that prenatal maternal protein intake was not related to infant outcome. However he relied solely upon diet histories for assessment of protein intake, using no other means of determining the protein status of the participants. Rush, Stein and Susser (1980), utilized a high risk urban minority population to investigate the effects of protein supplementation on maternal and infant outcome. They reported that women receiving a high protein supplement evidenced an increase of very early premature births, associated neonatal deaths and associated intrauterine growth retardation up to 37 weeks gestation. This is the first research to indicate that high maternal protein intake may have detrimental effects on the outcome of pregnancy. Hegsted (1980) criticized this work noting that the groups were not adequately randomized, and that the supplementation was unbalanced in terms of calcium, zinc, and magnesium, elements necessary for the metabolism and utilization of amino acids within dividing cells. Furthermore, Hegsted felt that excess supplementation over a short term has rarely proven to be valuable.

Other authors have reported the positive correlation of birth weight to maternal nutritional status using maternal weight gain during pregnancy as an indicator (Eastman & Jackson, 1968).

Despite the acknowledged high correlation of birth weight to the overall maternal nutritional status, the variable of birth weight has limitations when considered singlularly or with the estimated gestational age. Other variables such as infant sex, maternal race and preconceptual weight, have high independent correlations with birth weight. Miller and Hassanein (1971; 1974), in an attempt to classify intrauterine malnutrition, use clinical observation of decreased subcutaneous fat, and the Rhorer Ponderal Index (PI). The PI is the birth weight in grams multiplied by 100 and divided by the cube of the crown-heel length in centimeters:

$$\frac{\text{Weight in grams X 100}}{(\text{length in centimeters})^3}$$

The PI has the advantage of accounting for skeletal size in the calculation. Thus, infants whose skeletal size is large but who have decreased depositions of fat and subcutaneous tissue secondary to malnutrition in the third trimester, might have a birth weight within normal limits for gestational age, but still be malnourished. This type of malnutrition would be reflected in the PI. A PI in the lower 3% is indicative of intrauterine malnutrition in the last trimester of pregnancy (Naeye et al, 1973; Miller & Hassanein, 1971, 1974; Metcoff, 1974).

The occipital frontal circumference (OFC) of the newborn, as a measurement of intrauterine growth, is affected by malnutrition occurring during the entire last half of pregnancy. Deprivation which affects the OFC is often the least changed of all parameters due to the brain-sparing effect, where the head is the last part of the body to be affected by deprivation (Naeye et al., 1973). Higgins (1975) and Metcoff (1974) reported that the OFC may be decreased in small for gestational age infants (SGA) due, theoretically to prolonged malnutrition.

Another parameter worthy of consideration as an outcome variable is the condition of the placenta. The functional capacity of the placenta plays a major role in fetal growth throughout gestation but especially so in the last trimester of pregnancy. When intrauterine growth retardation was first recognized, it was attributed to placental insufficiency because of the small and abnormal placentas often found in association with the growth of retarded infants. Recent research however, has failed to correlate placental size with placental insufficiency (Thomson, Billewicz & Hytten, 1969; Molteni, Stys & Battaglia, 1978). Placental growth has been noted to continue through 42 weeks gestation in average and large for gestational age infants (Molteni et al., 1978). This fact and the association of small placentas with intrauterine growth retarded and small for gestational age (SGA) infants makes relative placental weight a variable worth consideration in terms of infant outcome.

Fetal weight and placental weight have been shown to correlate at any gestational age (Thomson et al., 1969; Molteni et al., 1979). Numerous other factors such as pre-eclampsia and maternal multiparity have correlated with decreased placental size as well as decreased infant birth weight (Pritchard & MacDonald, 1976). Lechtig, Yarbrough, Delgado, Martorell, Klein and Behar (1975) found lowered placental weight present in a group of women who demonstrated moderate protein/calorie malnutrition; though the concentration of DNA, hemoglobin, protein, and water did not differ significantly in the two samples. Those researchers postulated that ". . .reduction of placental weight may be the mechanism by which maternal malnutrition is associated with high prevalence of low birth weight babies in these populations (Lechtig et al., 1975, p. 191).

Summary

The additional needs for protein in pregnancy are related to both the mother and the fetus. Dietary intake of protein provides amino acids for maternal use in expanded maternal blood volume, increased breast tissue, expanded uterine size, and maternal protein storage. The feto-placental unit is directly dependent on maternal intake of essential amino acids and/or metabolism of maternal protein stores for all its growth needs. These needs are the growth of the embryo/fetus, the growth and development of the placenta, and the continued production of amniotic fluid. The relationship of calorie intake to the utilization of protein is essential because, in the absence of adequate calorie intake, protein intake or stored protein are used for energy and may produce signs of malnutrition.

With these facts in mind, the current study was designed to investigate maternal protein status using a unique combination of dietary surveys, clinical/physical observations, and laboratory parameters in the methodology, then to compare this information to maternal and newborn outcome measures. These topics were addressed in this study through the following research questions:

1. What is the relationship between reported dietary intake of protein and calories and measurable laboratory parameters of protein during pregnancy?
2. What is the relationship between reported dietary intake

of protein and calories and the course and outcome of pregnancy?

3. What is the relationship between measurable laboratory parameters of protein and the course and outcome of pregnancy?

CHAPTER II

METHODOLOGY

Design

A non-experimental descriptive design was used to examine correlations between recorded intake of protein and calories, blood parameters of protein, and selected maternal and infant outcomes of pregnancy. Twenty-seven (n = 27) subjects were followed throughout the second and third trimesters of pregnancy, labor and delivery, and through the three day immediate postpartum period.

Data were analyzed by the use of inferential statistical methods, including the Pearson "r", and the Chi square, and the two-tailed "t" test.

Setting

The study was conducted at Hill Air Force Base (HAFB) Hospital in order to obtain a relatively homogenous income population within the Antepartum Clinic, In-patient Obstetrical Service, and the Newborn Nursery. Diet history analysis, after coding by the researchers, was done by computer at Utah State University, Logan, Utah. To obtain protein calorie intake levels, analysis of blood specimens took place at the HAFB laboratory.

Selection of Subjects

Women registered at the antepartum clinic were contacted for informed consent between 14 and 24 weeks gestation. Data were collected initially in the second trimester between 16 and 27 weeks gestation, and again in the third trimester between 29 and 39 weeks gestation. Selection of this gestational period was because of a desire to avoid the nausea and vomiting of early pregnancy and the possibility of early miscarriage. An attempt was made to avoid the period of maximal hemodilution of pregnancy which occurs between 28 and 32 weeks gestation. However, due to errors in estimating individual subjects weeks gestation, two subjects did have data collection during the hemodilutional period.

After informed consent was obtained, subjects were screened by interview and chart review for conditions which could adversely affect nutritional status or the outcome of pregnancy.

Factors which excluded any subject were:

endocrine disorders,
cardiac disease,
persistent nausea and vomiting or use of Bendectin after 20 weeks gestation,
renal disorders,
hepatic disorders,
chronic gastrointestinal disorders,
essential hypertension,
plans for delivery elsewhere than HAFB,
age below 17 or above 35 years of age,
cigarette smoking,
alcohol intake of more than one drink per day,
use or abuse of controlled substances,
current evidence of multiple gestations, and/or
current psychological problems.

