Protein nutrition of expectant mothers in American Samoa and its effect on the health of the infant
by Kathleen Graney Baron

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE in Home Economics
Montana State University


Abstract:
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Signature Kathleen M Bacon

Date Dec. 30, 1970

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

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Approved:

Marjorie Kaiser
Head, Major Department

Andrea L. Pogenkopf
Chairman, Examining Committee

K Goering
Graduate Dean

MONTANA STATE UNIVERSITY
Bozeman, Montana

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## ABSTRACT

The purpose of the study was to investigate the status of protein nutrition of expectant mothers in American Samoa and the possible effect of this status on the health of the infant. The mother's diet before and during pregnancy is most important to her adjustment during pregnancy and the infant's growth and development. The sample included sixty mothers that delivered and the new born babies at the LBJ Tropical Medical Center, Pago Pago, American Samoa. Multiple regression and correlation were the statistical methods employed in the research. It appears two of the criteria, weight of the baby at birth and chest circumference, might be predicted from the measured predictor variables but that more research is needed to make its use practical. It is possible for both mother and infant to obtain an adequate diet.

# CHAPTER I

# INTRODUCTION

## Importance of Protein Nutrition

The problem of total food intake is of great importance in its relationship to good health but that of food quality is even more important. All of the specific components of the various tissues of the body must be provided. Protein is of major importance since it composes the greatest proportion of the body tissue, except for water, and is an indispensable constituent of every living cell (1). For the purpose of this study, it shall be the only one discussed.

It is estimated that approximately two-thirds of the world's population is suffering from some degree of malnutrition (2). At the heart of the malnutrition problem is the serious lack of protein. Protein deficiency in young children is the major nutritional problem of the world. In some population groups, the protein deficiency is further accentuated by a lack of calories and, thus, part of the protein is used for energy.

## Protein Sources

The main source of protein in the United States is food from animal origin (3). Foods from animal proteins are complete proteins, that is, they contain all the essential amino acids. Many countries have

extreme limitations on the quantity and quality of high protein foods. Developing countries use plants as their chief source of protein (4). Plant protein, unless used in combination with other plants, is not a complete protein because no one plant contains all the essential amino acids in proper proportion.

Production of foods high in animal protein is greatly limited in developing countries; transportation, storage facilities are inadequate, purchasing power is low and prejudice against certain foods all add to the problem (5).

Many suggestions have been made as to a solution to the protein malnutrition problem. The Protein Advisory Group from the FAO, WHO, and UNICEF suggest that the highest priority be given to development of local agricultural resources (6). All protein sources must be utilized. While these measures represent an important contribution toward prevention of protein malnutrition, developments in other fields are potentially useful in improving protein nutrition. One of the major new developments is the upgrading of the nutritive value of cereal proteins by genetically changing the amino acid pattern. Fortification of cereals with synthetic amino acids is another possibility.

One answer to the problem would be a protein-rich food mixture for supplementary feeding which would be accepted by the people of developing nations. Grain, legumes, groundnuts, cottonseed, soybeans and fish protein concentrates are used as a supplementary

feeding. Currently sesame, sunflower, and coconut are being studied as possible sources of protein for human use (7).

## Purpose of Study

This study was undertaken to investigate the status of protein nutrition of expectant mothers in American Samoa and the possible effect of this status on the health of the infant. Since the last study was completed in 1954 and many changes have taken place since then, the physicians felt some current research should be done.

## Hypotheses

1. Is the baby's birth weight predictable from selected physical measurements and dietary habits of the mother?
2. Is the baby's birth length predictable from selected physical measurements and dietary habits of the mother?
3. Is the baby's head circumference predictable from selected physical measurements and dietary habits of the mother?
4. Is the baby's chest circumference predictable from selected physical measurements and dietary habits of the mother?
5. Is the average weight gain per day of the baby predictable from selected physical measurements and dietary habits of the mother?
6. Is the baby's hemoglobin predictable from selected physical measurements and dietary habits of the mother?
7. Is the expectant mother's diet adequate in protein?

# CHAPTER II

# REVIEW OF LITERATURE

## Functions of Protein in Human Nutrition

Protein is essential in the growth and replacement of tissue. When growth occurs, the protein requirement is necessarily large, thus, in the case of the fetus, infant, child, and nursing mother, the increase of tissue and the secretion of milk makes great demands (8). All living cells undergo constant changes throughout their life span and are constantly in need of renewal.

Metabolism of protein includes the existence of protein pools in the liver and other body tissue. This permits rapid and continuous interchange of nitrogenous compounds between cells and the surrounding fluid. These pools insure a balance between the nitrogenous products of synthesis and breakdown (9).

When more protein is eaten than is needed for repair processes, the excess may function as a source of energy or be stored in the body. This stored protein is used during times of fasting and when the intake of fat and carbohydrate is low. When protein is used to meet energy requirements, the quantity available for growth and repair is reduced (10).

Protein is important as a regulator of osmotic pressure and of water balance within the body. It aids in maintaining one of the body's

important constants, the hydrogen ion concentration, very close to that of water. Proteins are amphoteric substances which combine with acid or base and serve as buffers when an excess of either an acid or base compound is present (11).

Many body hormones are protein in nature. The tropic hormone from the pituitary gland, thyroxin, adrenaline, insulin, and the digestive enzymes, to name a few, are all nitrogenous in nature (12).

Other dietary factors are involved in protein metabolism. Minerals and vitamins are an important part of protein synthesis. Since the average day's diet may not always be favorable for optimal utilization, the advantage of a fifty percent safety factor over the minimal need is evident (10).

## Nutrition of Expectant Mothers and Infants

Pregnancy and childbirth link the present generation to future ones. Factors that affect reproduction affect the family as well as the mother. Every mother has the right to both a high quality and a high standard of health care. This includes a food intake that will prepare her for and carry her through pregnancy, childbirth, and permit the infant to flourish (13).

