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A COMPARISON OF NUTRITIONAL FACTORS
IN SELECTED CHILDREN WITH AND WITHOUT
IRON DEFICIENCY ANEMIA

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Helen Dersch

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A COMPARISON OF NUTRITIONAL FACTORS IN SELECTED CHILDREN WITH AND WITHOUT IRON DEFICIENCY ANEMIA

By

Helen Dersch

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ABSTRACT

A COMPARISON OF NUTRITIONAL FACTORS
IN SELECTED CHILDREN WITH AND WITHOUT
IRON DEFICIENCY ANEMIA

By

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The work described in this thesis was a part of an interdisciplinary study investigating some of the physiological, sociological, psychological, and nutritional factors which may contribute to the occurrence of iron deficiency anemia. Emphasis in this thesis was on nutritional aspects.

Sixteen infants 6 to 24 months of age from low income families were included in the thesis group. They were placed in iron deficiency anemic or non-anemic control groups on the basis of hematological values. Data collection was conducted during the fall of 1971 and winter of 1972.

Results indicated generally adequate diets in all nutrients except iron. Iron intake was significantly higher for the control group but both groups fell well below the recommended dietary allowance for iron. Mothers of control children had significantly greater nutritional knowledge. Families of anemic children had significantly lower per capita income and larger number of children per family.

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INTRODUCTION

Purpose of the Study

Iron deficiency anemia is the most prevalent nutritional deficiency in the United States and continues to be as common today as 30 years ago (1). While iron deficiency and iron deficiency anemia may occur in any segment of the population, certain groups seem to be more at risk than others. In these high risk groups, iron deficiency does not occur alone but as part of a constellation of medical, social, and economic factors (2). Although much research has been done on iron deficiency anemia, relatively little of that research has investigated the social and ecological factors which lead to iron deficiency in some children within an environment where others within the same family are not iron deficient (2).

Because of the complex etiology of iron deficiency anemia, a multidisciplinary project was undertaken to investigate some of the medical, physiological, nutritional, and socio-psychological factors which may contribute to the occurrence of iron deficiency and iron deficiency anemia.[1] The age group of children 6 months to 2 years of age was chosen because of the high reported incidence of iron deficiency anemia in this age group (4, 5, 6, 7). The

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1 Principle investigators of the project, of which this thesis was a part, were Theresa B. Haddy, M.D., David J. Kallen, Ph.D., and Dorice C. Narins, Ph.D., of the Department of Human Development, College of Medicine, Michigan State University. A report of the larger study has been made (3).

study included physical examinations of the children, collection and evaluation of medical and hematological data for incidence of iron deficiency anemia, and appropriate treatment of those children with iron deficiency. Families were interviewed for demographic and sociological data, and for the mother's attitudes concerning homemaking and child rearing. The nutritional information included collection and evaluation of data regarding past and present nutritional status of the children and the nutritional practices of their families.

The emphasis of this thesis was on the nutritional aspects of iron deficiency and iron deficiency anemia, although some other data were also included. The objectives of this thesis were to investigate and compare:

(1) the nutritional adequacy of diets of children with and without iron deficiency anemia;

(2) the food patterns and habits of the children and their families;

(3) the level of nutrition knowledge of the mothers; and

(4) some of the parental attitudes toward child-rearing.

REVIEW OF LITERATURE

Iron Metabolism

Iron Compounds in the Body

Due to its ability to undergo reversible oxidation and reduction, iron functions in the body in oxygen transport and cellular respiration (8). There are a number of iron compounds in the body. Hemoglobin is the most prevalent and, with myoglobin, a similar compound present in smaller quantities, account for 70-75% of total body iron. The storage forms or iron, ferritin and hemosiderin, account for about 15-25% of body iron. Iron is also found in serum transferrin and as a component of a number of cytochromes and tissue enzymes (8, 9, 10). Table 1 shows the distribution of iron by approximate percentages of total body iron.

Table 1: Distribution of Iron in the Body[10]

Iron Compound	Percentage of Total Body Iron
Hemoglobin	67
Storage Iron (Ferritin, Hemosiderin)	27
Myoglobin	3.5
Labile Iron Pool	2.2
Enzyme Iron	0.2
Transport Iron	0.08

The exact amounts of iron in the body flucuate with storage iron subject to the greatest flucuation (10).

The largest proportion of body iron is in hemoglobin. The hemoglobin molecule consists of 4 polypeptide chains each with an attached iron-porphyrin (heme) group. The iron

content of hemoglobin is constant; iron deficiency results in decreased hemoglobin synthesis. The formation of red blood cells (erythropoiesis) is controlled by the hormone erythropoietin. Changes in hemoglobin mass such as would occur with transfusions, hemorrhage, or erythrocyte destruction, results in a compensatory change in erythrocyte synthesis in the bone marrow (10). Most of the iron in hemoglobin is conserved when the red blood cells are catabolized and the iron is then available for reutilization (10). This reutilization of iron accounts for more than 90% of the daily bone marrow iron requirement (11).

Myoglobin, an iron-containing heme compound similar to hemoglobin, is found in muscle tissue where it apparently functions to provide oxygen during muscle contraction. The myoglobin content is greatest in muscles specialized for sustained contraction, when blood flow is most dimished. However, the contribution that oxygen from myoglobin makes to total oxygen consumption is relatively small (12).

Iron is stored primarily in the liver, spleen and bone marrow. There are two main forms of storage iron, ferritin and hemosiderin. Some researchers have suggested that iron may be stored first as ferritin and as the level of iron increases to a critical value, further storage is primarily as hemosiderin (13). Both ferritin and hemosiderin seem to be readily available for use in the body. It has been suggested that ferritin also has important regulatory and transport functions in the mucosa of the small intestine and possibly in the placenta (10).

Iron is transported by the iron-binding plasma protein transferrin, whose major function appears to be the transport of iron to the bone marrow (10). The amount of iron-binding sites which contain iron are measured as percent transferrin saturation. In the normal adult, approximately one third of the iron-binding sites of transferrin contain iron, giving a normal transferrin saturation of about 32% (10). In iron deficiency, the amount of transferrin-bound iron is usually diminished (10).

Iron is also important in tissue enzymes, although the amount of total body iron represented by enzymes is small. There are 3 types of iron enzymes: (1) enzymes and cytochromes which are heme-proteins; (2) iron-flavoproteins; and (3) enzymes requiring iron as a cofactor. In the heme enzymes and iron-containing cytochromes, iron is a part of the prosthetic group at the active site of the molecule. In other iron enzymes, the function of iron is less clear (10).

Absorption of Iron

Absorption of dietary iron is influenced by a number of factors. These include the form of iron present in food, the presence of other food substances which can solubilize, chelate, or precipitate iron, the quantity of iron in the diet, and the body's need for iron.

Iron is present in foods in two basic forms, ferric-iron complexes and heme compounds. These are absorbed by different mechanisms and affected differently by various other factors within the gastrointestinal tract (14).

In the stomach, hydrochloric acid helps keep ionic iron in solution; iron absorption decreases if there is a lack of gastric acid as in the case of achlorhydria. Mucoprotein substances help form soluble iron chelates which remain in solution as food passes into the alkaline medium of the small intestine (10, 14).

The exact mechanism by which iron is transported across the intestinal mucosa is not completely clear despite intensive investigation (10). Iron is absorbed primarily in the duodenum and upper jejunum. The duodenum is the only portion of the intestine able to transport ferrous iron against a concentration gradient. This portion of the intestinal mucosa contains the most ferritin, although the role of ferritin in the transport process has not been definitely determined. Iron absorption is a 2-stage process. In the first, relatively rapid step, iron enters the mucosal cell. There the iron accumulates and is either distributed throughout the cytoplasm or incorporated in ferritin. The second, slower step, is the release of iron into the blood stream. This transfer from mucosal cell to plasma is regulated by the body need for iron. Iron is carried by the plasma globulin transferrin (15).

Because of the short life-span (2-3 days) of mucosal cells, iron remaining in the cells as they are sloughed is lost (15). Plasma iron can be also taken up by the mucosal cell, retained, and ultimately sloughed into the intestinal lumen. This suggests an excretory role of the mucosa, but

the capacity of this mechanism is limited (10).

In absorption of heme iron, the metalloporphyrin portion is split from the protein by digestion and is absorbed directly into the mucosal cells. Substances which affect absorption of inorganic iron do not seem to change the absorption of heme iron which is absorbed best in an alkaline medium (14). However, some researchers have stated that heme iron (or other complexed iron) may not be as efficiently used in hemoglobin synthesis as ionizable iron (16).

Observations support the concept of some kind of mucosal regulation of the rate of iron absorption. Additionally, the level or iron stores in the body influences the rate of iron absorption, and it has been suggested that the level of saturation of iron-binding proteins also plays a role in iron absorption rate (10). There may also be a relationship between iron absorption and rate of erythropoiesis, due either to the effect of erythropoiesis alone or the action of erythropoietin which stimulates erythropoietic activity (10). In general, iron absorption is increased in iron deficiency anemia.

The total quantity of iron in the diet is the most important single factor in determining the amount of iron absorbed. The greater the quantity of iron in the diet, the greater the amount which is absorbed (up to toxic amounts) although the percentage of dietary iron absorbed decreases as quantity increases (8).

Both the form of iron in various foods and other substances within foods consumed at the same time affect iron

absorption. Heme iron is better absorbed than inorganic iron, and ferrous iron better than ferric (14). Dietary constituents which solubilize iron increase iron absorption (ascorbic acid, sugars, amino acids); compounds which cause molecular aggregation or precipitation of iron decrease absorption. Carbonates, oxalates, phytates, and phosphates all can combine with iron to form insoluble or poorly absorbed complexes (8).