Procedure

Prenatal charts were reviewed in the antepartum clinic to obtain the names of those clients with an expected date of delivery (EDD) which indicated that they were at less than 24 weeks gestation at the time of initial contact. At the next scheduled appointment, participation was requested and informed consent obtained. The subject was informed that there is currently no proof that nutrition effects individual pregnancies. Eligible subjects, with the assistance of the researchers then completed the Information Questionnaire (Appendix A). Subjects in the second trimester were mailed the three-day diet history form, with instructions to complete it in the three days prior to the next appointment (Appendix B).

At the clinic visit, prior to examination, the diet history was reviewed with the subject. If the diet history was complete, a urine specimen was obtained which was tested for protein, and ketones. Blood was obtained which was examined for serum protein, serum albumin, blood urea nitrogen (BUN), hematocrit, and hemoglobin.

The same procedure was repeated with the subjects whose gestational age was 38 weeks, the third trimester of pregnancy. During the entire course of the investigation prenatal care was provided, as usual, by the clinic staff.

Approximately six weeks prior to the expected date of delivery, the labor and delivery chart of each subject was flagged with a Nutritional Study Protocol tag and instructions to refrigerate the placenta after delivery. The placentas were placed in a tagged plastic bag and stored at 4 degrees centigrade until the researchers removed the cord, clots and measured the weight.

Prior to discharge of the mother and infant from the hospital, one of the researchers visited the subject to review with her the general findings of her diet histories and laboratory work. She was informed that a copy of the finished thesis would be placed in the clinic, available for her review. The subjects were thanked for participation in the study. They were informed that currently there is no proof that nutrition affects individual pregnancies, although correlations do exist between optimal nutritional status and the outcome of pregnancy among large numbers of subjects. Prior to the discharge of the subject, antepartum, intrapartum, postpartum and newborn charts were reviewed and information was obtained on the occurrence of complications. This information was added to the data collection worksheet (Appendix C).

Operational Definitions

1. Dietary intake of protein and calories was determined by computer analysis of intake recorded by the subject over a three day period of time. Analysis was done at Utah State University, Logan, Utah, utilizing the established program (Sorenson, Wyse, Wittmer, & Hansen, 1976); comparing individual intake to the standard United States Department of Agriculture Recommended Daily Allowances (RDA), which is 76 grams of protein per day. For the purpose of comparison in this study, subjects were categorized by protein

and calorie status as outlined below:

Protein Status

Group 1 = protein level greater than 90% of RDA (69 grams +)

Group 2 = protein level 76-90% of RDA (58-68 grams)

Group 3 = protein level less than 75% of RDA (less than 58 grams)

Calorie Status

Group 1 = calories greater than 90% RDA (2184 K/cal/day or more)

Group 2 = calories 76-89% RDA (1824-2183 K/cal/day)

Group 3 = calories less than 75% of RDA (less than 1823 K/cal/day)

2. Low dietary intake was considered to be a mean daily intake for the three days that was less than 90% of the RDA for protein and calories. These subjects were classified as Group 2 (76-90% RDA) or Group 3 (less than 75% RDA).

3. Laboratory parameters of protein were serum protein, serum albumin, and blood urea nitrogen.

Total serum protein determinations were made on blood collected on the day following completion of each of the three-day diet histories. Mean serum total protein was considered 6.2 mg/dl plus or minus 9.5 mg/dl (Hytten & Lind, 1975). Analysis was done manually on a standard refractometer. Total serum proteins were classified as high (greater than 8.0 gm/dl), average (6.0-8.0 gm/dl), and low (less than 6.0 gm/dl) (Luke, 1979).

Serum albumin determinations were made on blood collected on the day following completion of each of the three day diet histories. Normal mean serum albumin is 3.5 gm/dl, plus or minus 0.5 gm/dl (Hytten & Lind, 1975). Analysis was performed in a Gilford Automatic instrument using the Brom Cresol Green method and Pierce Reagent. For the purpose of analysis, the albumin levels were classified as high (greater than 3.5 gm/dl), average 3.0-3.5 gm/dl), and low (less than 3.0 gm/dl) (Hytten & Lind, 1975; Luke, 1979).

Blood urea nitrogen (BUN) determinations were made on whole blood collected on the day following completion of each of the three-day diet histories. BUN analysis was done on the Gilford Automatic instrument using urease/GLDH method. Classifications for analysis were high (greater than 15 mg/dl), average (6.1 - 14 mg/dl), and low (less than 6 mg/dl) (Hytten & Lind, 1975).

3. Antepartum complications were defined as any one or more of the following conditions occurring in the period before delivery, anemia, toxemia, second or third trimester bleeding, fetal demise, or infection including urinary tract infections or upper respiratory tract infections. Anemia was defined for the purpose of this investigation as a hematocrit of less than 35% mg (other than during the hemodilution period between 28 and 32 weeks gestation). Hematocrit was determined on central venous blood by centrifugation. Toxemia, otherwise known as pregnancy induced hypertension (PIH), pre-eclampsia or eclampsia, was defined as; blood pressure of 140/90 or an elevation in the blood pressure of 30/15 millimeters of

mercury over baseline, and either non-dependent edema, or one plus (1+) or greater proteinuria on a clean catch midstream urine specimen, or both. The urine protein levels were obtained by the clean catch method from patients with intact membranes, or catheterized specimens from patients with ruptured membranes. For the purpose of this study, a diagnosis of toxemia determined by the attending physician was also accepted. The definition of second or third trimester bleeding was vaginal bleeding after the 14th week of gestation. Fetal demise was defined as death of a fetus in utero after the 28th week of gestation. Infection was defined by the primary care provider (febrile episodes and/or positive cultures for pathogenic bacteria in the urinary tract or upper respiratory tract).

4. Maternal morbidity was defined as the presence of any one or more of the following conditions concurrent to or following pregnancy; infection, toxemia, postpartum hemorrhage, placental infarction, terminal placental abruption, vaginal lacerations and/or extension of the episiotomy. Infection was defined as the presence of a body temperature orally, of 100.4 degrees Farenheit or greater on two consecutive readings at least four hours apart, after the first 24 hours postpartum (Pritchard & MacDonald, 1976). Toxemia was defined as above in antepartum complications, with symptoms occurring in the intrapartum or postpartum periods (Pritchard & Macdonald, 1976).

Terminal placental abruption was determined by the primary care provider during labor. It is defined as separation of the placenta after the onset of labor and before completion of the second stage of labor. It was characterized by bleeding during labor. Presence of placental infarction was determined by the primary care provider and by the researchers during examination and weighing of the placenta. It was defined as a darkened, fibrosed, non-perfused area of placenta.

5. Poor infant outcome was defined as the presence of any one or more of the following conditions; low birth weight for gestational age, high fetal/placental weight ratio, low Ponderal Index, and/or low occipital frontal head circumference. Fetal distress was defined by the primary care provider as any one or more of the following:

a. the presence of meconium stained amniotic fluid,

b. prolonged (30 minutes or more) tachycardia (above 160 beats per minute),

c. prolonged (30 minutes or more) bradycardia (below 100 beats per minute), and

d. any late decelerations in the fetal heart rate as described in the maternal labor chart by the primary care providers. These heart rate changes were recorded by internal or external fetal monitoring techniques.