Relationship of the newborn infant to the mother is very important. The infant has depended completely upon the mother during the prenatal period, nine months. Many theories offer an explanation for

the well-being of an infant from a poorly nourished mother. One theory is that the mother is endowed with a special ability to produce a healthy offspring regardless of her health or nutritional status. Another is a pregnant woman will, from instinct, act to meet the health of herself and her infant. Many studies have shown these theories to be false (14).

## Status of Mother

The nutritional status prior to becoming pregnant is most important. The body should be functioning properly in order for it to make the necessary adjustments to the added burden of the developing fetus.

Experiments indicate that maternal nutrition is important to both mother and child. Knowledge about nutrition and its involvement in the cause and prevention of disease is expanding rapidly. The number of stillbirths and infant deaths have increased in the United States, which may or may not be related to nutrition (14).

Well-nourished mothers enjoy better health, fewer complications, and are better risks during pregnancy. Incidence of miscarriages, stillbirths, abortions, and premature births increases in women consuming an inadequate diet (15). The nutrition of the mother during the prenatal period influences to a considerable degree the entire course of pregnancy and directly affects the health of the child during the first

six months of life (16). More infant illnesses and increased deaths occur up to that time.

Many changes take place in the woman's body during reproduction. Growth and development of the tissues which are concerned with maternal and infant well-being take place. A critical period is the first two weeks after conception until the eighth week during which time major organogenesis occurs (17).

Weight gain reflects the overall physiologic consequences of pregnancy. Weight gain varies greatly with the individual. Young women, given the same diet, tend to gain more than older women (18). In the United States the total average weight gain is 24 pounds. In the developing nations such as India and Africa the average weight gain is 12 to 14 pounds (19).

The nutrient requirements for pregnancy are increased above that for the nonpregnant woman. The caoloric increase is about 200 calories per day. It is important that a portion of these calories be taken in the form of protein. Protein is necessary for the growth and development of the fetus and the changes that take place in the mother's body. The protein requirement increases from 55 grams to 65 grams per day (20).

Superstition, gossip, fads, and taboos surround pregnancy. These sometimes encourage the consumption of a poor diet. A mother on a poor diet has a low total weight gain. Other complications such as toxemia, poor appetite, disturbances in digestion, nausea, and

vomiting during the nine-month period occur as well. At childbirth, complications tend to be more frequent and the incidence of miscarriage, abortion and stillbirth is higher in the malnourished mother (21,22,23).

During lactation the mother requires additional amounts of nutrients to replace those lost in milk and in the energy used for its production. The protein requirement is increased by 20 grams per day above the recommended amount for the average woman, from 55 grams to 75 grams per day. In severely malnourished mothers, lactation may continue for a considerable period with only slight deterioration of the quality and quantity of milk (19).

## Status of Infant

There is a close association between the nutritional status of the mother during pregnancy and lactation with the health during the first years of the child's life. The first month after birth adjustments in homeostasis are being made rapidly and at different rates in all infants. These adjustments are especially concerned with digestion, excretion and secretion of hormones. Nutritional status is affected by these things because if these adjustments are not made correctly body functions are hampered (24).

The growth rate during infancy is rapid necessitating high energy intakes. The full term infant has the ability to digest and absorb a

moderate amount of fats, simple carbohydrates, vitamins, and minerals. His renal system functions well but he needs more water relative to his size than does an adult (25).

Protein is important in the infant's diet. The infant has some nutritional stores from gestation, especially iron, so other mineral and vitamin supplements are required. Some minerals and vitamins are used rapidly and not stored in the body, thus a daily supplement is needed (26).

Breastfeeding is considered the best source of food for the infant (27). In addition to its nutritional value, there seems to be a psychosocial development between mother and child related to breastfeeding. In the United States only a small number of mothers breastfeed. The highly educated and the low economic, poorly educated are the groups that breastfeed. A social stigma seems to prevail among the middle class.

In the developing nations, the majority of infants are breastfed. Authorities feel this is fortunate because fewer nutritional deficiencies are seen during the time the infant is breastfed. Many infants are breastfed until two years of age or until another child is born, whichever comes first. The weaning period is the time when protein, caloric, and other nutritional deficiences develop and cause severe problems (28).

When a change in the behavior of the oral musculature occurs, usually around three months, solid food should be introduced. The biting and chewing reflex begins between seven and nine months. At this time, foods that require chewing should be introduced (29).

Kwashiorkor and Marasmus

Frank protein deficiency is known as kwashiorkor wherein calories may be sufficient but protein is lacking. The syndrome of kwashiorkor comprises retardation of growth and development, edema, muscular wasting, depigmentation of the hair and skin, scaly changes in skin texture, hypo-albuminemia, reversible fatty infiltration of the liver, reduction of enzyme activity of the duodenal juice, diarrhea, and moderate anemia (30).

Kwashiorkor develops after six months and commonly between one to four years of age. The breastmilk production is usually declining and is insufficient for the growing child's protein needs. It is most common in places where starchy foods are the main staple, inadequately supplemented by protein-rich foods of animal or vegetable origin (31).

In marasmus, both calories and protein are deficient (32). Marasmus can develop in the first few months of life and will result if the mother's milk supply is insufficient and little or no other food is given. Although less dramatic, it is often more serious clinically with less fatty change but gross depletion of liver substance (33).

## Mental Development

The relationship of protein intake and mental development is under much investigation (34,35,36,37). It appears that infants suffering from malnutrition have decreased mental ability. At least a portion of the mental apathy can be upgraded with a nutritious diet and is reversible (38). During the first two years of life, the brain is increasing in size, thus it is reasonable that an adequate protein intake is necessary for growth and development.

Prenatal nutrition is important, too, as the brain is developing with the rest of the fetus. The peak growth of the brain occurs very close to time of birth (39).

## Methods of Determining Protein Deficiency of Infants

### Anthropometrical

Anthropometry, human measurement, is used in determining nutritional status. It provides the operational measurement of longterm nutritional status, giving two limiting assumptions, first for children, second adults (40). For individuals who are still growing, the assumption is that larger ones are better nourished. For those who have already finished their fat-free growth, the assumption is that the degree of fatness meters the cumulative caloric surplus.