Thus there is considerable variation in availability of iron depending on the composition of the total meal with which it is consummed as well as the type of iron-containing food. Iron absorption is decreased with increased bulk of the diet (17). Interaction between foods modify the absorption of iron compared to iron absorption from individual foods (18). Phosphates and phytates decrease absorption of inorganic iron by precipitation (14). Ascorbic acid increases iron absorption (17); orange juice will increase absorption of non-heme iron such as from eggs and cereals. But egg, (considered a good source of iron in diets of infants and children) decreases absorption of non-heme iron from other foods (8, 16). Addition of animal foods to a meal may increase absorption of iron from vegetables sources (14). Meat increases iron absorption of some foods, with cysteine shown to be of importance in the enhancing effect (19). Calcium may interfere with iron absorption since iron absorption increases if milk is absent or reduced in the diet, according to one report (16). And a study with rats indicated that excess calcium may inhibit iron absorption but the

authors cautioned that it remains to be seen if the rat is a suitable model for absorption studies (20). Another report suggests that wide variations found in the availability of iron from the same sources but between laboratories may be due in part to assay methods rather than true differences in availability of the iron (21).

Absorption of dietary iron is generally believed to be about 10% for individuals with normal iron status and 20% for iron deficient subjects. However, some researchers suggest that these figures are too high and that absorption may be generally less than 10% for normal persons and only somewhat over 10% for iron deficient patients (8). Studies of iron absorption from single foods gave values of less than 10% from vegetable sources and less than 15% for most animal products. Using a mixed "Western" diet, iron absorption values were 6% for males and 14% for females with normal iron status and 20% for iron deficient subjects, but less even for the iron deficient subjects when a predominately cereal diet was used (19).

There is also question about the effective absorption of iron from fortified foods. This may be particularly true in infants. There is some evidence that during the first 4-5 months of life only a small amount of dietary iron is incorporated into hemoglobin and has little effect on hemoglobin level of full term, normal birth-weight infants (22). (In the case of premature and low birthweight infants, the benefit of early iron supplementation is more widely recognized.) Little is known about iron absorption in

infants of either sodium iron pyrophosphate or metallic iron, forms commonly used for fortification, according to one study (23). Another report states that some of the commonly used salts are poorly absorbed, although ferrous sulfate is better absorbed than ferric orthophosphate and sodium ferric phyrophosphate (19). Other studies of iron absorption from cereal products indicate that natural iron in whole meal flours may be absorbed somewhat better than iron added to fortify white flour (15).

Development of Iron Deficiency Anemia

Iron deficiency anemia is generally considered to be a nutritional deficiency where dietary intake of iron is insufficient to meet body needs. Prolonged dietary intake below the level necessary for replacement of iron losses may lead to eventual iron deficiency in any individual, but both increased need and excessive loss of iron put some people at greater risk than others.

Increased need is generally the result of increased growth rate, and occurs during infancy, especially the period of 6 - 24 months of age, adolescense, and pregnancy. The pregnant adolescent is at particular risk due to demands for her own growth in addition to that of the fetus and maternal tissues associated with pregnancy.

Pregnancy increases need for iron for both maternal and fetal tissues. Total iron demand during pregnancy is about 1000 mg (8). Iron deficiency anemia is the most common complication of pregnancy and is frequently due to inadequate dietary iron intake. Routine iron supplementation is

generally recommended, particularly during the second and third trimesters (24).

However, iron deficiency anemia of the mother, unless very severe, does not seem to produce anemia of the infant (25). There is no difference in frequency of iron deficiency anemia among infants born to iron deficient mothers compared to those born to non-anemic mothers (10). Infants of iron deficient mothers show normal hemoglobin levels at birth, although evidence of low iron storage levels may become apparent later in the first year of life (25, 26). Maternal hemoglobin concentration does not affect the infant's iron stores unless the mother's hemoglobin level falls below 9 gm/dl (27). Iron supplementation during pregnancy does not seem to influence hemoglobin levels in the infant (25).

Iron transport across the placenta to the fetus appears to be an active process against a concentration gradient. The exact transport mechanism is not clearly understood, but there is some indication that ferritin may play a role (10). Iron transfer to the fetus does not take place at a uniform rate throughout the gestation period, but increases during the latter half of pregnancy and particularly in the third trimester (8, 25).

At birth the normal, full term infant has about 300 mg of iron, the majority as circulating hemoglobin. Normal hemoglobin levels range from 13-20 gm/dl with the mean 16-17 gm/dl. An average of about 70% of this is fetal hemoglobin and 30% adult hemoglobin. During the first few weeks of life, hemoglobin level drops, reaching its lowest level of about

10-11 gm/dl at 6-10 weeks of age (25). This decrease in hemoglobin level, termed the physiologic anemia of the newborn, is due to the shorter life span of fetal red blood cells, about 2/3 that of adult RBC, a slightly increased rate of RBC hemolysis, and stationary or decreased rate of erythropoiesis. The resulting fall in hemoglobin and RBC levels allows adjustment to the increased oxygen saturation of blood with lung rather than placental oxygenation (25).

The physiologic anemia is self-limited and does not respond to iron or other nutritional supplementation (28). When hemoglobin concentration falls to about 11 gm/dl, erythropoiesis begins to increase. The iron need for this rise in hemoglobin synthesis is met by the iron stores including prenatal accumulation and iron from RBC degradation during the first few weeks of life (25). Iron stores of the full term infant are usually sufficient for normal erythropoiesis for 4-6 months without dietary supplementation (28). Individual variability of infants in growth and iron stores determine how quickly iron is depleted, but by the age of 6 months the infant is usually dependent on dietary intake to meet iron needs. Hemoglobin level normally remains fairly constant about 10-12 gm/dl during the first two years of life (25).

Since the greatest quantity of iron is stored by the fetus during the last months of pregnancy, premature birth results in smaller iron stores for the infant. These stores are rapidly depleted and the premature infant is therefore

at greater risk of developing anemia, which is common and may be severe (10). Low birth weight infants also have increased risk of developing iron deficiency anemia because of smaller iron stores and rapid growth (25). Hemoglobin level is lower in the premature than the full term infant and fetal red blood cells have an even shorter life span (28). In addition, the bone marrow of the premature infant is immature, and the capacity of the hematopoietic system is inadequate for the requirements of rapid growth. The degree of immaturity of bone marrow is related to the degree of prematurity of the infant (29). The decrease in hemoglobin level resulting from physiologic anemia is more pronounced in premature than full term infants (28). Supplemental iron therapy is generally successful in treating iron deficiency in premature and low birth weight infants(10).

Iron is well conserved by the body and daily loss of iron is relatively small, averaging 0.5-2 mg/day (27). Iron is normally lost primarily through desquamation of gastrointestinal mucosa and some excretion of iron in bile. Urinary loss of iron is usually less than 0.1 mg/day, and loss through sweat and sloughed skin cells is not likely to exceed 0.15 mg/day under normal circumstances. Adolescent girls and women of reproductive age have the additional loss due to menstruation of an average of 0.5-1 mg/day. Children have smaller iron losses in feces, urine and sweat than do adults (27).

Greater iron losses, however, may lead to development

of iron deficiency anemia. Excessive losses of iron result most often from blood loss such as hemorrhage or heavy menstruation. Intestinal bleeding is one avenue of blood loss which may result in chronic loss of iron. It has been suggested by some that intestinal blood loss may be a major factor in iron deficiency anemia in infants (10), but the Committee on Nutrition reported that such blood loss in infants was negligible and may be a secondary gastrointestinal manifestation of iron deficiency rather than a cause (21). Cow's milk has been shown to contain a substance which induces gastrointestinal bleeding in infants, but the substance is thermolabile and thus heat processed milk and formulas should not cause bleeding (30).

The development of iron deficiency anemia is a progressive decrease in total body iron. Storage forms are depleted, evidenced by the absense of bone marrow iron. Then follows a gradual decline in serum iron concentration and concomitant rise in serum iron binding capacity. Transferrin saturation of 16% or less is characteristic of iron deficiency. Red blood cell changes characteristic of iron deficiency occur with the appearance of hypochromic microcytosis (28). Hemoglobin synthesis and erythropoiesis are decreased in iron deficiency and the hemoglobin concentration of erythrocytes also decreases (10). Table 2 shows the stages of deficiency in development of anemia.

Table 2: Stages of Iron Deficiency[a] (10)

Stage of Deficiency	Characteristics			
	Iron Stores	Serum Iron	Transferrin Saturation	Anemia
Iron depletion	decreased or absent	normal	normal	none
Iron deficiency	absent	usually low	usually 16% or less	none
Iron deficiency	absent	usually low	usually 16% or less	normo-chromic to hypo-chromic

a This classification was adopted by the Council on Food and Nutrition of the American Medical Association in 1968.

Aberrations in absorption or utilization of iron may also lead to iron deficiency. The emphasis in this study however, was on iron deficiency caused by low dietary iron intake coupled with increased iron demand for growth.

Standards for Determining Iron Deficiency Anemia

Although iron deficiency is considered by many to be a major public health problem, there are differences of opinion as to what hematological levels constitute iron deficiency and iron deficiency anemia. The Ten-State Nutrition Survey set hemoglobin levels for infants 6-23 months of age as less than 9 gm/dl "deficient"; 9.0-9.9 gm/dl "low"; and above 9.9 gm/dl "acceptable" (31). Other studies have considered hemoglobin of less than 10 gm/dl (32) or 10.5 gm/dl (33) as evidence of iron deficiency anemia, and still others regard less than 11 gm/dl as "anemic" (6).

Likewise there is variation regarding transferrin levels. The Committee on Nutrition considered that transferrin saturation of less than 15% as indicative of body iron depletion (22). One author stated that erythropoiesis is impaired when transferrin saturation is less than 18% (18), while another researcher used a 20% saturation level as indicating low body iron stores (33). Elwood stated that ideal values are unknown and the accepted "normal" values are either empirically determined or based on findings in selected groups of individuals (16). Since it was found that some apparently normal infants showed a substantial increase in hemoglobin level in response to iron therapy (34), some researchers have suggested that such a response may be

a better indication of iron deficiency than any single laboratory value (35, 36).

Effects of Iron Deficiency

Common clinical manifestations of iron deficiency and iron deficiency anemia include pallor, fatigue, and increased irritability as well as characteristic hematological changes such as decreased hemoglobin, hematocrit, mean corpuscular volume, serum iron, transferrin saturation, and increased total iron binding capacity (17). There has been relatively little information about the pathologic changes which occur in most tissues of the body. Greatest attention has been given to changes in bone marrow since this tissue is readily available for study through biopsy. Although there is usually increased erythroid activity in the bone marrow of iron deficient patients, this is not always the case and the correlation between severity of anemia and degree of erthyroid hyperplasia is poor. The morphology of bone marrow of iron deficient individuals is not sufficiently distinctive to be of diagnostic value (10).