A low birth weight, or small for gestational age infant (SGA), was any infant in the bottom 5th percentile for weight using standards established by Lubchenco, Hansman and Dresser (1963), as measured on a calibrated balance scale in the newborn nursery. Gestational age assessments were accomplished by the attending pediatrician at HAFB and were based on the Dubowitz standards

(Dubowitz, Dubowitz & Goldberg, 1970). The weight of the placentas without the cord, membranes, and blood clots were measured on a calibrated balance scale in the labor and delivery unit. A fetal/placental weight ratio of 10.0 or greater at any gestational age was considered high (Molteni et al., 1978). The Ponderal Index (PI) is the ratio of birth weight to length of the infant. Length was measured in the recumbant position while eliciting the tonic neck reflex to obtain straightening of the hip and leg. The formula for obtaining the PI is the weight in grams times 100 divided by the cube of the length in centimeters. For the purpose of this research a low PI was considered to be any PI less than the 10th percentile, utilizing distributions developed by Miller (1971) which were based on calculated gestational age. The occipital frontal circumference (OFC), of the head of the infant was measured at least 24 hours after a vaginal birth or at any time after a Caeserian birth, to control for error from molding of the fetal head. Measurement was accomplished by using a nonstretchable paper tape supplied to the institution by Ross Laboratories. The tape was applied snugly to the head of the infant at the broadest area from the occiput to the forehead. Comparison of the OFC to standards for gestational age was made using standards established by Lubchenco (1963), any value below the 10th percentile was considered low.

CHAPTER III

RESULTS AND DISCUSSION

Description of Sample

Four sources of data were utilized in this investigation. The average protein and calorie intake of subjects in the second and third trimesters was obtained by computer analysis of three day diet histories written by the subjects, coded by the researchers, and analyzed at Utah State University, Logan, Utah. Laboratory data for individual subjects on blood and urine were obtained from samples analyzed at the Hill Air Force Base laboratory. Data on the course and outcome of pregnancy were obtained from a maternal and newborn chart review. The informational questionnaire provided information on past pregnancies, medical history, personal habits and demographic data.

The data gathered from all these sources were analyzed by the researchers using the following inferential statistical methods: Pearson "r" correlation coefficients, Chi Square test and two tailed "t" tests. Formulae for the inferential statistics were drawn from Bartz (1976). Any correlations with a significance at the $p = .05$ level were reported.

Demographic Data

The sample included 27 women, who were predominantly Caucasian, married and Protestant, with an average age of 23.5 years. A complete summary of race, marital status, religious preference and the range of ages can be found in Table 1. The sample consisted of nine primigravid women (pregnant for the first time), one functional primigravid woman (one previous spontaneous abortion but no term pregnancies), and 17 multigravid women (having had one or more previous term pregnancies) (Table 2).

Paternal demographic data revealed 24 Caucasians, one Hispanic, one Negro, and one father about whom data was withheld by the unmarried subject. Paternal age ranged from 19 to 32 years with a mean of 24.5 years.

Three subjects were active duty Air Force personnel; the remaining 24 were dependents of active duty personnel. The average monthly income was $1,015., with a mean monthly grocery expenditure of $172. The average number of persons per household was 3.1, resulting in a mean of $55 per person spent on groceries per month (see Table 3).

Data Collection

The second trimester data collection consisted of a three day diet history, total serum protein, serum albumin, Blood Urea Nitrogen (BUN), hematocrit, and urine for protein, ketones and sugar. Data collection occurred between 16 and 27 weeks gestation with a mean of 22.96 weeks. The third trimester data collection occurred

Table 1

Summary of Demographic Data Including Race, Religion, Marital Status, and Age of Subjects

	Number	Incidence
Race		
Caucasian	22	81.4%
Fillipino	2	7.4%
Negro	1	3.7%
Hispanic	1	3.7%
Vietnamese	1	3.7%
Religion		
Protestant	11	40.7%
LDS (Mormon)	6	22.2%
Roman Catholic	6	22.2%
Buddhist	1	3.7%
Jewish	1	3.7%
No Preference	2	7.4%
Marital Status		
Married	25	92.3%
Separated	1	3.7%
Single	1	3.7%

	Mean	Range	Standard Deviation
Age of Subjects	23.5	18-32	3.78

Table 2

Summary of Subjects Grouped by

Parity

Parity[a]	Number of Subjects	% Sample
0 0 0 0	9	33.3%
0 0 1 0	1	3.7%
1 0 0 1	6	22.2%
1 0 1 1	2	7.4%
2 0 0 2	7	25.9%
3 0 0 3	1	3.7%
1 0 3 1	1	3.7%

[a] Four Digit Parity Nomenclature

- the first digit represents the number of pregnancies carried 37 weeks or more,
- the second digit represents pregnancies delivered between 20 and 37 weeks,
- the third digit represents pregnancies delivered before 20 weeks, and,
- the fourth digit represents the number of living children.

Table 3

Summary of Demographic Data Including Average Income, Number of Persons in Household and Amount Spent on Groceries Per Person in Household

Variable	Range	Mean
Income for household per month	$550.-$2000.	$1015.
Amount spent on groceries per household per month	$50.-$400.	$ 172.
Number of persons per household	2-8	3.1
Amount spent per person per month on groceries	$25.-$100.	$ 55.

between 29 and 39 weeks gestation, with a mean of 34.7 weeks, and consisted of repeat three day diet history and laboratory parameters. After delivery maternal and newborn charts were reviewed for incidence of complications, type of delivery, newborn weight and length, and other outcome variables. The placentas were examined and weighed by the researchers.

Course of Pregnancy

The mean pregravid weight for the 27 subjects was 112 pounds, with a range of 87 to 195 pounds. Heights ranged from 57 to 70 inches, with a mean of 61.2 inches. The mean total weight gain during pregnancy for the sample was 31.8 pounds with a range of 16.5 to 62 pounds. Prior to the current pregnancy, seven women were more than 10% under the recommended weight for height (based on the Metropolitan Life Insurance Company tables) and four women were obese, more than 20% over the recommended weight. For the seven underweight women, the weight gain during pregnancy ranged from 18 to 42 pounds with a mean weight gain of 30 pounds.

The antepartum complications noted in the sample were anemia (15%) and Upper Respiratory Infection (7%).

Maternal Outcome

Twenty-five subjects delivered vaginally, two of these with low forceps assistance. Two subjects were delivered by Caesarian Section, one for prolapsed cord associated with fetal distress; the second was planned due to a history of a fractured pelvis.

The intrapartum complications noted in this sample were toxemia, terminal abruption of the placenta, fetal distress, extension of the episiotomy, vaginal laceration, and placental infarction (See Table 4).

The postpartum period was uncomplicated for the majority of the subjects. There were, however, six cases in which the second day post partum hematocrit was below 35 mg% (anemia) and one incident of toxemia noted in this period.

Twenty-three placentas were collected and examined. The range of placental weights was from 340 to 624 grams, with a mean of 470 grams. This mean is significantly higher than the mean reported in the literature for 2000 placentas prepared in the same manner by Molteni et al. (1978) $p = .01$. The difference in the mean weights of placentas in a population with infants of the same gestational age could be due to the selection of sample in this study, or due to the increased altitude in the area where this study was conducted (5000 feet above sea level). Elimination of smokers and chronically ill women could decrease the incidence of smaller placentas since these factors are known to affect both infant and placental weight. It is also possible that the placentas of women living at higher elevations might be larger to compensate for the decreased concentration and pressure of oxygen at these altitudes. Normative data for placental weights is not available specific to the Intermountain West. Two placentas were noted to have areas of infarction of more than 25% of the surface area. Other findings included four marginal insertions of cord into the placenta, one velamentous insertion and one circumvallate placenta.