Weight is the anthropometric measurement most used. In developing countries, the prevalence of protein-calorie deficiency appears to

be best indicated by underweightedness (41). Weight indicates gross body size and a rough approximation of body volume (42).

Length for age is a valuable measurement. The length of the infant is affected directly by the body stature of the parents. Length measurements are concerned with total body length (43).

Head and chest circumference indicate body build and developmental status. The extent of development is determined by soft tissue, fat, and muscle (44). This appears to be the most direct way of measuring frame size objectively, reliably, and without an excess of interfering soft tissue.

The most often used standard for comparison of weight, length, head and chest circumference is that of the Children's Medical Center in Boston. The percentile position of any measurement at a given age can be determined from this anthropometric chart (45).

Many skinfold measurements are done to determine nutritional status on older children and adults. These, however, are not used on newborn infants (46).

Growth specialists observe that the best measure of short-term nutritional status is not how big the child is but how fast he is growing. It is better to compare measurements with previous measurements of the same infant over a period of time than to compare with a cross-sectional norm established at a given age (40).

Clinical

The best clinical method of determining protein status is a blood test used to determine the concentration of total serum albumin. Concentration of albumin less than 3.5 grams per 100 milliliter suggests poor protein status (47).

## Protein Nutrition of Samoan Mothers and Infants

### Typical Diet and Eating Pattern

Food plays an important role in Samoan customs and traditions, It is a tribute of respect, payment, hospitality, and festivity. While customs are much stronger in the rural areas, they are still practiced to some extent in all areas.

The Samoan eating pattern favors a very light breakfast of whatever food is available, or nothing at all, for the morning meal. The largest meal comes at midday when it is too hot to work. Large amounts of starchy foods are consumed. The chiefs and adults eat first, then the children are fed. There is usually sufficient staple foods, fruits and coconut to satisfy all, but protein foods are less abundant. The infants and children may not receive a share of these protein foods when the quantity is small. A short period of resting and socializing follows the noon meal before work is resumed. The last meal of the day is eaten at dusk. The food is limited in variety and is

prepared in the umu or underground oven. Taro, fish, chicken, breadfruit, green banana, sweet potato, taro leaves and coconut are the usual foods. Taro is a traditional food of Samoa. It is similar to a potato but contains more starch. Taro is prepared in many ways and is used at almost every meal. Breadfruit is similar to an acorn squash in taste and texture. It grows on a tree and is prepared by boiling or baking. Pig may be added to this for ceremonies. Fruits are eaten as snacks, right from the trees, but rarely served at mealtime (48).

## Factors Influencing Protein Intake

### Cultural Influences

Babies are usually born in the hospital. Most are breastfed on demand. The mother's milk is tested by passing a spoonful of milk over a flame. If the milk curdles, it is unfit for the child. In this case, there is no good substitute available in many families and often the child gets only water. At the age of 10 to 14 months a breastfed child is weaned and given solid foods. Papaya soup, green coconut soup, masticated taro, banana, breadfruit, rice, or oatmeal are introduced at about five months of age.

There are some foods which are taboo during pregnancy. It is thought that octopus causes rash and shell fish causes intestinal difficulties. Expectant mothers must never eat alone. Parental misbehavior is believed to be the cause of abnormalities in the newborn

infant. If an expectant mother sneaks a bite of pig, when alone, superstition says her infant will resemble a pig (51).

Investigators in the United States find superstitions about food are found among pregnant women there. Superstitions seem to be associated with protein and protein rich foods. Pork, cheese, fish, eggs, and milk seem to be the main foods connected with taboos. In many cases, these foods and others were disliked as well as being connected with superstitions. Poor nutrition is due to ignorance and dislikes but superstitions played a significant role and should not be overlooked when dealing with people (52).

Value System

The Samoan is a group-oriented person. He strives for achievement for his group. Individual thinking is not developed or encouraged. A Samoan is such an amiable and accommodating individual that he will often give in reply the answer he knows one would like to hear. The matai, or chief, does all the planning and decision making for his people. The Samoan is a follower.

The Samoan in his natural surroundings is an industrious man. His day starts before dawn, as he likes to tend to his chores before the sun's heat becomes too intense. Women do lighter tasks of cleaning, cooking, and cultivating around the village. Children are assigned the duties of cleaning village grounds, gathering firewood, and

caring for infants. Infants are never left alone. Older siblings have the responsibility of full care while the mother is away from home.

If cooking is done in the oven, it is usually done by the untitled men. Cooking over charcoal is done by the women. Most traditional infant dishes are prepared by boiling (53).

The ruling class, or alii, is at the top with the matai directing the people. The matai is elected by the aiga, or family group, for his memory, cunning, physique, intelligence, and ability to talk. As the matai assumes his position, he takes the name belonging to that position. He makes all decisions for his aiga relating to food, travel and trouble. If a family member wants something, a full verbal explanation and justification must be given. The final decision is made by the matai who is supported by his people as in the feudal systems of Europe.

American values of ownership, purchasing, possession, financing, or obligation mean nothing to the Samoan. Needs which an individual is unable to fill alone are satisfied by asking the assistance of relatives. These requests, or "fa'a lava lava," are rarely denied (54).

Westernization

American Samoa is a group of seven islands located in the South Central Pacific Ocean between $13^{o}30'$ and $14^{o}32'$ South Latitude and $168^{o}08'$ and $172^{o}50'$ West Longitude. The territory covers an area of

76 square miles with a population of approximately 26,000 Polynesians. It is the halfway mark between Hawaii and New Zealand. The Islands are of volcanic origin, surrounded by coral reefs. They are heavily forested, but the soil is thin and rocky so cultivation is limited to coastal areas and adjacent slopes. The climate is mild with an average temperature of 78.4 degrees (55).

By treaty in 1878, the United States confirmed the right to build a naval station at Pago Pago, Samoa. The United States was especially interested in Pago Pago because of its fine harbor. In 1899, the United States obtained what is now known as American Samoa (49).