Gastric achlorhydria is frequently associated with iron deficiency as are mucosal abnormalities of the stomach and epithelial changes of the tongue and esophagus (10, 13). Some authors have suggested that the gastric atrophic changes occurring with iron deficiency are of significance in the origin of the deficiency state while others take the view that gastric atrophy is a result of prolonged iron deficiency rather than its cause (10). Some studies have found no correlation between the severity of the anemia and the

presense of changes in gastric mucosa. The results of iron therapy to patients with mucosal atrophy is mixed in terms of improvement of histological appearance of gastric mucosa or ability to secrete gastric acid (10).

The presense and intensity of various symptoms often associated with iron deficiency anemia are not directly correlated with the severity of the anemia (10). Symptoms of anemia such as pallor, fatigue and weakness depend mainly on the rate of development of the anemia rather than its severity. In slowly developing anemia the body may gradually become adapted to anemia showing fewer symptoms, whereas a relatively sudden onset of anemia may produce more definite symptoms (11). Particularly in the case of slowly developing mild anemia, compensatory processes may lead to more efficient release of oxygen from hemoglobin, with few noticeable symptoms (14). In slowly developing anemia, symptoms may be due to adaptation to the decreased oxygen-carrying capacity of the blood, such as acceleration of heart and respiratory rate and increased cardiac output. Symptoms of fatigue may be related to decreased oxygen transport, pallor to decreased blood volume and hypochromic blood, and palpitation to increased cardiac output (37). The decreased hemoglobin levels may play a part in producing symptoms common to all anemias such as weakness, pallor and dizziness (10). In infants, the early stages of development of iron deficiency are usually unaccompanied by clearly recognizable symptoms. Even low hemoglobin levels are tolerated if development is slow (38).

Although it was once thought that enzyme iron was not reduced significantly in iron deficiency, careful studies have shown that the activities of several iron enzymes are definitely affected by body iron depletion. Iron deficient individuals have been shown to have a deficiency of the iron enzyme cytochrome oxidase and a rapid return to normal activity of this enzyme followed iron therapy (10). Other enzymes shown to have diminished activity in iron deficient persons are aconitase and xanthine oxidase (10). Decreases in cytochrome c in heart, kidney and muscle tissues in iron deficient rats (39), cytochrome c and catalase in rats and pigs, and cytochrome oxidase, aconitase and succinic dehydrogenase in rats have been shown by several studies (10, 40, 41).

Those enzymes which show such sensitivity to iron deficiency may decrease in activity before the characteristic hematologic changes of anemia are evident, as well as in cases of iron deficiency without anemia (10, 40). One study found a decrease in cytochrome oxidase level in one half of patients with iron deficiency without anemia and in three-fourths of patients with iron deficiency anemia (42).

The consequences of changes in tissue enzymes are not yet clear, but iron has an important role in cellular metabolism: nearly half the enzymes and cofactors in the Kreb's tricarboxylic acid cycle either contain iron as an integral part of their molecular structure or require its presense (10). The influence of iron deficiency on tissue enzymes may cause symptoms such as headache, fatigue, palpitation, and changes in fingernail and epithelial tissues (10, 17).

Epithelial changes such as atrophy of the papillae of the tongue and angular stomatitis may be caused, at least in part, by diminished function of iron containing respiratory enzymes (14).

Researchers do not completely agree on possible lasting effects of iron deficiency or iron deficiency anemia, especially in cases of mild deficiencies which are most prevalent. (See section on prevalence.) One author stated that "no deleterious effect of mild iron deficiency has... been demonstrated" (16). Another study found that infants with iron deficiency anemia showed no decrease in either weight gain or linear growth when compared to normal infants (1), but other reseachers found that iron deficient children tended to be underweight and slightly shorter in linear growth, and that normal growth patterns returned following adequate iron therapy (10). Another study found that those children ages 1-6 years who were below the 25th percentile in height had lower hemoglobin and transferrin saturation levels than did children whose heights were above the 25th percentile, and suggested that iron deficiency may be associated with measureable uncerachievement in somatic growth (43). Since this latter study included children already past the time of highest incidence of iron deficiency (6-24 months), these findings may reflect effects of a longer period of iron deficiency than studies limited to infants.

Research has also been conducted on possible effects of iron deficiency anemia, as well as malnutrition generally,

on mental development. One study of children 4-6 years of age with mild iron deficiency anemia found that attention span and ability to concentrate on mental tasks were lower in anemic than non-anemic children, although intellectual potential as measured by I.Q. tests was not affected (44). Another study reported significant differences between children with low hemoglobin and those with normal hemoglobin levels on some intelligence tests and associative reaction time tests. It was not determined whether this lower level of achievement of the iron deficient children resulted from lower learning ability, from lower or less sustained level of motivation, or greater fatigue as the testing progressed (45). Another study of children in which diet history records in infancy were taken, found that even mild deficiencies in nutritional adequacy during infancy may be related to differences in mental abilities on subsequent mental tests taken at beginning school age (46).

Prevalence of Iron Deficiency and Iron Deficiency Anemia

Many studies have investigated the prevalence of iron deficiency and iron deficiency anemia in various segments of the population. Although specific figures vary, there are similarities in the findings.

Physiological Factors

Growth

A number of studies have found that a higher incidence of iron deficiency and iron deficiency anemia occurs during the rapid growth period of about 6-24 months of age than in other children, until the adolescent growth period is reached

when the incidence of iron deficiency and iron deficiency anemia again increases (4, 5, 6, 7). One researcher, speaking of malnutrition generally (of which iron deficiency is the most common type among infants and children under age 2), stated that growth rate was a major factor, either in precipitation of malnutrition by rapid growth or in protection against malnutrition by slower growth. Further, borderline nutritional status converted to manifest malnutrition with the added stress of rapid growth (7).

The incidence of iron deficiency, determined by low transferrin saturation levels, was found to be considerably higher than the incidence of iron deficiency anemia, determined by low hemoglobin values. One study reported a 5% incidence of anemia and a 35% incidence of low transferrin saturation (33); another study found anemia in 6% and low plasma iron in 50% of children studied (47); a third found that the incidence of low transferrin saturation was more than 1.5 times as frequent as identifiable anemia (18); and yet another suggested that iron deficiency may exist as a "subclinical" or marginal deficiency state in spite of "normal" hemoglobin concentration and diets apparently adequate in iron (5).

Race

Racial differences in incidence of iron deficiency also seem to exist. The Michigan nutrition survey showed a higher incidence of low hemoglobin values for blacks in the 0-6 year age group as well as for all ages (children and adults) combined (31). Mickelsen et al found somewhat lower hemoglobin

and hematocrit values in black Head Start children than in their white classmates. Additionally, he cites other studies where similar racial differences have been found and quotes one researcher that "it would appear that iron deficiency is at least twice as prevalent" among black as among white children. Mickelsen states that while racial differences seem to be consistently observed "causal factors remain unexplained" (6).[1] However, Garn suggested that there may be genetic differences in hemoglobin levels between blacks and whites such that comparing blacks to the "white" standard for hemoglobin may result in a higher apparent incidence of iron deficiency anemia in blacks (48).

Sociological Factors

Economic Level

Several studies showed that differences in the incidence of iron deficiency anemia were found to correspond to economic level. For example, one study found a 6% incidence of anemia among children 12-23 months of age whose families represented an economic cross-section, but a 20% incidence when only those children in the study from families economically classified as below the "poverty" level were considered (47). Other studies have cited the incidence of anemia as high as 56% (7) and 64% (18) among disadvantaged children. However, one study of 9 month old patients of private physicians, presumably from middle class families, revealed that 14% of the

1 Racial differences may be related to socio-economic factors which are important in prevalence of iron deficiency anemia. (See section on sociological factors.)

infants had iron deficiency anemia (32). Owen summarized his study by stating that iron deficiency was fairly common among preschool children regardless of socio-economic status, although the incidence was probably greater among the poor, and that additionally, it appeared that the preschool child without iron deficiency anemia was frequently iron deficient (47).

Education and Nutrition Knowledge

Several studies have found correlations between the nutritional status of children and the general education level or the nutritional knowledge of the mother. Filer and Martinez found that in general, infants consumed less of several nutrients, including iron, when the average education of the parents was lower (5). Garn stated that low hemoglobin concentration was related to the educational level of parents and to the mothers' knowledge of food (48). Other studies (49, 50) found that, although health and nutrition reasons were often given as a basis for food choices by school children and adults, there was a "disturbing reliance on erroneous nutrition information" (49). Wang, using a nutrition knowledge questionnaire, found that higher levels of education and greater varities of experience seemed to increase knowledge of nutrition and that the poor knew less about nutrition and the nutritional value of foods (51).

Food Preferences

Studies of food preferences of children have supported theories that early home environment is instrumental in

development of food attitudes. A child's attitudes toward food may be formed at an early age and continue to influence his food choices in later life. The range of the child's experience is limited by parental food attitudes, particularly those of the mother who is most influential in development of the child's food habits and behavior (49).

Psychological Factors

Parental Attitudes toward Child Rearing

It has long been recognized that infants who lack adequate maternal nurturing may fail to grow and develop normally. This failure has been attributed to lack of social, psychological and sensory contact and stimulation (52). Hepner, in his study relating quality of "mothering" to malnutrition, found a very strong correlation between serum vitamin A and/or hemoglobin and mean corpuscular hemoglobin concentration values, and the quality of mothering. He concluded that adequate mothering was protective to a child even under the combined stress of rapid growth and low nutrient intake, but inadequate mothering precipitated malnutrition in the rapidly growing child even with a more adequate and balanced diet. He stated that despite a mother's best intention and desire to perform adequately, social and economic situations beyond her control might interfere with the maternal-child relationship needed for successful child development (7).

Whitten and Fischoff, however, have suggested that some problems of growth failure in infants are due not so much to the socio-psychological effects of lack of "mothering" but

to simple undernourishment; that is, failure on the part of the mother to provide the child with adequate food (52, 53, 54).