Table 4

Summary and Incidence of Maternal and Newborn Complications

	# of subjects	Incidence
Maternal		
Antepartum		
Recurrent Upper Respiratory Infection	2	7.4%
Anemia	6	22.2%
Intrapartum		
Toxemia	2	7.4%
Terminal Placental Abruption	3	11.1%
Fetal Distress	5	18.5%
Extension of Episiotomy	2	7.4%
Vaginal Lacerations	2	7.4%
Placental Infarction	2	7.4%
Postpartum		
Anemia	6	22.2%
Toxemia	1	3.7%
Infant		
Low Ponderal Index	5	18.5%
Large for gestational age	2	7.4%
Small for gestational age	2	7.4%

Newborn Outcome

The average gestational age at delivery was 40.4 weeks with a range from 39 to 42 weeks. Eleven infants were male and sixteen were female. The mean range and standard deviation for birth weight length, occipital-frontal circumference (OFC), chest circumference, and placental weight are summarized in Table 5.

The mean fetal-placental (F/P) ratio for the sample (N = 23) was 7.52 and ranged from 6.2 to 12.03. This mean was consistent with the mean reported in the literature (Molteni et al., 1978). There was only one infant for whom F/P weight ratio was high (above 10); this was an infant of a diabetic mother and an elevated F/P ratio is typical for infants of diabetic mothers due to the increased fat storage in these infants. Of the remaining infants, ten had F/P weight ratios of more than two standard deviations from the mean. None were defined as high or low by Molteni et al. (1978).

Description of Dietary Status

The mean calorie intake from the second trimester diet history was 2501 kilocalories per day, with a range from 1717 to 3561 Kcal/day and a standard deviation of 429.19. This mean was within the range of means reported by Hytten and Lind (1975) in a review of the international literature for mean calorie intake for the third trimester of pregnancy (See Table 6). The mean calorie intake for the third trimester diet history was 2180 Kcal/day with a range from 1255 to 3521 Kcal/day and a standard deviation of 598.85

Table 5

Mean, Range, and Standard Deviation for Infant Weight, Length, OFC, Chest Circumference and Placental Weight

Variable	Range	Mean	S.D.
Infant Weight (grams)	2750-4188	3515	379
Infant Length (cms)	48.25-55.5	52	--
OFC (cms)	32.75-37.0	34.89	1
Chest circumference	31.25-35.5	33.77	--
Placental weight (grams)	340-624	470	81

Table 6

Means, Ranges, and Standard Deviations for Dietary and Laboratory Parameters Including Norms from Hytten and Lind (1975)

Variable	Range	Mean	Standard Deviation	Norms Reported in Literature
Weeks gestation at data collection	16-27	24	3.27	------------
Second Trimester Diet (N=27)				
Kilocalories/day	1717-3561	2501	429.2	2312-2720
Grams of Protein/day	54-155	97.8	25.9	72-80
Second Trimester Laboratory				
Total Protein (gm/dl)(n=26)	5.8-8.2	6.7	0.6	5.74-6.6
Albumin (gm/dl)(n=26)	3.3-5.4	4.1	0.6	2.59-3.79
Blood Urea Nitrogen (n=22) (mg/dl)	5-18	8.75	3	13-21
Hematocrit (mg%)(n=25)	33.2-46.2	38.7	2.9	mean[a] 36.6

Table 6 Continued

Variable	Range	Mean	Standard Deviation	Norms Reported in Literature
Weeks gestation at data collection	29-39	34.7	2.1	---------------
Third Trimester Diet (n=27)				
Kilocalories/day	1255-3521	2180	598.9	2327-2620
Grams of Protein/day	41-127	83.4	22.7	77-80
Third Trimester Laboratory				
Total Protein (gm/dl)(n=27)	5.9-8.0	6.6	0.6	5.9-6.8
Albumin (gm/dl)(n=26)	5.7-4.9	3.8	0.5	2.4-3.6
Blood Urea Nitrogen (n=25) (mg/dl)	5.2-30	9.6	5.1	12-20
Hematocrit (mg%)(n=27)	30.3-42.0	38.0	3.2	mean[a] 36.2

[a]Means at sea level

Kcal/day. This was well below the range of means reported by Hytten and Lind (1975) (See Table 6).

The mean protein intake for the second trimester was 94.81 grams per day with a range of 54 to 155 grams and a standard deviation of 25.9 grams. The mean protein intake for the third trimester was 84.4 grams/day with a range from 41-127 grams/day and a standard deviation of 22.73.

When protein-calorie intake was examined in relation to parity it was discovered that the multigravidas had lower intake than the primigravidas, though this did not adversely effect the average birth weight of the newborns (Table 7).

Laboratory Parameters

The mean serum total protein level in the second trimester was 6.7 gm/dl and 6.6 gm/dl in the third trimester. These results were within the upper limits of the range suggested as normal by Hytten and Lind (1975). The serum albumin levels correlated with those presented in the literature; the second trimester mean was 4.09 gm/dl and the third trimester was 3.78 gm/dl. The second trimester mean BUN was 8.75 mg/dl and the third trimester mean was 9.9 mg/dl.

The mean hematocrit in the second trimester was 38.68 mg%: four subjects had hematocrits below 35 mg%. In the third trimester, the mean hematocrit was 38 mg% with only two subjects exhibiting anemia, (hematocrit below 35 mg%)(See Table 6).

Table 7

Summary of Average Protein and Calorie Intake by Parity with Average Infant Weights

	Second Trimester		Third Trimester		Average Infant Weight
	Calories	Protein	Calories	Protein	
All primigravidas	2655	106	2362	86	3433
All secundagravidas	2545	100	2363	94	3170
All multigravidas	2259[a]	87	1747[a]	69[a]	3617

[a]Value less than the Recommended Daily Allowance

Findings

Research Question One

What is the relationship between reported dietary intake of protein and calories and measurable laboratory parameters of protein during pregnancy?

There was a significant difference between the means for both protein and calorie intake between the second and third trimesters ($p = .05$). In the second trimester, 85% of the subjects had an intake of more than 2184 Kcal/day which is 91% or more of the RDA for calories. In the third trimester, however, only 40% of the subjects had calorie intakes in this range. The incidence of subjects with below 75% of the RDA was only 7.4% in the second trimester but rose to 33.3% in the third trimester.

Similarly, the percentage of the sample with more than 91% of the RDA for protein decreased from 81.5% to 66.6% between the second and third trimesters of pregnancy. See Table 8.

This significant decrease in intake of both calories and protein was not anticipated as it had not been noted elsewhere in the literature. The common discomforts of the third trimester including mechanical crowding of the stomach, heartburn, constipation, and fatigue may have been factors influencing this decrease in dietary intake. Decreased emphasis on nutritional counseling in the third trimester by the care providers could also have contributed to the decrease. Dietary intake below the RDA in the third trimester is of concern to care providers since this time of

Table 8

Summary of Protein-Calorie Groupings

by Trimester

Intake by Group	Second Trimester Number	Second Trimester % Sample	Third Trimester Number	Third Trimester % Sample
Calories				
Group I ≥ 91% RDA	23	85.2%	11	40.7%
Group II 70-90% RDA	2	7.4%	6	22.2%
Group III ≤ 75% RDA	2	7.4%	9	33.3%
Protein				
Group I ≥ 91% RDA	24	88.9%	18	66.6%
Group II 76-90% RDA	2	7.4%	5	18.5%
Group III ≤ 75% RDA	1	3.7%	3	11.1%

Note. See page 20 for review of protein/calorie groupings maximal fetal brain growth represents a period of vulnerability to nutritional insult (Reeder, 1976).