In 1951, Samoa was made an unincorporated territory and turned over to the Department of the Interior. The President of the United States appoints a governor for the Islands with the consent of the Samoan Legislature consisting of a Council of Chiefs and a House of Representatives elected by the people (50).

Western influence can be seen in what the Samoan buys in addition to native foods. Tinned corn beef, a soup made from it known as "pea soupo", canned fish, rice, flour, bread, biscuits, coffee, sugar, candy, and carbonated beverages are purchased in large quantities. Foods such as cheese, butter, canned soup, and spaghetti items are occasionally purchased. Milk is bought in small quantities. Most of these food items are imported and are very expensive.

Meat is a scarce commodity on the Island. Most meat is imported from New Zealand (56). Poultry and pig are used for festivals. Fish is used often as the Samoan is a good fisherman. Milk, eggs, and cheese are not traditional foods but are imported from the United States and New Zealand.

There is an abundant supply of food in Samoa. Westernization has influenced the food habits of the Samoan and will continue to do so in the future.

## Nutritional Status of Infants in Samoa

Sheila Malcolm, dietitian and nutritionist, conducted a study on diet and nutrition in Samoa in 1954, under the sponsorship of the South Pacific Commission (57). The aim of this research was to investigate the diet and nutrition of Samoan children during the first two and one-half years of their life. Growth and development, feeding habits, foods available, food customs, and food preparation were reported.

The data showed that the growth and development of children from birth to the age of two years is, on the whole, satisfactory. Up to the age of nine months, the condition of the healthy Samoan child compares favorably with that of the European child. During the weaning period, the child's condition seems to depend largely on the nature of the care given by the mother.

Food supplements are usually introduced into the child's diet at a convenient time. Although Samoans have a number of good food recipes for the preparation of children's foods, the food is seldom in a suitable form.

Although a certain number of children suffer from evident malnutrition, it appears possible to obtain an adequate diet for children in American Samoa. Adequate foods are available or can be easily obtained but their use is not always satisfactory. From the data of the study, it was concluded that more education is needed and importance should be placed on diet and nutrition.

# CHAPTER III

# PROCEDURE

## Sample

The sample was to be all Samoan mothers who delivered and their new born infants at the LBJ Tropical Medical Center, Pago Pago, American Samoa, between July 27 and September 7, 1970.

## Survey Instrument

A questionnaire (Appendix A) was developed with the assistance of a nutritionist, a statistician, and a physician. It was used to structure an interview with each mother. Information to be obtained would thus be consistent because more than one person would be doing the interview. It was designed to determine approximate food intake, eating patterns, feeding habits, food customs, and food preparation. Food intake was determined by doing a modified food recall on the mother. The mother was asked the number of meals she usually ate per day to establish an eating pattern. Food habits and customs were generally determined by asking food likes and dislikes in general conversation. Methods of preparation were established by asking each mother how food was usually served. The hospital charts were used to gather information that was important to the study but would not be available through the interview with the mother.

## Procedure on Collection of Data

It was necessary to use an interpreter in the interview because many Samoans do not speak or understand English. Several women were available as interpreters: a Public Health Nurse, a student nurse, and a Samoan woman in her forties who had a family and was respected in the community. The most successful interviewer proved to be the Samoan woman. Each interpreter was instructed as to the purpose of the study and how to use the questionnaire for interviews.

### Mother

The mothers were visited the second day after delivery, usually during the morning. Charts were read before the interview in order to know some of the background of the mother. Weight, height, hemoglobin, and sketchy family information also was recorded from the charts. Mothers were asked about their diet, nursing the baby, and the diet they intended to feed the baby.

When the baby was brought back to the clinic from two to four weeks after dismissal from the hospital, the mother was again consulted about her diet.

### Infant

The infants were seen within 24 hours after delivery. Records were made of physical features.

Weight — was weighed on an infant scale without clothing.

Length — was measured with infant lying on a firm surface parallel to the rule. Care was taken so the knees were straight and the head was up.

Head Circumference — was measured with infant lying on his back. The tape was placed over the lower forehead and around the back over the most prominent part of the back of the head.

Chest Circumference — was taken at the nipple line where the chest was largest.

Maximum circumference was obtained with these two measurements (40).

The baby was returned to the Well Child Clinic from two to four weeks after being released from the hospital. The weight of the infant was recorded again. The baby's diet and eating habits were discussed. A blood sample was taken from the baby by a heel prick for determination of hemoglobin by the Wong Method and hematocrit by the centrifuge method in the hospital laboratory (58). Hemoglobin was determined because physicians use this test to determine if the baby is healthy.

## Treatment of Data

The statistical techniques used to analyze the data were multiple regression and correlation. Multiple regression is used to

examine the relationship between a dependent variable, the criterion, and two or more independent variables, the predictors. Correlation is concerned with describing the degree of relation between variables.

# CHAPTER IV

# RESULTS AND DISCUSSION

## Characteristics of Sample

### Infants

There were 28 females and 32 males born to sixty mothers at the hospital during the six-week period. The weight for infants ranged from 92.00 ounces to 166.00 ounces for the females and from 80.00 ounces to 175.00 ounces for the males. The mean weight for the group was 122.97 ounces. The average weight gain per day was 1.08 ounces. Length for females ranged from 19.00 to 22.00 inches and from 18.00 to 22.00 inches for the males with a combined mean of 19.84 inches. Head circumference ranged from 12.00 to 16.00 inches for males and females. The mean was 14.16 inches. Chest circumference ranged from 12.00 to 17.00 inches and the mean was 14.00 inches (Table 1).

The heaviest baby was also the longest with the largest head and chest circumference. The same was true of the lightest; it was the shortest with the smallest head and chest circumference. The heaviest mothers had the heaviest babies but the reverse was not true.

Out of sixty babies, 36 (60%) were breastfed. This was interesting as it was suspected that breastfeeding was decreasing in Samoa (59).