Summary

Clearly there are many factors which contribute to the development of iron deficiency and iron deficiency anemia, but a pattern begins to emerge in its etiology; in young children it occurs most frequently during the infant-toddler period of rapid growth, and particularly in the poor and the black child (although the latter may be due in part to their higher representation among the "poor and disadvantaged"). The child under age two is of interest not only because of his high risk for development of iron deficiency but for several other reasons as well. He experiences an extensive change in diet from a total (or nearly so) milk preparation diet as a newborn to essentially an "adult" diet in type and variety of food as he reaches the age of one to two years. His eating pattern changes from one which may be unique to him as an infant (such as eating every few hours) to one which probably corresponds to the existing family eating pattern, whatever that may be. He is dependent upon an adult for the quality and quantity of food provided, but, as Dwyer points out, "nutritional considerations...have never played the major factor in determining the dietary habits of the American people" (50). Perhaps the most interesting point is the fact that only some children become iron deficient within an environment where other children do not.

EXPERIMENTAL PROCEDURE

Selection of the Sample

The children selected for this study were between the ages of 6 and 24 months of age at the time of their initial participation in the program in the fall of 1971 and winter of 1972. Contact with the families was made through the Ingham County child health clinics where the children were seen for routine health care. These clinics serve a generally low income population of families who do not have other access to medical care. Racially the population seen at the clinics is about equally distributed among black, Spanish-American, and white families. All the children included in this study were considered to be in generally good health without congenital abnormalities, chronic illnesses or obvious neurological defects. A total of sixteen children were included in the study group for this thesis.

Those children with hemoglobin values below 11 gm/dl as tested at the Ingham County clinic were referred to the Michigan State University health clinic for further medical and laboratory study. Those with hemoglobin values above 11 gm/dl were contacted as "control" children.

Medical and Laboratory Evaluation

Of the sixteen children, ten (8 anemic and 2 control) participated in the medical and laboratory evaluations at the Michigan State University health clinic. They were given complete physical examinations by Dr. Theresa Haddy.[1]

1 See Appendix A for medical examination form.

Diet history and 24-hour dietary recall information were obtained at that time. Laboratory tests included: hemoglobin, hematocrit, red blood cell count, serum iron, total serum iron binding capacity, transferrin saturation, routine urinalysis and determination of occult blood in the stool. In addition, hemoglobin electrophoresis and a glucose-6-phosphate dehydrogenase (G6PD) screening test were carried out as a service to the black patients. Hemoglobin was determined by the cyanmethemoglobin method; erythrocyte counts, mean corpuscular erythrocyte volumes, and leukocyte counts were done on the Coulter S model counter. Hematocrits were done in duplicate by the microhematocrit method. Serum iron and iron binding capacity levels were measured by a one-tube colorimetric method and percent saturation of transferrin was determined by dividing the serum iron by the iron binding capacity and multiplying the result by 100. Stools were checked for blood with a tablet containing orthoiioin.

Diagnosis of iron deficiency anemia was based on the presense of 9 of the following 11 conditions:

hemoglobin less than 11 gm/dl
hematocrit less than 35 %
mean corpuscular volume less than 82 cuu
mean corpuscular hemoglobin less than 27 umcg
mean corpuscular hemoglobin concentration less than 32%
hypochromia present
microcytosis present
poikilocytosis present
serum iron less than 65 ugm/dl
total serum iron binding capacity greater than 350 ugm/dl
transferrin saturation less than 17%

Oral ferrous sulfate in doses of 5 mg per kg per day was prescribed for those children with iron deficiency anemia. Medication continued until normal hemoglobin, hematocrit,

and transferrin saturation levels were achieved.

The six children for whom home interview but no medical of laboratory data was obtained were included in the non-anemic (control) group on the basis of hemoglobin values of 11 gm/dl or above tested at the county health clinic.

Home Interview

The interviews were conducted by appointment in the homes of the families. This was done for several reasons. First, it was generally more convenient for the mothers, many of whom did not have transportation of their own. Secondly, it eliminated the problem of mothers bringing one or more children with her for the interview. Third, it was felt that the mother would be more relaxed in her own home and more at ease answering questions. In addition, it provided the opportunity to observe the home environment and the child in his family situation. All the mothers interviewed were willing to do so; those who did not wish were not interviewed. Several mothers expressed appreciation for the interest taken in them and their children. Questions were read to the mothers and the answers written on the interview form by the interviewer to eliminate error which might be introduced by a mother's inability to read the questionnaire accurately.

The interview questions covered a range of topics.[1] Demographic data included the number of persons in the

1 See Appendices B-F for complete interview forms.

family, their ages and relationships, education, occupation, income, marital status and housing situation.

A substantial portion of the interview dealt with nutrition practices. Since iron deficiency is a condition that develops over a period of time, a diet history for the child was taken as well as a 24-hour recall of diet for the day preceeding the interview. In some cases additional information on 24-hour intakes were obtained later by mail. Information concerning diet history and recall was also obtained by the doctor during clinic visits for those children seen at the university health clinic. Dietary intake for calories, protein, vitamin A and C, and iron was calculated from the 24-hour recall record and compared to recommended dietary allowances (RDA) for each nutrient. Further, total iron intake was divided according to the food source of iron.

The nutrition knowledge section of the interview was given to determine whether or not there was a significant difference in knowledge between mothers of anemic and control children. Later it was decided to determine in which areas of nutrition the mothers had the most and the least knowledge. This questionnaire contained 67 questions all of a True-False form.[1] Questions were obtained from three sources: twenty-three were adapted from Lund and Burk (55) and 24 questions from Wang (51); the others were

1 In the early part of the study only the first 29 questions were used. This was determined to be inadequate and the other questions were added making the total 67.

added by those working on this study. General questions on foods and eating habits, and more specific questions concerning the food sources and functions of various nutrients and the nutritional needs of infants and children were included. Nearly half of the questions were concerned with the food sources of nutrients. Mothers were given the option of replying "I don't know" to the questions. This choice was provided to eliminate a forced guess and to help keep the interview on a relaxed and informal level by indicating that the mothers were not necessarily expected to know all the answers. It also gave some idea of what they knew correctly or incorrectly and also what was unfamiliar to them. Answer sheets containing a brief explanation of the nutritional facts covered by each question were provided at the end of the interview or by mail.

Two different food attitude questionnaires were used. The first was an adaptation of the list used by Lund and Burk (55), listing various meats, fruits, and vegetables. Interviewees were asked whether they liked, did not like, had no feeling, or had never eaten each of the foods. Reasons for disliking a food were also asked. Although many foods were reportedly liked, food intake records and conversations with the mothers seemed to indicate that the variety of foods served to the family, at least on a regular basis, was not as great as the number of foods which the mothers said they liked. A new questionnaire was prepared listing various categories of foods and the frequency with

which these were served to the child in the study.

Another section of the interview included open-ended questions on food shopping such as frequency of shopping, the type of food store, expenditures for food, purchase of "convenience" and "health" foods, use of shopping lists, advertized "specials" and discount coupons.

A parent attitude scale was given to determine whether or not there were significant differences between mothers of anemic and control children in their attitude toward the role of "mother." Items on the parent attitude scale were adapted from Schaefer and Bell (56). Thirty-five items were selected reflecting a variety of parental characteristics such as abdication of parental role, rejection of homemaking role, martyrdom and irritability, and such attitudes toward children as showing affection, encouragement of development, and punishment. The items were read to the mother who responded with the extent to which she agreed or disagreed with the statements on a 4-part scale: strongly agree, agree, disagree or strongly disagree.

A short section of the interview included questions concerning parental expectations for their children. There were two parts to these questions: the first was a list of activities to which parents gave the age at which they would expect a boy or girl to perform the activity; the second part consisted of open-ended questions about what the parents felt were the most important things they could teach their children in life, what they hoped their children

would become as adults, and whether luck or effort would play the greatest part in their child's future. This part of the questionnaire was completed by the parent.

Statistical Analysis

Because of the small numbers involved the children were placed in two groups,"control" and "anemic" on the basis of hematological data, that is presense of 9 of the 11 conditions listed on page 28. Student's t-test was used to determine significant differences between the two groups for each section of the data (57).

Informed Consent

The study was explained to the mother and if they wished to participate with their children, an informed consent form was signed by each child's parent or legal guardian at the time of the initial interview. Two forms were used, one for control and one for anemic children, the difference being a statement regarding treatment of the anemic children.[1]

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1 See Appendix G for consent forms.

FINDINGS[1]

Laboratory Data

Mean hemoglobin values were 12.5 gm/dl for the controls and 9.7 gm/dl for the children with anemia. Among the anemic children, those having hemoglobin values between 10.0 and 10.9 gm/dl were considered to be mildly anemic while those with hemoglobin values below 10.0 gm/dl were considered to be moderately or severely anemic. Sixty-three percent of the anemic children fell into the mildly anemic category.

Additional hematological data was available on all children with anemia but only three of the control children. However, in the larger study of which this thesis is a part, laboratory data indicated that the control children can be placed into two different groups on the basis of transferrin saturation. Those children with a transferrin saturation of less than 17% were considered to be iron deficient despite a hemoglobin concentration of 11 gm/dl or above. On this basis it was found that among control infants and children up to 24 months of age, nearly 42% were iron deficient.

Demographic Data

The demographic data are summarized in Tables 3 and 4. Seventy-three percent of the control children were only children while only one (11%) of the anemic children was an only child. On the other hand, seven (77%) of the anemic

1 Throughout this report, several items have been omitted from discussion since responses were extremely variable and no trends were discernable. Since this study continued beyond data collected for this thesis, certain items may become significant to the findings when the number of respondents is increased. All major findings and trends are reported here from data collected for this thesis.

children were youngest children in their families while only two (18%) of the control children were the youngest child. The average number of children per family was 1.8 for control and 3.2 for families of anemic children.[1] This difference in number of children is reflected in number of persons in the household, 3.8 and 5.1 for control and anemic children respectively. Despite the larger size of families of anemic children, they lived in slightly smaller housing measured by number of rooms and of bedrooms.

Race and sex distributions of the children showed a tendency for the anemic child to be black and male. The control children were about equally distributed among races and between sexes.