Subjects were also categorized into groups according to laboratory findings: high, average and low for each parameter. See Table 9. The only parameter that deviated significantly from the norms reported in the literature was serum albumin (Hytten & Lind, 1975). The sample had a high percentage of population above the mean serum albumin levels reported by Hytten and Lind (1975). In the second trimester, 84.6% of the sample were in the high range; in the third trimester, 79.9% of the sample were classified as high. This may be due to sampling bias -- a small sample size that eliminated chronically ill women and smokers. Exclusion of this population could have caused a higher mean value for albumin, by excluding a group under additional nutritional stress. Higgins (1976) also reported higher than normal albumin and total protein levels in those subjects with above average intake of protein and calories, and demonstrated associations between higher albumin levels and improved pregnancy outcome. Presence of these elevated levels in association with low overall dietary intake might imply a very good initial nutritional status among this sample group.

Comparison of dietary intake to laboratory parameters in the second trimester demonstrated a significant correlation between increased dietary intake of protein and increased serum protein ($p \geq .01$). A significant correlation was also shown between increased calorie intake in the second trimester and increased total serum protein levels ($p \geq .05$). There were no significant

Table 9

Summary of Distribution of Subjects into High, Average, and Low Groupings

For Laboratory Parameters by Trimester

Laboratory Parameter	Group	Second Trimester		Third Trimester	
		Number	% of Sample	Number	% of Sample
Total Protein (gms/dl)	High (> 8)	1	3.8%	0	--
	Average (6-8)	24	92.4%	26	96.2%
	Low (< 6)	1	3.8%	1	3.8%
Albumin (gms/dl)	High (> 3.5)	22	84.6%	20	79.9%
	Average (3-3.5)	4	15.4%	4	15.4%
	Low (< 3)	0	--	2	7.6%
BUN	High (> 15)	1	3.8%	3	11.0%
	Average (6-14)	17	77.2%	17	69.2%
	Low (< 6)	4	18.1%	5	18.5%

correlations between dietary intake of protein or calories to the serum albumin or BUN levels. However, in the second trimester a trend toward relationship between increased dietary protein and increased BUN levels did appear.

In the third trimester no statistically significant correlations or trends could be demonstrated between the dietary intake of protein or calories and any of the laboratory parameters. Table 10 contains a summary of the high, average and low distributions of laboratory levels by trimester; and Table 11 is a summary of the significant correlations between diet and laboratory parameters.

Therefore, in the second trimester, since there is a strong positive relationship between diet history protein intake and serum protein, either assessment method could be used clinically. The use of one method over another would depend upon the care providers preference, and the cost and availability of the services. Where coding assistance, computer analysis and cooperative clients exist, the three day diet history is marginally less expensive and obviously less invasive as a method of nutritional assessment. Though no relationships between diet and laboratory parameters were shown for the third trimester, an increase in the number of subjects below the RDAs for protein and calories was demonstrated by the diet history. Thus the use of the diet history to screen for those women with nutritional deficits in the third trimester is warranted. Given the preselected low risk character of this sample and the incidence of poor diets (less than 75% RDA for both protein and calories), assessment of dietary intake is indicated to screen for

Table 10

Summary of Distribution of Dietary Intake By Groups

With Laboratory Parameters of Protein

Dietary Intake	Second Trimester			Third Trimester		
	Total Protein[a]	Albumin[b]	BUN[c]	Total Protein[a]	Albumin[b]	BUN[c]
	#Hi-Ave-Low	#Hi-Ave-Low	#Hi-Ave-Low	#Hi-Ave-Low	#Hi-Ave-Low	#Hi-Ave-Low
Calories						
Group I-91% RDA	1-19-1	18-3-0	1-14-2	0-10-1	7-1-2	1-9-1
Group II-76-90% RDA	0- 3-0	3-0-0	0- 2-1	0- 6-0	4-2-0	1-3-2
Group III-75% RDA	0- 2-0	1-1-0	0- 2-0	0-10-0	8-2-0	1-7-2
Protein						
Group I-91% RDA	1-21-1	20-2-0	1-16-2	0-18-1	13-3-2	2-14-3
Group II-76-90% RDA	0- 2-0	1-1-0	0- 1-1	0- 5-0	4-1-0	1- 3-1
Group III-75% RDA	0- 1-0	0-1-0	0- 1-0	0- 3-0	3-0-0	0- 2-1

[a]Total Protein - High = $>$ 8 mg/dl; Average = 6.1 - 8 mg/dl; Low = $<$ 6 mg/dl

[b]Albumin - High = $>$ 3.6 mg/dl; Average = 3 - 3.5 mg/dl; Low = $<$ 2.9 mg/dl

[c]BUN - High = $>$ 16 mg/dl; Average = 6.1 - 16 mg/dl; Low = $<$ 6 mg/dl

Table 11

Pearson r Correlations for Laboratory Parameters and Dietary Intake for Second and Third Trimesters

Variables	Second Trimester r=	Third Trimester r=
Caloric Intake to:		
Total Protein	.48*	-.3
Albumin	.05	-.12
BUN	.21	.18
Protein Intake to:		
Total Protein	.65**	-.31
Albumin	.06	.27
BUN	.37	.26

*Significant at the p $\geq$ .05 level

**Significant at the p $\geq$ .01 level

women at nutritional risk even in a "normal" population.

Research Question Two

What is the relationship between reported dietary intake of protein and calories and the course and outcome of pregnancy?

Course of Pregnancy. The incidence and types of complications noted during the course of pregnancy have been summarized in Table 4. When the overall incidence of complications occurrring during the course of pregnancy is compared to dietary status, it may be noted that 70% of subjects with any one or more complications had a diet that was less than 90% of the RDA at some time. Although this figure does not represent a statistically significant finding it represents a trend worth noting. The lack of statistical significance in this comparison could be due either to small sample size, or to the pre-selection of essentially healthy women as mentioned previously. The trend toward increased incidence of maternal complications in the presence of inadequate diet is significant to the practicing Certified Nurse-Midwife. Increased emphasis on optimal protein-calorie intake for a gravid woman could conceivably reverse this trend and improve the course of pregnancy.

When specific complications, such as anemia or toxemia, were compared to the individuals intake of protein or calories, no significant correlations or trends could be found. This could be due to the small sample size.

The summary of subjects with complications during the course of pregnancy and postpartum period may be found in Table 12, along

Table 12

Summary of Subjects Exhibiting Complications With Relevant Laboratory and Diet Parameters

Complications (% of Sample Population)	subj. code #	Protein/Calorie Status		Laboratory Values	
		second trimester	third trimester	second trimester	third trimester
Second Trimester Bleeding (n=1)(3.7%)	16	1-1[a]	1-1	WNL[b]	low hematocrit
Upper Respiratory Infections Antepartum (n=2) (7.4%)	9	1-1	1-2	WNL	WNL
	36	1-1	1-1	WNL	WNL
Antepartum Anemia (n=6)(22.2%)	6	1-1	1-3	WNL	WNL
	16	1-1	1-1	WNL	WNL
	22	2-1	2-3	WNL	WNL
	26	1-2	2-3	WNL	WNL
	27	1-1	1-1	WNL	WNL
	31	1-2	1-3	WNL	low BUN
Antepartum Toxemia (n=2)(7.4%)	34	1-1	2-3	low BUN	low BUN
	33	1-1	1-3	WNL	WNL
Placental Infarction & Terminal Abruption (n=5)(18.5%)	3	1-3	3-3	WNL	WNL
	8	1-1	1-1	WNL	low albumin
	13	1-1	1-1	WNL	WNL
	24	1-1	1-2	WNL	low BUN
	34	1-1	2-3	low BUN	low BUN
Episiotomy Extension/ Vaginal Lacerations (n=4)(15.4%)	5	1-1	2-2	WNL	WNL
	8	1-1	1-1	WNL	low albumin
	20	3-3	3-3	low BUN	low BUN
	30	1-1	1-2	WNL	WNL
Postpartum Anemia (n=6)(22.2%)	1	1-1	1-1	WNL	WNL
	6	1-1	1-3	WNL	WNL
	12	2-1	2-3	low BUN	WNL