TABLE 1

CHARACTERISTICS OF INFANTS

| Characteristic | Measurements | No. of Babies in Which Observed |
|---|---|---|
| Weight | less than 6 pounds | 5 |
| | 6-8 pounds | 30 |
| | 8-10 pounds | 23 |
| | more than 10 pounds | 2 |
| Length | less than 19 inches | 4 |
| | 19-20 inches | 19 |
| | 20-21 inches | 24 |
| | more than 21 inches | 13 |
| Head Circumference | less than 14 inches | 16 |
| | 14-15 inches | 36 |
| | more than 15 inches | 8 |
| Chest Circumference | less than 14 inches | 19 |
| | 14-15 inches | 30 |
| | more than 15 inches | 11 |
| Hemoglobin | less than 12 | 11 |
| | 12-16 | 15 |
| | 16-18 | 33 |
| | more than 18 | 1 |

No other statistics are available for Samoan newborns so no comparisons were made.

## Mothers

Mothers ranged in age from 17.00 to 42.00 years of age with the mean age 26.58 years. The weight of the mothers ranged from 118.00 to 247.00 pounds with a mean of 170.55 pounds. Hemoglobin ranged from 9 to 14. Only 11 (18%) of the mothers worked.

## Nutritional Status

All expectant mothers are routinely given a vitamin mineral supplement at the time of their first clinic visit. Of the sixty mothers interviewed, 27 (45%) said they did not take the vitamins even though they had been prescribed by the doctor. All mothers felt they had a good appetite and that their diet was adequate. Twenty-six (43%) did not eat three meals per day. The meal most frequently missed was breakfast. Forty-nine (82%) did not drink milk (Table 2). The mothers all ate at least three servings per day of a vegetable, fruit or juice and at least four servings of bread or cereal. All mothers ate their native foods of taro and breadfruit daily. All mothers ate meat, fish, chicken, or eggs at least twice a week. There were only five (8%) mothers who did not drink soda. The mean intake of ounces of soda per day was 9.6. This is likely a result of Westernization. The foods disliked most frequently were cheese, milk, and eggs.

TABLE 2

FOODS EATEN BY THE MOTHER

| Foods | Yes | No | % Yes |
|---|---|---|---|
| Milk | 11 | 49 | 18 |
| Fruits and juice | 60 | 0 | 100 |
| Vegetables | 60 | 0 | 100 |
| Cereals, Bread | 60 | 0 | 100 |
| Meat, Chicken, Fish | 60 | 0 | 100 |
| Soda Pop | 55 | 5 | 92 |

There were 25 (42%) mothers that did not have an adequate protein intake. Adequacy of the mothers' diet was determined by her intake from each of the basic four food groups. This was because the mother did not drink milk and only had two small servings of meat, fish, or chicken a week. In this group of 25 mothers, 6 were working, 13 nursed their babies, and 13 did not take the vitamins. There were only four babies from this group of mothers that could be considered not healthy. One baby was admitted to the hospital with diagnosis as failure to thrive. After many tests sepsis, blood poisoning, was diagnosed. Another baby did not gain weight from time of birth until the two week checkup. Three babies had a hemoglobin of 9 and were given an iron injection.

Hemoglobin was not routinely done on the newborns. For this study, hemoglobin was done on all newborns participating in the study at the insistance of the investigator. Since three low hemoglobins were detected, the pediatrician decided that hemoglobins should be routine on all follow-up examinations for newborns. The blood was obtained by a heel prick.

Information about the family and number of pregnancies was sketchy and hard to obtain. The weight gain during pregnancy is a cultural thing. The Samoan believes that the more the mother gains, the healthier and heavier the baby will be. The obstetrician gave up trying to fight culture.

## Regression Analyses

Multiple regression was the technique employed in the analysis of these data. Multiple regression was used to examine the relationship between the dependent variable, the criterion, and two or more independent variables, the predictors.

For example: Let us assume we are interested in predicting the weight of an unborn baby from the knowledge of the mother's age, mother's weight, number of pregnancies, and diet. In this case, the baby's weight is the criterion and the mother's age, weight, number of pregnancies, and diet are the predictors. The measures of the criterion and the predictors must be made on the individuals in the sample.

The regression equation will take the form of

$y' = b_1x_1 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots + b_4x_4 + k$

where y' = the criterion.

$b_1$-$b_4$ = Appropriate weights assigned to each of the predictors. These weights remain constant for each individual in the least squares solution of the prediction equation.

$x_1$-$x_4$ = The predictor variables. These will vary for each individual.

k = a constant.

How accurately the regression equation will predict the criterion depends upon the multiple correlation between the predictors and the criterion. A computed index, $R^2$, with a maximum range from 0 to 1 is

used to determine the effectiveness of the model. The square root of $R^2$ or R is the multiple correlation coefficient.

An $R^2$ of 1 indicates that we can predict a criterion perfectly. An $R^2$ of 0 indicates that there is no relationship between the predictor variables and the criterion.

It is unlikely that we would ever have a regression equation whose $R^2$ was 0. Chance fluctuations would allow for some relationship although very small. We are usually interested in determining whether the $R^2$ is significantly better than chance (different from zero). There is available an F test for such a comparison (60). When the value of F is obtained, it is compared in the traditional manner to a critical value in an F table.

## Relationship of Mother to Baby

In this model there are 21 variables. The first six variables are the criteria and the remaining 15 are the predictors. Each criterion was tested within the 15 predictors and a value of $R^2$ and F was obtained. The critical value of F is 2.52 at the one per cent (.01) level of significance with the degrees of freedom for the lesser mean square as 44 and the degree of freedom for the greater mean square as 14. The criteria and the value of $R^2$ and F are listed in Table 3.

The coding for the 21 variables was as follows:

1. Baby's birth weight in ounces.

TABLE 1

CRITERION VARIABLES WITH VALUE OF $R^2$ and F

| Criterion Variables | $R^2$ | F |
|---|---|---|
| Birth Weight | 0.4946 | 2.87* |
| Birth Length | 0.2911 | 1.20 |
| Head Circumference | 0.4238 | 2.16 |
| Chest Circumference | 0.5065 | 3.01* |
| Average Weight Gain per Day | 0.2848 | 1.17 |
| Baby's Hemoglobin | 0.3068 | 1.30 |

* Significant

Critical value of F, df = 44 and 14, $\alpha = .01$, one tail test is 2.52. The same fifteen predictor variables were used with each criterion variable in determining $R^2$ and F.