More mothers of control children were married with an adult male present in the home. Total income was slightly higher for families of anemic children, but because of the larger family size, per capita income was less by nearly 25%. Educational level was similar for all parents, with control mothers attaining the highest level, 12.2 years. Fathers of control children averaged just about high school graduate level, followed by fathers and then mothers of anemic children. The differences in educational level between mothers and between fathers of control and anemic children was not significant by the t-test.

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1 Significant @ $t_{(.1)}$

Table 3: Physiological Characteristics[a]

	Control	Anemic
Mean age of children	16.4 mos.	13.2 mos.
Mean birth weight	6.9 lbs.	6.7 lbs.
Birth position:		
oldest/only	8 (73%)	1 (11%)
middle	1 (9%)	1 (11%)
youngest	2 (18%)	7 (78%)
Child's race:		
white	5 (50%)	1 (10%)
black	2 (20%)	7 (70%)
Spanish-American	2 (20%)	2 (20%)
mixed	1 (10%)	
Child's sex:		
male	7 (54%)	9 (82%)
female	6 (46%)	2 (18%)
Mean age of mother	22.2 yrs.	24.3 yrs.
Mean time between pregnancies	13.3 mos.	17.7 mos.

a Information on some items was not available for all families, therefore total numbers vary from item to item. Percentage figures are for each item separately.

Table 4: Familial Characteristics[a]

	Control	Anemic
Mean number of children/family	1.8[b]	3.2[b]
Mean number of persons/family	3.8	5.1
Marital status of mother:		
married	10 (83%)	3 (33%)
unmarried	1 (8%)	4 (45%)
separated, divorced	0	2 (22%)
unknown	1 (8%)	
Mother's employment:		
housewife	11 (83%)	6 (55%)
employed	0	1 (9%)
unemployed	0	1 (9%)
student	2 (15%)	3 (27%)
Adult male in the home:		
yes	10 (83%)	5 (50%)
no	2 (17%)	5 (50%)
Father's employment:		
employed	5 (56%)	2 (67%)
unemployed	4 (44%)	1 (33%)
Major source of income:		
job	6 (55%)	4 (40%)
public assistance	3 (36%)	5 (50%)
other	1 (9%)	1 (10%)
Income:		
family/year	$4488.50	$4554.67
person/year	$1180.75[c]	$ 899.47[c]
Mean educational level attained		
mother	12.3 yrs.	10.8 yrs.
father	11.9 yrs.	11.0 yrs.

a Information on some items was not available for all families, therefore total numbers vary from item to item. Percentage figures are for each item separately.

b Significant @ $t_{(.1)}$

c Significant @ $t_{(.05)}$

Nutritional Data

Diet History

There are many similarities in the diet histories of control and anemic children. Most children were bottle fed, 82% and 64% of control and anemic children respectively. A higher percentage of anemic children were breast fed (36% vs. 18%) or if bottle fed, received iron-fortified formula (71% vs. 50%); however, anemic children were changed to whole milk at a slightly earlier age. Consumption of cereals and strained baby foods started earlier and table foods later for the control children than for the anemic children. In both cases fruits and vegetables were started before meats, but by 6-8 months of age all infants were receiving meat.

Weaning from the bottle to cup occurred at an average age of one year for those children who were weaned at the time of the interview. Of the control children, 3 still drank from a bottle at ages 7, 11, and 12 months respectively; two anemic children ages 12 and 23 months, were still taking bottles. Several other children, drinking from a cup at mealtime, received bottles at bedtime (3 control and 5 anemic children).

More mothers of anemic children reported having "feeding problems" with their children and described the child's appetite as "poor" than did mothers of control children.

The average age at which the child sat up to the table with the family at mealtime was 7.0 and 8.2 months for control and anemic children respectively. Whether or not the child was fed at that time was not asked. One anemic child

was, at 14 months of age, still not at the table during family meals. The average age at which table foods were started is almost exactly the reverse of the age of sitting at the table with the family. Table foods were started at 7.1 and 8.0 months of age, the anemic children having the younger age. Table 5 shows the diet history data.

Food Attitudes

Results of the food attitude questionnaire showed little difference between the two groups of mothers. Many foods were reportedly liked by both groups, but dietary recall records and conversations with the mothers during the interview seemed to indicate that the variety of food likes were not closely related to the variety of foods served to the family, at least on a regular basis. Some mothers commented that although they liked a particular food, they had eaten it only a few times. The reasons why so many foods were liked but seldom served was not asked directly but conversations indicated that high price, unusual preparation and seasonal availability of a food were factors.

Favorite foods of the children included some predicatable choices. Fruits were generally well liked. A number of meats and vegetables were also listed as favorite foods, particularly chicken, hot dogs, mashed potatoes, corn and green beans. Vegetables, however, were the most frequently mentioned foods which the child reportedly did not like. The same pattern was found in the foods given as favorite or disliked by the mother and the family as a whole.

Responses to the food frequency questionnaire, the

Table 5: Diet History[a]

	Control	Anemic
Breast fed as newborn		
number, percentage	2 (18%)	4 (36%)
average length of time	4.5 mos.	3.8 mos.
Bottle fed as newborn		
number, percentage	9 (82%)	7 (64%)
bottle fed later in infancy	2	4
Type of furmula: (number, percentage)		
iron fortified	6 (46%)	6.5[b] (72%)
non-fortified	7 (54%)	2.5[b] (28%)
Mean age changed to regular milk	5.4 mos.	4.7 mos.
Mean age baby cereal started	1.6 mos.	1.9 mos.
Mean age strained foods started	2.7 mos.	3.0 mos.
meat started later, latest age	6-7 mos.	7-8 mos.
Mean age table foods started	8.0 mos.	7.1 mos.
Mean age most of milk from cup	12.0 mos.	11.5 mos.
number still on bottle	3	2
ages of those still on bottle	7, 11, & 12, mos.	12, 23 mos.
Receive bottle at bedtime:		
yes	6	7
no	3	1
Mean age child first present at table for family meal	7.0 mos.	8.2 mos.
Mother's assessment of child's appetite: (number, percentage)		
good	9 (82%)	3 (37.5%)
fair	1 (9%)	2 (25%)
poor	1 (9%)	3 (37.5%)
"Feeding problems" reported by mother (number, percentage)		
yes	1 (12.5%)	6 (86%)
no	7 (87%0	1 (14%)

a Information on some items was not available for all families, therefore total numbers vary from item to item. Percentages are for each item separately.

b One child received both.

second version of the food attitude questionnaire, are again very similar between the anemic and control groups, and suggest that both receive a fairly well balanced diet. All the children reportedly received meat, fish or poultry, as well as milk or other dairy product, and bread and/or cereal products every day. Citrus fruits or juices were served several times a week, and in some cases every day. Eggs and vegetables were each eaten several times per week. No significant differences between the two groups of children were found in frequency of various foods eaten.

The mothers were asked to describe their favorite meal to give some idea of whether or not such a meal would be balanced in terms of food groups, including a main meat dish, vegetables, fruits, cereal products and beverage, or at least most of these. Every favorite meal contained a meat dish, and all but one included a vegetable. Many included two or more vegetables. Fruits and milk were included least often.

Nutrition Knowledge

Results of the nutrition knowledge questionnaire for mothers of anemic and control children were compared according to:

(a) total number of correct answers; and

(b) right minus ½-wrong answers.

The "don't know" responses did not enter into the scoring. The scores of the shorter questionnaire (the early form) were corrected mathematically for comparison with the longer form.

Table 6: Food Frequency- Percent of Children Served Each Food Category per Week

Food Category[a]		Daily	1-4	S[b]
Eggs	C[c]	0	100	
	A	20	80	
Meat, fish, poultry	C	100		
	A	100		
Milk products	C	100		
	A	100		
Bread, cereal products	C	100		
	A	100		
Yellow vegetables	C	0	100	
	A	25	75	
Other vegetables	C	50	50	
	A	20	80	
Citrus fruits, tomatoes	C	75	25	
	A	60	40	
Other fruits	C	75		25
	A	0	75	25
Candy, desserts	C	50	50	
	A	20	60	20

a Some categories have been omitted from the table.

b Daily = everyday; 1-4 combines 3-4 and 1-2 times per week frequencies; S = seldom.

c C = control; A = anemic.

Table 7: Mothers' Favorite Meal- Food Categories Included

	Control	Anemic
Main meat dish	100%	100%
Vegetables	100%	83%
Bread and /or cereal product	38%	50%
Fruits	25%	0%
Milk	63%	17%
Beverage (including milk)	75%	33%
Dessert	25%	50%

Table 8 shows the total number correct and mean correct scores. A significant difference was found between the mean scores of the two groups of mothers. As can be seen, the mean score, 46, achieved by the mothers of control children is higher than all but one of the scores of mothers of anemic children, while the latter's mean score of 34 is lower than any score of the control mothers. Calculating the scores by right minus ½-wrong to correct for guessing which might falsely increase the number of correct answers gave very similar results (Table 9).

The 67 questions were grouped into four major sections: (1) food sources of nutrients; (2) function of nutrients; (3) food needs of infants and children; and (4) eating patterns.[1] The number of correct responses of the two groups of mothers was compared within each section. Results were calculated as the percentage of correct responses (100% being the number of questions in each section times the number of mothers answering each question). Results are shown in Table 10. As can be seen, mothers of control children correctly answered more questions in each section and scored significantly higher in 3 of the 4 sections. It is interesting to note that the highest number of correct answers for both groups was in the section on food needs of infants and children. This was the only section in which mothers of anemic children scored higher than about 50% correct, and the only section where the differences between scores of the

1 See Appendix C for the nutrition knowledge questionnaire and grouping of the questions, questions answered correctly by most and by less than half the respondents.

Table 8: Nutrition Knowledge Scores- Number Correct[a]

Control	Anemic
59	49[b]
53	41
49	36
49	34 (mean = 34[a,c])
47 (mean = 46[a,c])	33
44	30
39	28
36	25
35[b]	

a nearest whole number of 67 total
b shorter form corrected to compare with longer form
c significant @ $t_{(.005)}$

Table 9: Nutrition Knowledge Scores- Right Minus ½-Wrong

Control	Anemic
56.5	39.1[a]
50	36
42.5	26 (mean = 25[b,c])
40.5	24.5
40 (mean = 38[b,c])	24.5
36.5	19
28	18
25	16
23.1[a]	

a shorter form corrected to compare with longer form
b nearest whole number
c significant @ $t_{(.025)}$

two groups of mothers was not statistically significant.