Table 12 Continued

Complications (% of Sample Population)	subj. code #	Protein/Calorie Status		Laboratory Values	
		second trimester	third trimester	second trimester	third trimester
Postpartum Anemia Cont.	13	1-1	1-1	WNL	WNL
	23	1-1	1-2	WNL	WNL
	31	1-2	1-3	low BUN	WNL
Postpartum Toxemia (n=1)(3.7%)	3	1-3	3-3	WNL	WNL

[a]Protein Calorie Status Groups: 1 = greater than 91% RDA

2 = 75% to 90% of RDA

3 = less than 75% RDA

[b]WNL = Within Normal Limits

with pertinent dietary and laboratory findings.

Outcome of Pregnancy. The outcome parameters examined included: the occurrence of fetal distress, newborn weight, length, OFC, chest circumference, Ponderal Index (PI), fetal-placental weight ratio and placental weight. Deviations from the norms for these parameters along with incidence and relevant dietary and laboratory parameters are included in Table 13.

When overall dietary status was compared to the incidence of complications, no statistically significant correlations could be demonstrated. However, when individual intake of calories and protein were compared with each outcome variable, significant relationships were shown between the second trimester protein intake and the Ponderal Index and the second trimester protein intake and the fetal-placental weight ratio, ($p \geq .05$). Protein intake in the third trimester failed to correlate with any outcome variable. Similarly, reported caloric intake did not correlate with the outcome variables.

The correlations of second trimester protein intake with PI and F/P ratio suggest that the intake of protein in the second trimester can make a difference in relation to the optimal outcome. The PI and F/P ratio are not commonly utilized outcome parameters, and reflect more subtle gradations of 'good' and 'poor' outcomes. The presence of a low value for either variable is suggestive of the failure of the fetal-placental unit to achieve the maximal efficiency for best outcome. Long term follow-up studies might be of assistance in determining the effect on the infant of this subtle

Table 13

Summary of Fetal and Newborn Complications with Relevant

Diet and Laboratory Parameters

Complication (% subject population)	Subject Code Number	Protein-Calorie Status		Laboratory Values	
		Second Trimester	Third Trimester	Second Trimester	Third Trimester
Low Ponderal Index (18.5%)	1	1-1	1-1	WNL	WNL
	3	1-3	3-3	WNL	WNL
	22	2-1	2-3	WNL	WNL
	26	1-1	1-1	WNL	WNL
	27	1-1	1-1	WNL	Low BUN
Small for Gestational Age (7.4%)	13	1-1	1-1	WNL	WNL
	20	3-3	3-3	Low BUN	Low BUN
Fetal Distress (18.5%)	8	1-1	1-1	WNL	Low Albumin
	20	3-3	3-3	Low BUN	Low BUN
	26	1-2	2-3	WNL	WNL
	30	1-1	1-2	WNL	WNL
	31	1-2	1-3	Low BUN	WNL

Note. WNL = Within Normal Limits; Overall incidence of complications = 41%

deprivation in utero. None the less, demonstration of a correlation indicates again the need for continued assessment and intervention throughout the pregnancy for optimal nutritional status and outcome.

Other researchers (Burke, Beal, Kirkwood & Stewart, 1943; Naeye et al., 1973; Higgins, 1976) have reported significant correlations between intake of calories and the infant outcome. Failure of this investigation to validate previous studies in this area could be due to small sample size, and in no way de-emphasizes the importance of adequate calorie intake. This is especially true in view of the role of calories in sparing protein from use as energy by the body.

When the number of abnormal outcome findings was compared to diet, a trend toward increased number of complications was observed in the gravidas with the poor diets as was noted with complications during the course of pregnancy. For example, infant #20 had distress during labor, was small for gestational age (SGA) and had a F/P ratio more than two standard deviations above the mean. This infant's mother had dietary intakes consistently below the 75th percentile of the RDA for both protein and calories. This clustering of complications occurred both during the course of pregnancy and in the outcome of pregnancy. It is possible that there is some threshold below which the nutritional intake must drop in the individual to see this increased incidence of complications.

Research Question Three

What is the relationship between measurable laboratory parameters of protein and the course and outcome of pregnancy?

Course of Pregnancy. There was no statistically significant correlations between the overall incidence of complications and the laboratory parameters for protein. Similarly, individual analysis of each complication to the total protein, albumin, or BUN levels revealed no correlations, and no trends.

In this population laboratory parameters of protein status did not provide indication of maternal risk for complications during the course of pregnancy and labor. The lack of statistically significant relationships or trends could be in part explained by the laboratory values used.

Long term indicators of protein status, such as albumin and total protein, may often fail to reflect deficiency during a short term of intense nutritional need or stress (Arroyave, 1962). The demands of pregnancy, particularly after 20 weeks constitute a period of increased demand (Higgins, 1976; Reeder, 1976), which could lead to a deficiency state not detectable in these parameters. Although BUN does fluctuate more rapidly with the protein intake and bodily demand, its levels also vary with the rate of glomerular filtration and hemodilution, which are altered in pregnancy.

These parameters might show some trends in protein status, but could be more potent indicator of protein status if used with other indicators. Other researchers have reported success in determining protein status utilizing urinary urea nitrogen to total nitrogen and reatinine to total nitrogen ratios (Arroyave, 1962; Reddy, 1964; Zlatnick, 1979). The addition of these measures of short term fluctuations in protein status to the traditional measures might demonstrate relationship to the occurrence of complications during the course of pregnancy.

Outcome of Pregnancy. When total protein, albumin and BUN were compared with the outcome variables, several relatinships were noted. Table 14 summarizes the findings of these comparisons.

Although BUN is seldom used alone as an indicator of protein status, it may at times be a good indicator of nutritional status. In the second trimester increasing BUN levels correlated with increased F/P ratio. The predictive value of BUN is limited, however, especially since beyond a value of ten, the F/P ratio may indicate a poor outcome. Fetuses with F/P ratio of more than ten have in general outgrown the placenta and often show distress during labor and problems adjusting to extrauterine life. This parameter might therefore be less clinically useful than others discussed in this work, such as the second trimester dietary protein in relationship to the F/P ratio.

A correlation was also noted between the fetal-placental weight ratio and the occurrence of any abnormal laboratory value ($p = .05$). Seventy percent of the infants with F/P ratio more than two standard deviations from the mean had mothers with at least one abnormal laboratory parameter for protein during the pregnancy. This is in contrast with only 25% of the infants with normal F/P ratios who had any abnormal laboratory parameters.

Albumin levels in the third trimester correlated with infant weight and OFC ($p = .05$), and with placental weight ($p = .01$).