2. Baby's birth length in inches.

3. Baby's head circumference in inches.

4. Baby's chest circumference in inches.

5. Average weight gain per day in ounces, birth to follow up.

6. Baby's hemoglobin.

7. Mother's age in years.

8. Mother's weight in pounds.

9. Number of pregnancies of the mother.

10. Mother's age at time of first pregnancy.

11. Mother's hemoglobin.

12. Nursing the baby: Yes - 1, No - 0.

13. Working mother: Yes - 0, No - 1.

14. Breakfast eaten by mother: Yes - 1, No - 0.

15. Ounces of soda consumed by mother per day.

16. Adequate protein in mother's diet: Yes - 1, No - 0.

17. Adequate milk intake in mother's diet: Yes - 1, No - 0.

18. Adequate meat intake in mother's diet: Yes - 1, No - 0.

19. Adequate vegetable and fruit intake in mother's diet: Yes - 1, No - 0.

20. Adequate bread and cereal intake in mother's diet: Yes - 1, No - 0.

21. Sex of baby: Male - 0, Female - 1.

The adequacy of the mother's diet was determined by her intake from each of the basic four food groups. This information is contained in the predictor variables 16 through 20. The protein intake was then decided from the combined intake of milk and meat.

## Birth Weight

In the first model, birth weight was tested using predictors 7 through 21 in the multiple regression equation. The value of $R^2$ was 0.4946; the value of F 2.87 (Table 3). The standard F table shows the value of F to be significant. It may be possible therefore to predict an unborn baby's weight from the given predictors. This information could be valuable in counseling a mother on diet and her allowed weight gain for the nine months. If the baby was predicted to be especially heavy, the doctor could decide if the mother's body was such that she could deliver a heavy baby or would special precautions need to be taken. For example, would the opening in the cervix area be large enough to accommodate the passage of the baby or would it be necessary to do a Caesarian Section? If the baby was predicted to be especially light, it might be that some special measures should be taken to safeguard its life at birth. Before this could be put into practical use, it would be necessary to test the relationship between the criterion variable and the predictor variables more thoroughly. If the measurement procedure could be refined, it is possible that a higher

degree of relationship could be established between the criteria and predictors.

## Birth Length

Birth length was tested using predictors 7 through 21 in the equation. $R^2$ was 0.2911 and the value of F was 1.20 (Table 3). The value of F was not significant when compared to the F table. Thus, these predictors cannot successfully be used to predict the baby's length. One reason which could account for this result was that all the predictors were taken from the mother, none from the father. Length and the tendency to be tall or short is an inherited factor which is influenced by both mother and father.

## Head Circumference at Birth

In this regression equation, head circumference was predicted using variables 7 through 21. The value of $R^2$ was 0.4238 with the value of F 2.16 (Table 3). The value of F was not significant when compared to the F table. This can be accounted for by the fact that the fontanels would be at a different stage of development in each child. Nutrition or inheritance do not play an important role in the head circumference (59). Thus, the predictors cannot be used to predict the head circumference of the infant.

## Chest Circumference at Birth

Criterion four, chest circumference, was set up with variables 7 through 21 as the predictors. The $R^2$ was 0.5065 and the F was 3.01 (Table 3). The value of F was significant. Chest circumference would be affected by the mother's weight, diet, eating patterns, sex of the baby, and to a certain extent inheritance of body build from parents. Chest circumference is a measure of the fleshy part of the chest and thus is affected by nutrition. It can be said that chest circumference probably can be predicted from the given predictor variables.

## Average Weight Gain Per Day During Early Infancy

Average weight gain per day was tested by using the predictor variables 7 through 21. The value of $R^2$ was 0.2848 and the value of F was 1.17 (Table 3). There was no relationship between the 15 predictors and the average weight gain per day of the infant. The average weight gain of the infant was dependent upon the diet of the infant after birth rather than the variables measured on the mother.

## Baby's Hemoglobin

In this regression equation, the baby's hemoglobin was tested using variables 7 through 21 as predictors. The value of $R^2$ was 0.3068 and the value of F was 1.30 (Table 3). When F was compared with the table, it was not significant. The mother's diet prior to and during pregnancy plays an important part in providing an iron supply for the

baby. The mother's iron stores that have been built up over the years play an important part in the amount of iron the baby receives before birth. There is no way of accurately measuring these stores (61). It is also possible the baby does not absorb all the iron available from the mother. The baby's hemoglobin cannot be predicted from these variables.

In two of the models a significant relationship was found between the criterion and predictors. There was a relationship between the baby's birth weight and chest circumference and the 15 predictor variables. These variables depend more on the predictors that were taken from the mother than do the other four criterion variables. These four remaining criterion variables were more dependent on outside factors that have little to do with the mother or factors that could not accurately or easily be measured.

Correlation Analyses of Characteristics of Mother to Baby

The most widely used measure of correlation is the Pearson Product Moment Correlation Coefficient (62). Correlation is concerned with describing the degree of relationship between variables.