Table 10: Percentage of Correct Answers to Grouped Nutrition Questions[a]

	Question Group	Control	Anemic
I	Food Sources of Nutrients	54[b]	40[b]
II	Function of Nutrients	79[c]	53[c]
III	Food Needs of Infants and Children	81	75
IV	Eating Patterns	76[d]	50[d]

a nearest 1%
b significant @ $t_{(.025)}$
c significant @ $t_{(.025)}$
d significant @ $t_{(.005)}$

Individual questions were also considered in analyzing the results. No single item distinguished between the two groups of mothers. Fifteen questions were answered correctly by nearly everyone, with approximately equal numbers of these questions in each of the four sections. Twelve items were answered correctly by less than half of all mothers.[1] All but one of these was in the section on food sources of nutrients; the other was in the section on function of nutrients.

24-Hour Dietary Intake Records

Food intake was calculated from the recall records and intake of several nutrients compared to the recommended dietary allowance (RDA). Table 11 shows the mean intake of each nutrient as a percentage of the RDA for each group of

1 See Appendix C for questions answered correctly the most and the least frequently.

children. Of greatest importance is the fact that the difference in iron intake between the control and anemic children is significant at the .025 level by the t-test. Additionally, it is the only significant difference in intake of the nutrients analyzed. Although the percentage-point difference in RDA is greater for some other nutrients, the variance for those nutrients was also greater, resulting in an insignificant difference by the t-test. Of particular interest, however, is the fact that not even the control children averaged 50% of the RDA level for iron intake.

Table 11: Mean Daily Nutrient Intake- Percent of RDA[a]

	Control	Anemic
Calories	112	101
Protein	218	195
Vitamin A	230	136
Vitamin C	194	129
Iron	47[b]	30[b]

a nearest 1% b significant @ $t_{(.025)}$

To determine the major sources of iron in the child's diet, food sources were categorized into 6 groups, and the mean percentage of iron coming from each food group was calculated (Table 12). These figures indicate that the diets of the two groups of children were very similar as far as the source of iron is concerned and there are no statistically significant differences.

Table 12: Source of Iron- Mean Percent of Total Daily Iron Intake[a]

Food Group	Control	Anemic
Eggs	15.4	21.8
Meat	22.3	26.1
Breads and Cereals	32.2	29.7
Fruits	18.1	12.8
Vegetables	18.2	17.9
Milk and Milk Products[b]	5.0	5.7

a Numbers are the mean % of total daily iron intake contributed by each food group. Although figures for each individual child totaled 100%, percentages listed here are the means for the group as a whole, and therefore, totals do not equal 100%.

Milk consumption was nearly the same for the two groups, not only in the percentage of daily iron it provided, but in total milk intake and percent of daily calories as well. Differences were not significant (Table 13).

Table 13: Milk Consumption- Mean Daily Intake[a]

	Control	Anemic
Mean Milk Consumption (ounces/day)	18.8	19.1
Percent of Total Daily Calories	27.1	34.8

a Includes infant formulas and cow's milk.

Shopping Patterns

Despite the fact that some families lived in the "inner" city and did not have cars, they shopped at suburban supermarkets, sometimes located miles from their homes. Their reasons for shopping at supermarkets were most often the lower prices, and better quality and selection of foods. While the homemakers generally went to those stores where they felt the prices were lowest, not all took advantage of newspaper discount coupons or items advertized at special prices. Several families did not take a newspaper because of its cost.

Most of the families shopped every two weeks which was the pay interval of many jobs as well as the schedule of welfare payments. Three shoppers mentioned making daily or bi-weekly trips to the store for a few items such as bread or milk, in addition to larger trips made less frequently. Two mothers said they made a major shopping trip every month or two months, with smaller trips in between on occasion. More shoppers than not took a list, at least some of the time, although a few made such comments as "I know what to get" or "I get what I always do," indicating a somewhat repetitious nature and limited variety of food preferences and intake. It would appear that most of the mothers are fairly organized in their shopping, buying groceries for a two-week or greater time period and shopping where they felt the overall prices were lowest. Five women mentioned that they might go to more than one store. There were no significant differences between mothers of control and anemic children in

shopping practices.

The families spent an average of $24 and $26 per week for food, families of anemic children having the higher figure. When calculated on a per-person-per-day basis, the food cost figures are $.80 and $.73, control families having the greater amount. These figures are not significantly different.[1]

Neither group used "convenience", prepared or semi-prepared foods to any great extent. Cake mixes were the convenience food most frequently mentioned. Two homemakers used so-called "health" foods occasionally.

Most of the mothers liked to cook and used recipes occasionally for special dishes and for variety. Most learned to cook from their mothers and had had some kind of home economics training in school or through clubs such as Girl Scouts or 4-H.

Some women felt that the public was getting confusing nutrition information from mass media sources. When asked what sources they would use for nutrition information, most seemed hesitant in deciding. A variety of sources were given, some potentially knowledgeable such as doctors, dietitians, health clinic personnel, and nutrition books. Other sources mentioned were of more questionable reliability such as other family members or store clerks.[2]

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1 Cost figures are for 1971-1972.

2 Data collection was conducted in 1971 and 1972. Responses to questions on use of convenience foods and sources of nutrition information might be quite different if the study were repeated due to increases in types of convenience foods and in public awarness of nutrition concerns.

Parent Attitudes and Expectations

Two points stand out on the parent attitude questionnaire when responses are compared: (1) the extent of similarity between the two groups of mothers; and (2) the extent to which mothers within each group were divided between agreement and disagreement to a given item. Responses to some items, including autonomy of the child (24)[1], non-punishment (22), avoidance of communication (17), avoidance of tenderness (23), expressing love and affection (29), and irritability (6) were nearly identical between the two groups. Close agreement in response was given to items on encouraging verbalization (1, 11), breaking the will (3), harsh punishment (31), rejection of homemaking role (14), comradship and sharing (20), and equalitarianism (25), and infantilization (30).

Items where both groups were divided between agreement and disagreement to a given statement included acceleration of development (21, 26), suppression of agression (9), martydom (4), abdication of parental role (35), irritability (12), excluding outside influences (7, 13), ascendency of mother (18), ignoring the child and baby (28, 32, 34), and avoidance of tenderness (27).

No item showed a clear-cut division between the two groups of women. Items showing some degree of difference between the groups included approval of activity (16), strictness (5), deification of mother (8), rejection of the

1 Numbers refer to item number on the parent attitude questionnaire. See Appendix E for complete questionnaire and grouping of the items.

mother role (10), abdication of parental role (33), equalitarianism (15) and intrusiveness (19). However, the differences between the two groups were not statistically significant on any item.

The items were also grouped into four general categories: (1) mother role; (2) mother-child relationship; (3) development of the child; and (4) discipline. Responses are shown in Table 14. There were no significant differences between responses of the two groups of mothers. Within each category there were items to which the two groups of mothers gave some nearly identical responses, some divided within their own group, and some which showed a degree of difference between groups.

Table 14: Combined Responses to Parent Attitude Categories-Percent Agree and Disagree Responses

		Response	Control	Anemic
I	Mother Role	A[a]	57[b]	54
		D	43	46
II	Mother-Child Relationship	A	52	46
		D	48	54
III	Development of Child	A	68	76
		D	32	24
IV	Discipline	A	36	34
		D	64	66

a A combines "strongly agree" and "agree" answers; D combines "strongly disagree" and "disagree" answers.

b nearest 1%

The mothers were about equally divided between those who did and those who did not like housekeeping. There seemed to be no correlation between the homemaker's answer to that question and the condition of the home at the time of the interview. The most poorly-kept home (with broken glass on the kitchen floor and the children barefoot) was that of a mother who said she liked to keep house, while the homes of mothers who reportedly didn't like housekeeping were at least reasonably neat and clean for the interview. This may have been related to concern for the interviewer's expectations.

The questionnaire concerning the ages at which parents expect children to be capable of certain tasks indicated that mothers of anemic children generally expected performance at an earlier age on such tasks as toilet training, dressing himself, and taking care of younger children. An important exception from a nutritional standpoint was the age at which mothers expected a child to eat at the table with adults. Control mothers gave an average age of 10 months while mothers of anemic children cited 18 months. However, this difference is greater than that indicated in the diet histories of the ages at which the children in the study began to sit at the table with the family at mealtime, although in that case also the age for anemic children was the greater (7.0 vs. 8.2 months). In contrast, mothers of anemic children responded with 10-11 months of age for a child to begin eating adult food rather than baby food, while control mothers gave 15-18 months as an average age.

Again the difference between the two groups is greater than that indicated by diet histories as the actual practice, but the order is the same (7.1 vs. 8.0 months for anemic and control children respectively).

The questions concerning the most important thing a mother teaches her child and how she does this were broad, general questions and elicited broad, general answers. However, some interesting trends do appear, particularly regarding what is most important to teach a girl versus a boy. Cleanliness, neatness, and being a "young lady" were cited most often for a girl. A greater variety of things was given for boys with no one thing predominant. Things cited only for boys included responsibility, self-assurance, and self-reliance. Things listed equally for boys and girls included self-respect and teaching the "facts of life". The most frequent answer to the question of how one should teach the most important thing were by "example" and "talking and explaining". It seemed more difficult for the mothers to answer these general questions than the other more specific questions in the rest of the interview.

DISCUSSION AND RECOMMENDATIONS

Laboratory Data

Laboratory data collected in this study and the larger study of which it was a part indicated that iron deficiency anemia was most often mild, with the children having hemoglobin levels between 10.0 - 10.9 gm/dl. Additionally, iron deficiency without anemia was more prevalent among the children in the larger study. It was not possible to predict the incidence of iron deficiency without anemia on the basis of hemoglobin value. This would indicate that testing of hemoglobin alone is not adequate to detect those children with marginal iron status.

Demographic Data

Race

A greater proportion of black than white or Spanish-American children were found to have iron deficiency anemia in this study, as has been the case in some other studies (6, 31). Since the children in this study were all from "low income" families, the higher incidence of anemia among black children cannot be dismissed simply on the basis of socio-economic level. As was already mentioned, the "normal" hemoglobin values for blacks may be slightly lower than for whites so that comparison of blacks to standard hemoglobin levels for whites may not be appropriate (48).