Table 14

Summary of Significant Correlations for Laboratory Parameters of Protein and Pregnancy Outcome Variables

Variable	Second Trimester r=	Third Trimester r=
BUN to:		
F/P ratio	.48*	.29
Albumin to:		
Infant weight	-.17	.43*
Placental weight	-.26	.87**
OFC	-.05	.51*
Total Protein to:		
Second day post-partum hematocrit	.22	-.51**

*Significant at the p = .05 level

** Significant at the p = .01 level

With such strong correlation between third trimester albumin and three of the principle measures of infant outcome, albumin levels in this period may be recommended to clinicians as an additional screening method for nutritional status. This parameter, though invasive, is relatively easy to obtain, and could be incorporated with other laboratory tests done in the third trimester.

Additionally, Higgins (1976) has described a phenomenon of decreased hemoglobin levels in well nourished women in the third trimester. She postulates that this is due to hemodilution; as the serum protein levels increase and vascular volume is expanded, hemodilution occurs. Thus with further study albumin levels might be of use in determining the nature of lowered hemoglobin or hematocrit in the last trimester. That is, how much of the decreased value is due to iron deficiency and how much to hemodilution -- which could be reflected in increased protein parameters.

Another finding which was unexpected might be tentatively explained by a similar phenomenon. An inverse relationship between total protein and the second day postpartum hematocrit was noted. As the protein level rose, the second day hematocrit fell ($p = .05$). It is possible that elevated protein levels delayed postpartum diuresis from the usual 24 to 36 hours resulting in prolonged hemodilution and lowered hematocrits. The authors can tender no other explanation for this unusual finding.

CHAPTER IV

SUMMARY AND RECOMMENDATIONS

Summary

A descriptive study of the nutritional status of 27 pregnant women was conducted at Hill Air Force Base Hospital. Socioeconomic survey, three day diet history and laboratory assessment of blood parameters of protein were used to determine nutritional status, and related to maternal and infant outcome variables. The purpose of the investigation was to answer the following research questions: 1) What is the relationship between reported dietary intake of protein and calories and measurable laboratory parameters of protein during pregnancy? 2) What is the relationship between reported dietary intake of protein and calories and the course and outcome of pregnancy? 3) What is the relationship between measurable laboratory parameters of protein and the course and outcome of pregnancy?

The total sample group of 27 subjects consisted of ten primiparous and 17 multiparous women. Data were collected between September 1, 1980 and May 1, 1981.

All subjects completed a questionnaire developed by the researchers to determine demographic data, socio-economic background and gynecologic/obstetric history prior to the second trimester of pregnancy. During the second and third trimesters of pregnancy, every subject completed a prospective three day record of all dietary intake followed by blood analysis for total serum protein, albumin, and blood urea nitrogen (BUN) levels. Oucome data were obtained from the subjects hospital record after delivery, and the researchers examined and weighed all placentas.

Pearson "r", Chi Square and two tailed "t" tests were used to compare data and answer the research questions.

The findings indicated a significant decrease in protein and calorie intake between the first and second trimesters ($p = .05$). The third trimester reported calorie intake was below the mean reported in the ltierature (Hytten & Lind, 1975).

The reported dietary intake of protein and calories correlated with the laboratory parameter of total protein level in the second trimester significant at the .05 level. The other laboratory parameters failed to correlate significantly with reported dietary intakes.

Correlations were found between second trimester reported protein intake and the Ponderal Index of the infant ($p = .05$). Second trimester reported protein intake also correlated with the fetal/placental weight ratio ($p = .05$). Dietary intake failed to correlate significantly with any other maternal or infant outcome parameter.

Correlations were demonstrated between several laboratory parameters of protein and outcome variables. Protein parameters were correlated with infant outcome variables more frequently than with maternal outcome variables. Second trimester blood urea nitrogen correlated with fetal/placental weight ratio ($p = .05$). Third trimester albumin levels correlated significantly with placental weight ($p = .01$), infant weight and occipital-frontal circumference ($p = .05$).

The only maternal outcome variable that correlated with any laboratory parameter was second day postpartum hematocrit to third trimester serum total protein ($p = .01$). This was an inverse correlation, as the third trimester protein increased, postpartum hematocrit decreased. This type of relationship has not been noted in the literature elsewhere.

There were no significant relationships between maternal complications in the antepartum, intrapartum, or postpartum period and any of the nutritional parameters surveyed.

Recommendations for Further Research

Several considerations regarding methodology and the results should be noted before further investigations of this topic are undertaken. A random selection of pregnant women from a broader range of socioeconomic backgrounds would provide results more applicable to the general population. Ideally, future researchers could include in this random sample those women at nutritional risk secondary to chronic illness or use of alcohol or tobacco. The use of a convenience sample of low risk women in this investigation simplified the analysis of findings, but more complex interrelationships may have escaped notice.

A larger sample may have increased the number of statistically significant findings where only trends became evident in this investigation. Although random selection of a larger sample would involve a larger time and monetary commitment, results from such an investigation would be more generalizable and decrease potential sampling error biases.

This investigation was conducted in the months between September and May, therefore, questions concerning possible seasonal variations in diet were not addressed. Also, while significant difference in dietary intake was noted in this investigation between the second and third trimesters for protein and calories, possible variations in intakes between the preconceptional and first trimester, between first and second trimesters, and between the third trimester and the postpartum period were not examined. If there are variations evident between these segments of the child bearing year, further investigation should be undertaken to determine cause, including extensive questioning of the subjects themselves. Following a larger number of women over a longer period of time might reveal these interrelationships and provide useful information to direct nutritional counseling by care providers.

A standardized set of parameters for evaluation of nutritional status should be used to supply care providers with normative data for a given geographic area. Refinement of the questionnaire, to gather more information and to make data retrieval easier, would yield a more useful instrument. The use of the urinary urea nitrogen to total nitrogen ratio (UN/TN) has proven useful for determining short term protein status in pregnant women (Beydoun, Cuenca, Evans, & Aubry, 1972; Zlatnick, 1979). This investigation suggests that a refined basic questionnaire, a three day diet history in each trimester, total serum protein, serum albumin and UN/TN ratio in the second and third trimesters can be used effectively to determine protein nutritional status. This information of a larger sample would be useful in compiling normative data and in the planning of individual nutritional counseling and intervention to improve pregnancy outcome.

The methodological approach described in this investigation could be contrasted with other methods of nutritional assessment. Based on the individual nutritional status determinations a variety of interventions could be tested and outcome variables compared. More research in establishing the relationship between nutrition and the course and outcome of pregnancy is necessary so that the development of assessment instruments with predictive value can proceed.

The effects of a variety of care providers at all levels, with a wide range of attitudes toward nutritional counseling was not examined in this investigation and warrants further research.

An unexpected finding of this investigation that requires further research was the inverse relationship between second day postpartum hematocrit and third trimester protein levels. Also, the relatively high percentage of subjects with serum albumin levels in the high range needs further explanation.

In summary, the area of nutrition during pregnancy has abundant possibilities for research. Due to the complexity of the nutritional status of an individual and the difficulties in assessment, clinical research in this area is challenging but extremely necessary. Research directed toward developing accurate methods of assessment, individualized intervention for optimal diet and improved outcome of pregnancy for both the mother and the infant, could have a significant positive impact on the entire population.

Recommendations for Nursing and Nurse-Midwifery

The following recommendations for Nursing and Nurse-Midwifery are based on the findings in this investigation.