The Pearson Product Moment Correlation was computed between certain variables. These variables were used because they were of special interest to the physicians on the Island and to the researcher. These correlations are reported in Table 4. The relationship between

TABLE 2

CORRELATION OF VARIABLES WITH VALUE OF r

| Variable 1 | Variable 2 | $r_{1,2}$ |
|---|---|---|
| Weight of baby | Mother's age | .06488 |
| Weight of baby | Mother's weight | .39744* |
| Weight of baby | Length of baby | .49592* |
| Head circumference | Chest circumference | .74808* |
| Weight of baby | Breastfed | .23229* |
| Length of baby | Breastfed | -.08397 |
| Head circumference | Breastfed | .32478* |
| Chest circumference | Breastfed | .22221 |
| Weight of baby | Number of pregnancies | .18894 |
| Weight of baby | Age of 1st pregnancy | -.16443 |
| Weight of baby | Mother's hemoglobin | -.01268 |
| Length of baby | Mother's hemoglobin | -.01889 |
| Head circumference | Mother's hemoglobin | .09526 |
| Chest circumference | Mother's hemoglobin | .00326 |
| Baby's hemoglobin | Mother's hemoglobin | -.00929 |
| Weight of baby | Mother's breakfast | .15236 |
| Weight of baby | Mother working | .26657* |
| Length of baby | Mother working | .12367 |
| Head circumference | Mother working | .21321 |
| Chest circumference | Mother working | .49195* |

* Significant

Critical value of r, df= 58, $\alpha$= .10, two tail test is $\pm$.231.

the weight of the baby and the mother's weight was significant. This is understandable because as the fetus is developing the mother is gaining weight and the fetus is gaining. Length of the baby and weight of the baby were significant. As the fetus size increases both length and weight will increase. There is a relationship between head and chest circumference. These two measurements are important anthropometrical measures and indicate degree of development. Weight of the baby and head circumference are related to the baby being breast-fed. There is a relationship between the baby's weight and chest circumference and the working mother.

# CHAPTER V

# SUMMARY, CONCLUSIONS, RECOMMENDATIONS

## Summary

It is estimated that two-thirds of the world's population is suffering from some degree of malnutrition. At the heart of this problem is the serious lack of protein. There are two sources of protein, animal and vegetable. Animal protein is a complete protein that contains all the essential amino acids. No one vegetable protein contains all the essential amino acids in the proper proportions. The purpose of this study was to investigate the status of protein nutrition of expectant mothers in American Samoa and the possible effect of this status on the health of the infant.

The mother's diet before and during pregnancy is most important to her adjustment during pregnancy and the infant's growth and development. Protein is essential to the growth and replacement of tissue. Food plays an important role in Samoan customs and traditions. Their meal pattern is usually a light morning meal or nothing at all, a heavy midday meal, and a snack at dusk. Babies are usually born in the hospital and breastfed on demand. Western influence seems to be influential in the Samoan diet.

A questionnaire was developed to structure an interview with each mother. It was designed to determine approximate food intake,

eating patterns, feeding habits, food customs, and food preparation. The sample included all Samoan mothers that delivered and their new born infants at the LBJ Tropical Medical Center, Pago Pago, American Samoa, between July 27 and September 7, 1970. Sixty mothers were seen in the six-week period. The mothers and infants were seen in the hospital and again at the Well Child Clinic from two to four weeks after being released from the hospital.

Multiple regression and correlation were the statistical methods employed in this research. Multiple regression was used to examine the relationship between six dependent variables of the baby and 15 independent variables on the physical measurements and dietary habits of the mother. It appeared that the predictors could be used to predict two of the criteria. These criteria were the baby's birth weight and chest circumference. The Pearson Product Moment Correlation Coefficient was concerned with describing the degree of relation between variables. There was a significant relationship between: weight of the baby and the mother's weight; baby's weight and baby's length; baby's head and chest circumference; baby's weight and if it was breastfed; head circumference and if the baby was breastfed; weight of baby and if the mother is working; and chest circumference and if the mother is working. Less than half of the mothers (42%) received an inadequate quantity of protein in their diet. All mothers thought they had an adequate diet; 45% did not take vitamins; 43% did not eat three

meals per day; 82% did not drink milk; 8% did not drink soda; and 100% ate at least three servings of fruit and vegetables per day and four servings of bread or cereal.

## Conclusions

From data collected during a six-week period, the following can be concluded for this study:

1. The baby's birth weight is predictable from selected physical measurements and dietary habits of the mother.
2. The baby's birth length is not predictable from selected physical measurements and dietary habits of the mother.
3. Baby's head circumference is not predictable from selected physical measurements and dietary habits of the mother.
4. Baby's chest circumference is predictable from selected physical measurements and dietary habits of the mother.
5. The average weight gain per day of the baby is not predictable from selected physical measurements and dietary habits of the mother.
6. The baby's hemoglobin is not predictable from selected physical measurements and dietary habits of the mother.
7. The expectant mother's diet is adequate in protein.

## Recommendations

### This Study

Head and chest circumference and length should be measured on the infant at the clinic in addition to that done at birth so a comparison could be made. Weight gain during the pregnancy would have been a valuable figure to obtain. So that more information could be found about the father's role in the family, it would be interesting to get information on the father, the family as a whole, its income, and level of education. Much more could be learned about the Samoan from these data. It would have been interesting to interview in the villages instead of at the hospital. Laboratory facilities should be improved so tests would be more valid.

Anyone doing an interview with a Samoan would have problems obtaining valid answers. The Samoan tells one what he thinks one wants to hear so as to not have any unhappiness. When using interpreters in a study, the interpreter needs instruction with the sample before actually beginning. The interpreter should have complete understanding of it and what is hoped to be learned. The researcher should know all he can about the people, their customs, and language before initiation of such a study.

## Future Studies

For future studies a longer time period and a larger sample should be used. Measuring devices and techniques should be tested and improved when possible. Standards should be set for making comparisons. Know what laboratory facilities are available and what technicians can do. It might be necessary to use a field laboratory. Studies could be completed on other segments of the population. Excellent studies could be done with preschool children, elementary and high school students especially during the school year when a classroom situation would be available.