Sex

In this study more children with iron deficiency anemia were male than female. This is consistent with some other

studies (8, 25). The RDA recommendations for iron, as well as other nutrients and calories, are the same for both sexes during infancy and childhood, as are standard hematological values.[1] Such lack of distinction between sexes at this age would suggest that biological parameters and nutrient needs are similar.

Socio-Economic Level

The children in this study were all from families whose incomes were generally low, with the average annual family income approximately $4500. A number of family characteristics indicate trends which may become more apparent when data from the entire study are assembled.[2] Eighty-three percent of mothers of control children were married compared to 33% for mothers of anemic children. This difference may be an important factor in the somewhat greater reliance of families of anemic children on public assistance as the major source of income (50% vs. 36%). Per capita income was significantly greater for families of control children, but this difference was not reflected in the food budgets where average expenditures per-person-per-day for food were nearly identical for the two groups of families.

Educational level of parents was similar, but mothers of control children had completed the most schooling on the

1 Although standard hemoglobin values for adults are different for each sex, this difference becomes apparent during puberty and seems to be the result of a higher androgen level which increases the hemoglobin level in males (13).

2 A report of the larger study has been made (3).

average (12.3 yrs.) and the mothers of anemic children the least (10.8 yrs.). This difference was not significant for this sample, but as the number of families studied is increased a similar finding might be significant.

Seventy-three percent of the control children were the oldest or only children, while 77% of anemic children were the youngest in their families. The mean number of children per family was significantly larger for anemic than control children. Smith reported similar results, stating that iron deficiency was less likely to occur in first born than in later children (25).

While each of these factors may play a minor role in the etiology of anemia, their total effect may be of importance. A pattern which seems to emerge is that, in comparison to her counterpart in the control family, the mother of the anemic child has more children, less disposable income and less education. The absence of a husband in the home places greater responsibility on her for the care of the children and it is the youngest child who is most likely to develop anemia. It is possible that older children were also anemic during the vunerable period of infancy, but specific data on older siblings were not available.

Psychological Factors

The data regarding parental attitudes toward child rearing were very similar between the two groups of mothers. On many items mothers of both control and anemic children were divided as to agreement or disagreement to a given

statement. Only a very few items showed differences between the two groups and these differences were not significant.

The parental expectations questions indicated a general expectation of task performance at a slightly younger age for anemic than control children on at least some tasks. This may be related to the fact that a greater number of anemic children were the youngest in a family of several children. Included among the tasks were several which would be expected of children older than those in the study group. More mothers of anemic than control children had the benefit of experience with older siblings in determining ages of expected performance of these tasks.

Nutritional Data

The major part of this thesis was concerned with the nutritional status of the child, the differences between the knowledge of mothers of control and anemic children regarding nutrition, and possible ways to educate the mothers in nutrition.

Diet History

Diet histories of the two groups of children were similar. However, some differences in consumption of baby cereals and meats, important sources of iron in infant diets, may play a part in distinguishing between control and anemic children. (See Table 5). The number of iron-rich foods available to infants is somewhat limited, fortified cereals and meat being two of the most frequently consummed (58). The control children were started earlier on baby cereal,

as well as other baby foods (fruits, vegetables, meats) and continued on them longer before changing to adult foods. The anemic children were started on solid foods later and fed both baby cereals and meats for a shorter average length of time. Baby food cereal was generally discontinued before the age of greatest risk of iron deficiency, but meat was started about that same time (6-8 months of age). While the differences in consumption of cereal and meat between control and anemic children were slight and not significant statistically, in combination they may work to the advantage of the control child. Many adult type cereals do not contain as much iron as do baby cereals (about 1.5-2.0 mg vs. 14 mg per average serving) and thus the amount of iron consumed by an infant eating adult cereal would likely be considerably reduced (59). In addition, infants may have greater difficulty in eating adult meat unless it is ground or cut into small bites. The quantity of regular meat eaten by a child at one meal or in one day might therefore be less than the quantity of prepared baby food meat eaten.

Iron-fortified formulas did not seem to play an important role in this study. In fact, more anemic than control infants were given fortified formula (68% vs. 42% of all anemic and control children), but in both groups formula was no longer used by an average age of less than 6 months.

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1 Unfortified adult cereals contain about 1.5 mg of iron per serving while fortified adult cereals contain 8-10 mg per serving. Therefore, careful selection of fortified adult cereals could contribute a sizeable percentage of the RDA for infants <u>if a full adult serving were consumed</u>.

Nutrition Knowledge

Results of the nutrition knowledge questionnaire indicate that mothers of control children had greater knowledge in all four sections of that questionnaire: food sources of nutrients, function of nutrients, food needs of infants and children, and eating patterns. However, the section in which the mothers of anemic children had their highest scores (and the only section in which the differences in scores between the two groups of mothers was not significant) was that on food needs of children. This is interesting since children's nutrition was the area of particular concern in this study, and the mothers were grouped according to the nutritional status of their children in regard to iron. There are several possible reasons for these results. The questions about food needs of children may have been too few and too general so that a minimal knowledge was sufficient to answer them correctly. The low score (mean 40%) of mothers of anemic children in the section on food sources of nutrients may have been an important part of the reason for the apparent discrepancy between their knowledge of food needs of children as indicated by their relatively high score on that section of the questionnaire, and the nutritional status of their children. The control mothers' higher scores on the sections on food sources and functions of nutrients may reflect a greater overall nutrition knowledge enabling them to better understand and put into practice the general knowledge of children's nutritional needs. There may also be a discrepancy between what the

mother knows or believes to be good nutrition for her family and her actual feeding practices. One study found evidence of this, reporting that 72% of mothers questioned believed that vegetables, and 85% believed that fruits were important in a child's diet, yet these foods were rarely served to their children. It was concluded that nutrition knowledge and opinion could not be equated with feeding practices (60).

One additional fact stands out; neither group of mothers knew very much about the food sources of nutrients. That section of the questionnaire had the lowest scores for both groups. While the control mothers scored significantly higher, their mean score of 54% correct (compared to 40% for mothers of anemic children) can hardly be considered a high score. It would seem that this is an area where efforts in nutrition education for mothers of small children could focus attention.

During the course of the interviews it became apparent through conversations with the mothers that they lacked knowledge about iron deficiency anemia. There was confusion among black mothers concerning the differences between iron deficiency anemia and sickel cell anemia. Some mothers showed a lack of concern about iron deficiency, particularly if they or other members of their family had had it previously. One mother commented that she didn't realize that it could be serious enough to require medication. Perhaps the ready availability of iron supplementation in over-the-counter preparations such as multivitamin and iron tablets and

"tonics" suggests that medical consultation is not necessary.

A short educational pamphlet was developed as an aid in helping mothers better understand iron deficiency anemia.[1] A brief explanation of iron deficiency was included as well as a list of nutritional risk factors which contribute to its development, such as rapid growth during the period of 6-24 months of age, high milk consumption and low meat consumption. A list of iron-rich foods was included so that the mother could include these in the child's diet.

A sample pamphlet was distributed by the Ingham County child health clinic to a small number of mothers whose children were 6-24 months of age and had hemoglobin levels close to 11.0 gm/dl. The pamphlet was explained to the mothers by clinic personnel. Telephone calls were made to some of these mothers for their comments about the pamphlet. The mothers found the list of iron-rich foods the most helpful part of the pamphlet. Additional copies of the pamphlet were not made, but it might be used for distribution to mothers of infants through nutrition education programs, health clinics, or social service programs.

Food Attitudes

The food attitude questionnaire was an attempt to elicit a more complete response conderning overall diet than was obtained by the 24-hour recall records. The questionnaire itself was in the process of development during the time data for this thesis was collected, and, in fact, two

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1 See Appendix H for text of pamphlet.

versions were used in this study. The first version, a list of specific foods to which the mothers indicated the degree that they liked each food, did not indicate the frequency with which the food was eaten. This was considered a serious omission, and the second version was developed listing categories of foods according to essential nutrients provided. The frequency with which each group was served to the study child was asked. Because of the small number of mothers given each version it is difficult to draw conclusions. The food frequency responses indicated a fairly well balanced diet in terms of the number of time per week important food sources of essential nutrients were served. However, the quantity of the various foods actually eaten by the children appeared to be a more important factor in the incidnece of iron deficiency. Quantities of foods usually eaten by the child might be incorporated into the food frequency chart. In addition, the frequency questionnaire did not indicate the variety of foods within each category and might be expanded to include a section on the number of different fruits, meats, vegetables and so on served each week, or the specific foods. Further attempts should be made to design better instruments for evaluating dietary intakes both on a short term and long term basis.

Shopping Patterns

Some studies have indicated that the urban poor pay more for food because they cannot shop at suburban chain supermarkets where prices are generally somewhat lower (61); this was not true in this study. Families of both control

and anemic children shopped at the suburban markets to take advantage of lower prices. Other studies have also found this to be the case (62).

Intake Data Compared to RDA

Although a significant difference between the control and anemic children was found in intake of iron compared to the RDA for that nutrient, the striking fact was that not even the control children averaged an iron consumption of 50% of the RDA. Of all intake records of control children, only three were above 60% of the RDA for iron, with the mean intake being 47%. It would appear that daily iron intake is marginal at best. This is not different from the findings of a number of other studies. One study of infants found that iron intake expressed as percent RDA dropped steadily from close to 100% at 6 months of age to about 50% at 13 months (62). Another study found that less than 25% of infants met the recommendation for iron suggested by the Committee on Nutrition (5). A study of diets of preschool children found that only 20% met the recommendations for all major nutrients and that iron was the nutrient least well supplied. Fewer children had iron intakes of 100% of the RDA and more had iron intakes below 67% than for any other major nutrient (63). Other investigations have found that iron intake was below the RDA despite adequate protein and calorie intake in preschool children (33) and that among school children, 84% had iron intakes of less than 66% of the RDA (7).