1. Emphasis on nutritional assessment and counseling during pregnancy by nurse-midwives and other health care providers is a necessary part of care of the pregnant woman in order to achieve optimal outcome. It is advised that care providers become familiar with a number of assessment modalities (diet history, physical assessment, laboratory parameters) in order to use the method or combination of methods best suited to the client's needs.

2. The use of a variety of parameters in defining outcome could provide increased information to the care provider about the relative success of intervention. The fetal/placental weight ratio and the Rhorer Ponderal Index have been shown to provide more subtle distinctions in terms of the achievement of optimal outcome. These are readily available to the care provider and are not invasive. The examination and use of information provided by the placenta should not be minimized.

3. Careful record keeping, including the diet history recommendations, type and time of nutritonal counseling, and the maternal and infant outcome parameters could provide a clinical nurse-midwife with a more accurate picture of that population and the effectiveness of the intervention employed. Secondly, there is a need for consistency in obtaining data for establishing norms. There is a need for local normative data on populations that are stable but have some distinguishing characteristics, such as altitude, ethnic or socio-economic status. This information should be shared locally and nationally at regular intervals.

4. This investigation revealed that there is a need for repeated assessment of nutritional status at different intervals throughout pregnancy. Nutritional status is dynamic in nature. If nutritional assessment had been concentrated early in pregnancy, the decreased intake observed in the third trimester would have gone unnoticed. The third trimester represents a period of maximal brain growth in the fetus and deficits such as those noted in the diets surveyed in this investigation have the potential for adversely effecting newborn outcome.

5. This investigation also illustrated a high incidence of dietary intakes below the RDA among multiparous women. This should alert care providers to the special needs of this group who are often at additional risk due to decreased physiologic reserves from previous pregnancies. Special effort and attention should be directed toward assessment of the multiparous woman to the provision of sensitive counseling.

6. Assessment by diet history and laboratory parameters is indicated for women in the apparently "low risk" category. This investigation demonstrated a significant portion of apparently low risk gravidas with dietary intakes below the RDA's for both protein and calories. This situation, where apparent, should be noted and measures taken to correct the deficits.

7. Serum albumin levels in the third trimester provide an adjunct in assessment of nutritional status with predictive value since low albumin levels correlated with poorer infant outcome. This test should be included in the screening of all pregnant women and could be timed with routine hematocrits to spare the client additional venapunctures.

APPENDIX A

Nutrition Study

Informational Questionnaire

ID#________ Today's Date__________

Please complete the following information to the best of your ability, being sure to answer all the questions.

age_____ race_____ religious preference__________________________

marital status: married single separated divorced

widowed

the baby's father: age_____ race_____ height_____ weight_____

Number of persons in your household (including yourself)__________
Monthly income for your household________________________________
Average amount spent on groceries each month______________________
Who does the shopping for the household?___________________________
Who does the cooking for the household?___________________________
Do you receive food stamps?______________ Value____________________
Do you belong to the WIC program? (Women, infants, and Children Supplemental Foods)
____
Alcohol you consume per day, number of drinks per day____________
Did you smoke cigarettes in the past?_____ Number of packs/day____
Number of years you smoked_____ How long since you quit _____
Do you have any food allergies?_____ If yes, what foods?__________
____

Please check any of the following foods that you do NOT eat.

red meats___________________ cheese___________________________
poultry (chicken)___________ citrus fruits (oranges, grapefruit. . .)________________
fish________________________ green vegetables_________________
milk________________________ beans____________________________
eggs________________________
grain products (bread, cereal, rice)__________________________

How old were you when you first started your periods?___________
Have you ever used birth control pills______How long?____________
When quit?_________
Have you ever used an IUD (coil, loop, intrauterine contraceptive device) for contraception?____________ How many years?________
Current pregnancy: weight one month before you became pregnant _________ lbs. height__________ last menstrual period________
date of + pregnancy test________
Have you ever been told you were anemic, had "low blood"?_________
If yes, what was done for it?_________________________________

Do you take any medication or pills now?_____ If yes, please list
____
____
____

Have you had any nausea or vomiting with this pregnancy?________
____

If yes, when did it start?________________
When during the day were you sick?_______________
Do you vomit?_______________ How often?___________________
Have you lost weight?____________ How much?________________
Do you still have nausea and vomiting now?_________________
Are you eating anything special, or at special times to relieve these symptoms?_________________________________
____

What else have you done to relieve the nausea?_____________
____

Past Pregnancies

DATE	TOTAL AMOUNT WEIGHT GAINED	LENGTH OF PREGNANCY	LENGTH OF LABOR	PROBLEMS WITH THE PREGNANCY (bleeding, infection, toxemia/ high blood pressure)	BABY'S WEIGHT and PROBLEMS WITH THE BABY (trouble breathing, sick baby, birth defects)
#1					
#2					
#3					
#4					
#5					

APPENDIX B

Explanation of Three Day Diet History Form

Dear____________________________,

Enclosed is form for you to record the food you eat in the next three days before your next clinic visit, as a part of the nutrition study in which you agreed to participate.

Starting three days before your next clinic visit record the date on the top of the blank diet history form. Then write down everything you eat at all times of the day. Do this for the next three days.

You should write the type of food in the first column, a description of the food in the second column, in the third column, estimate the amount of food in cups or teaspoons. See the sample diet history form for an illustration of what you might eat and how to record these items.

Be sure to record all that you eat including snacks and beverages. Use a measuring cup to measure foods as necessary or estimate as best you can if one is not available. It is important that we know exactly what you eat. Record anything and everything as honestly as possible. If you have a question about how to record an item, write it on the sheet as completely as possible and we will review it with you at a later time.

Diet History Form

Date____________
ID#____________
Date of Last
paycheck________

Meal	Food	Description	Amount
Breakfast			
Snack			
Lunch			
Snack			
Dinner			
Snack			

APPENDIX C

Data Collection Sheet   ID #___________

#1 Date__________	#2 Date__________	Current Preg. Info.	Outcome
Wks gest.______	Wks gest.______	Totl. wt. gain______	date/time of birth
t. prot.______	t. prot.______	3rd tri. bleeding______	______
albumin______	albumin______	diag. previa______	length______cms
BUN______	BUN______	diag. abruptio______	weight______gms
Hct.______	Hct.______	Toxemia (PIG) AP IP PP	OFC
Urine	Urine	BP 140/90______	chest circum______
T. Nitrogen______	T. Nitrogen______	UA prot.______	placental wt______
Ketones______	Ketones______	NDedema______	Apgar--1___5______
Sugar______	Sugar______	Anemia (Hct 35mg%)______	gest age______
		UTI______	LGA__AGA__SGA__
		Infection______	Cong. defects______
Diet history	Diet history	Delivery type______	______
Prot.______	Prot.______	epis.______	______
Calories______	Calories______	induced______	RDS______
		augmented --______	Bili______
		LENGTH______TOTAL	lights______
		1ST____2nd____3rd____	bld gluc.______
		complications______	bld calcium______
		______	IP Factors
		______	Nucal cord______
		______	______
		EBL______	Prolapse______
		Analg/Anesth______	Fetal distress
			______

APPENDIX D

Table 15

Nutrient Requirements - Recommended

Daily Allowances

Nutrient	Male	Female	Pregnancy	Lactation
Calories	2,700	2,000	+300 2,300	+500 2,500
Protein	56 gms	46 gms	+30 76 gms	+20 66 gms
Calcium	800 mg	800 mg	1,200 mg	1,200 mg
Iron	10 mg	18 mg	18+ mg	18 mg
Vitamin C	45 mg	45 mg	60 mg	80 mg

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