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# APPENDIX

# APPENDIX A — QUESTIONNAIRE

## QUESTIONNAIRE

### INFANT

| Initial: | Category: | Follow up: |
|---|---|---|
| _____ | Date | _____ |
| _____ | Name | |
| M F | Sex | |
| _____ | Birth Date | |
| _____ | Length | _____ |
| _____ | Weight | _____ |
| _____ | Birth Order | |
| _____ | Gestational Age | |
| _____ | Head Circumference | _____ |
| _____ | Chest Circumference | _____ |
| _____ | Total Serum Protein | _____ |
| _____ | Serum Albumin | _____ |
| _____ | Hemoglobin | _____ |
| _____ | Hematocrit | _____ |
| ____Yes ____No | Breast Fed? | |
| _____ | General Health | _____ |
| | Other Comments: | |

# QUESTIONNAIRE

## MOTHER

_____ Date

_____ Name

_____ Age

_____ Weight

_____ Height

_____ Weight gain during pregnancy

Number of pregnancies:

_____ liveborn

_____ stillborn

_____ miscarriage

Number of liveborn infants:

_____ now living

_____ now dead

_____ age of death

_____ Age at first pregnancy

_____ Total Serum Protein

_____ Serum Albumin

_____ Hemoglobin

_____ Hematocrit

_____ Blood Pressure

_____ General Health:

## FAMILY

_____ Father's Age

_____ Yes _____ No Lives with family?

_____ Education, highest grade completed

_____Rural _____Urban Home location

_____ How many members in household?

Who are they and age?

_____ Family income, from where?

DIET

_____ When is the first time during the day you eat or drink anything?

What do you eat? How much?

_____Yes _____No Was intake unusual in any way?

If yes, why?

_____ What time do you go to bed?

_____Yes _____No Do you take vitamin or mineral supplements?

_____ If yes, how many/day? Per week?

_____ Multivitamins

_____ Ascorbic acid

_____ Iron

_____ Vitamin A & D

_____ Calcium

_____ Other:

_____Yes _____No Is your appetite good?

_____Yes _____No Is your diet good?

_____Yes _____No Do you eat three meals a day?

_____Yes _____No Do you eat morning meal every day?

_____Yes _____No Do you eat midday meal each day?

_____Yes _____No Do you eat evening meal every day?

_____Yes _____No Do you snack?

When?

_____Yes _____No Do you drink milk?

How often?

_____Yes _____No Do you drink fruit juice?

_____Yes _____No Do you eat cereal? Rice?

_____Yes _____No Do you eat bread?

_____Yes _____No Do you eat meat and fish?

_____Yes _____No Do you eat vegetables? (taro, breadfruit)

_____Yes _____No Are you on a special diet?

What kind?

_____Yes _____No Do you drink carbonated beverages?

_____ How often?

_____ General diet?

What foods do you dislike?

How do you prepare your food?

What foods do you like?

What and when do you feed your baby?

Of what will your baby's post-lactation diet consist?

Source of vitamins, minerals, carbohydrates, protein, fat?

# APPENDIX B — TOTALS, RANGE, MEAN

## QUESTIONNAIRE

## INFANT

| Initial: | Category | Follow up: |
|---|---|---|
| ------ | Date | ---- |
| | Name | |
| 32 M 28 F | Sex | |
| ------ | Birth Date | |
| Male 18.00-22.00 inches<br>Female 19.00-22.00 inches | Length | Mean<br>19.84 inches |
| Male 80.00-175.00 ounces<br>Female 92.00-166.00 ounces | Weight | 122.97 ounces |
| ------ | Birth Order | |
| ------ | Gestational Age | |
| 12.00-16.00 inches | Head Circumference | 14.16 inches |
| 12.00-17.00 inches | Chest Circumference | 14.00 inches |
| ------ | Total Serum Protein | ---- |
| ------ | Serum Albumin | ---- |
| 8—19 | Hemoglobin | |
| 30—45 | Hematocrit | |
| 36 yes 24 no | Breast Fed? | |
| ------ | General Health | ---- |
| | Other Comments: | |

# QUESTIONNAIRE

## MOTHER

| | | |
|---|---|---|
| -------- | Date | |
| -------- | Name | Mean |
| 17.00—42.00 years | Age | 26.58 years |
| 118.00-247.00 pounds | Weight | 170.55 pounds |
| -------- | Height | |
| -------- | Weight gain during pregnancy | |
| -------- | Age at first pregnancy | |
| -------- | Total Serum Protein | |
| -------- | Serum Albumin | |
| 9-14 | Hemoglobin | |
| -------- | Hematocrit | |
| -------- | Blood Pressure | |
| -------- | General Health: | |
| 11 Yes 49 No | Working | |

## DIET

| | |
|---|---|
| | When is the first time during the day you eat or drink anything? |
| | What do you eat? How much |
| Yes No | Was intake unusual in any way? |
| | If yes, why? |

| | | | |
|---|---|---|---|
| | | | What time do you go to bed? |
| 33 | Yes | 27 | No Do you take vitamin or mineral supplements? |
| | | | If yes, how many/day? Per week? |
| | | | Multivitamins |
| | | | Ascorbic acid |
| | | | Iron |
| | | | Vitamin A & D |
| | | | Calcium |
| | | | Other: |
| 60 | Yes | | No Is your appetite good? |
| 60 | Yes | | No Is your diet good? |
| 34 | Yes | 26 | No Do you eat three meals a day? |
| | Yes | | No Do you eat morning meal every day? |
| | Yes | | No Do you eat midday meal each day? |
| | Yes | | No Do you eat evening meal every day? |
| | Yes | | No Do you snack? |
| | | | When? |
| 11 | Yes | 49 | No Do you drink milk? |
| | | | How often? |
| 60 | Yes | | No Do you drink fruit juice? |
| 60 | Yes | | No Do you eat cereal? Rice? |
| 60 | Yes | | No Do you eat bread? |
| 60 | Yes | | No Do you eat meat and fish? |

60 Yes ____ No Do you eat vegetables? (taro, breadfruit)

____ Yes 60 No Are you on a special diet?

What kind?

55 Yes 5 No Do you drink carbonated beverages?

_____ How often?

_____ General Diet?

What foods do you dislike:
cheese, milk, eggs

How do you prepare your food?
fry, roast, boil

What foods do you like?
---

What and when do you feed your baby?
---

Of what will your baby's post-lactation diet consist?
---

Source of vitamins, minerals, carbohydrates, protein, fat?
---

Baron, Kathleen
Protein nutrition of expectant mothers in American Samoa and its effect on the health of the infant