Under such circumstances the question arises why more of the children were not anemic. It may be that the RDA is unnecessarily high or that the present standards for diagnosis of iron deficiency are too low. These values have been the subject of controversy as was already discussed, and have been revised from time to time reflecting current research findings and interpretations. Beal and Meyers did not find a clear relationship between iron intake and hemoglobin, hematocrit or mean corpuscular hemoglobin concentration levels in their longitudinal study (64). It was found that while iron intakes seldom reached the RDA recommendation, hematological levels were satisfactory. Further, Beal, in another study, pointed out that little is known about possible adaptation of individuals to their levels of iron intake (65).

The accuracy of intake records is, of course, an important factor in RDA calculations and one which is difficult to assess in the 24-hour recall record. In this study, the recall was taken for the day prior to the interview, and it is unlikely that the mother made any particular note of the child's intake during that day. In obtaining the intake records, mothers were more hesitent about the quantities eaten than about which foods were served, and were particularly hesitent if the child left some food on his plate or was given second helpings. Whitten et al found that in cases of growth failure due to undernourishment, parental dietary recalls were unreliable (54). Beal found the preschool period one of unevenness of intake and observed

100% variations between children in intake of calories, carbohydrates and protein, and even greater variations in ranges of some other nutrients. Daily variations for a given child were not so great (65). The use of single 24-hour recall records poses the possibility of unrepresentative intake compared to a child's "usual" diet. However, in those cases in this study where 2-3 recalls were obtained, differences in intake were not so great as to change the statistical findings. The range of intake for iron was less than for any other nutrient evaluated, and despite the inherent problems of 24-hour recall data, the findings of low iron with generally adequate intakes of other nutrients is consistent with other studies. Further, there is variation in iron content of different samples of a given food, and the published data on nutrient content of various foods used to calculate dietary intakes may contain errors.

Although complete hematological data were obtained on too few control children in this study to make a meaningful comparison of iron intake expressed as percent RDA between iron deficient children and non-deficient control children, preliminary data from the larger study indicated that there may be a difference between these two groups in average iron intake, with the non-deficient children having higher iron intakes than those with iron deficiency, and iron intake level of deficient children higher than that of anemic children. This would indicate some correlation between iron intake and hematological data, contrary to the findings of Beal and Meyers (64) already cited.

Food Sources of Iron, Fortification, and Utilization

The incidence of iron deficiency and iron deficiency anemia and the low intake levels of iron have led to much debate concerning both iron fortification of various foods and general feeding practices of children. A number of questions arise, including the kinds of foods which could or should be fortified, the type and amount of iron supplementation, the effectiveness of such foods in preventing iron deficiency and anemia, and the increased use of iron fortified foods by individuals with higher risk of development of iron deficiency.

Analysis of the source of iron in diets of children in this study showed a similarity between control and anemic children. The difference in percent of the RDA for iron intake seems to be due to greater quantity of food consumed by the control children on a daily basis rather than to higher quality in terms of iron-rich foods. For all children, the greatest percentage of iron came from the bread and cereal food group, a finding that would support the proponents of continued or expanded iron fortification of this food group in view of the persistence of iron deficiency in children. While fortification of commercial infant foods, particularly formulas and cereals, is common, these foods are frequently discontinued at an early age. Filer found that formulas were continued until about 4 months of age, and by 6 months of age 75% of infants studied were receiving regular milk rather than formula (66). Purvis found that while over 90% of infants studied consumed baby cereal at

age 4 months, this number dropped to less than 50% by 12 months of age, 10% by 18 months, and essentially 0% by age 24 months. Further, that study found that consumption of iron by infants was closely related to consumption of fortified cereal, the average iron intake falling below recommendations when these cereals ceased to be a major part of the child's diet (58). Another study found that only about 66% of 6 month old infants were receiving fortified baby cereals and that there were wide variations in iron intake depending upon the amount of cereal consumed (5).

There is also some question as to the effectiveness of iron fortification in the early months of life in full term, normal birth weight infants. As has already been mentioned, incorporation of dietary iron into hemoglobin may be low, and since formulas and cereals are so often discontiued at an early age, their role in prevention of iron deficiency is somewhat diminished. However, the RDA for iron during this period is so seldom met by the usual diet which supplies adequate amounts of other nutrients and calories, and the Committee on Nutrition suggests that fortification is probably needed (22). As mentioned earlier, there is some question of the availability of iron used for fortification. One author stated that the pyrophosphate in cereals has a very limited absorption (1). Filer, in referring to fortified formulas stated that the utilization of iron was greater when protein content of the formula was less than 28 gm/100 ml (66).

It seems apparent that while fortification is recommended on the one hand, there remains much research yet to be done on the source of iron and the foods to be fortified, and on the interaction on iron absorption of various foods as combined in a meal.

Summary

This thesis investigated some of the sociological, psychological and nutritional aspects of anemic and control children 6-24 months of age, from low income families. However, particular emphasis was on nutritional factors. Results indicated that the diets of all children were generally adequate except for iron, and, although there was a significant difference in iron intake between control and anemic children, the iron intake of all children was well below the RDA for this nutrient. There were also significant differences in family per capita income and mother's knowledge of nutrition, in both cases the families of control children having the higher values, and in number of children per family with the families of anemic children having the higher number. The anemic child was more often the youngest in his family of several children than was the control child. Black males seemed more likely to become anemic than black females or Spanish-American or white children of either sex. Other variables which were considered did not show significant differences between groups, although some trends were observed and these are more fully analyzed in the final report of the entire interdisciplinary study (3).

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APPENDICES

APPENDIX A

IRON DEFICIENCY ANEMIA STUDY PHYSICAL EXAMINATION FORM

Child's Name_____

Date_____

Weight - lbs, oz_____ Head circumference - cm_____

Weight - kg_____ (L) Mid-upper arm - cm_____

Weight - %ile_____ Chest - cm_____

Height - in_____ Abdomen - cm_____

Height - cm_____

Height - %ile_____

B P _____ P_____ R_____ T_____

General (physical development, developmental items, disposition, alertness:)_____

_____

_____

_____

Head:_____

Eyes:_____

Ears:_____

Nose:_____

Mouth and pharynx:_____

Teeth:_____

Neck:_____

Lymphatics:_____

Chest:_____

Lungs:_____

Heart:_____

APPENDIX B

IRON DEFICIENCY ANEMIA QUESTIONNAIRE

Child's Name:_____

Sex:_____ Birth Date:_____

Mother's Name:_____

Father's Name:_____

Address:_____

Telephone Number:_____

Interview-Appointment Information

Section	Date	Place	Time	Interviewer

Introduction:

We are trying to learn more about the growth and eating habits of young children. In order to learn not only what children eat, but why they eat it, we need to know certain things about the children's families. You, as a parent of a young child, can help to supply the information we need. There are no "right" or "wrong" answers to the questions you will be asked.

Pregnancy Record

Mother's Present Age_____

Pregnancy	Date[a]	MM[b]	S[c]	L[d]	Birth Weight	Length of Gestation	Complications[e]			
							Pregnancy	Labor	Delivery	Comments

[a] Date of termination of pregnancy

[b] Miscarriage

[c] Stillborn

[d] Live Birth

[e] Special reference to bleeding, abnormal placement of the placenta and premature separation of placenta.

Are you planning to have any more children?_____

What method of birth control, if any, are you using?

_____

FAMILY RECORD

HOUSEHOLD CHARACTERISTICS

How many persons live in your household?_____

Family Members Names	Relationship	Birthdate	Sex	State of Health	Highest no. yrs. school completed	Occupation	Number hours worked/week

Non-relatives living in home

1. Are you now married? If No, ask, Have you ever been married?

2. Do you have a paid job?

3. If response to question is Yes, What is your job? or, What kind of work do you do?

4. (If applicable only, ask) What about your husband? Is he employed?

5. How many hours each week is _____ cared for by someone else?

No. hrs./wk.	Where
_____	Within own home
_____	Home of relative
_____	Home of someone else
_____	Nursery school
_____	Other, specify_____
_____	Total Hours

6. About how much money in all does your family make (or get)? (Record verbatim answer, including whether amount given is per week, month, or year.)

_____

_____

7. Would you tell me where most of your money comes from? (DO NOT PROBE.)

8. Some people believe that food habits are related to religious affiliation: what is your religious affiliation?

9. Some people believe that the national origin of parents is related to food habits of children.

   a. What is your nationality?_____

   b. What is the nationality of your husband?_____

10. How long has your family lived at this address? (Record answer verbatim.)

11. How many times have you moved within the last three years?_____ (Actual number of moves.)

12. Where were you born and raised?

13. When did you move to Lansing?

14. Do you own or rent your housing?

15. How many rooms are there in this house? (Exclude bathroom, utility rooms, halls, and other areas unsuitable for sleeping or general living purposes. Include porch if used for living at least 9 months of the year.)

    _____ Number of rooms _____ Number of bedrooms

16. Do other persons regularly sleep in the same room as _____?

    0. No
    1. Yes How many?_____

17. How was _____ fed as an infant? (Breast or bottle)

18. If formula, which one? With iron?

19. When was _____ switched to whole milk?

20. When did you start cereal? Was this accepted easily?

21. When did you start strained foods? Was this accepted easily?

22. When did you start chopped or table foods? Was this accepted easily?

23. When did _____ start drinking most of his milk from a cup or glass? Was it a problem to wean him to a cup?

24. Is _____ allergic to any foods? If yes, which foods?

25. Did you have any feeding problems with _____?

26. Did _____ get vitamins, iron, or any other medication?

27. It is easier to talk about a specific day rather than in general terms, so let's talk about what _____ did and ate yesterday. What time did he get up in the morning? How did he feel?

28. Does he like to have breakfast right away or does he prefer to wait a bit?

29. What time did he have breakfast yesterday? What did he eat? How much milk (regular, 2%, skim) did he have?

30. Does the whole family have breakfast together or has you husband left before the children eat?

31. What did _____ do in the morning? take a nap? play with toy? Was he fussy or cheerful?

32. Did he have anything to eat or drink between breakfast and lunch? What?

33. At what time did he have lunch? What? How much?

34. Does _____ nap in the afternoon? What did he do the rest of the afternoon?

35. Did he have anything to eat or drink between lunch and dinner?

36. What time did he eat dinner? What? How much? Did the family eat together?

37. Did _____ have anything to eat between dinner and bedtime?

38. Does_____ like a bottle before bedtime?

39. Does _____ sleep through the night? What time does he usually go to bed?

40. Total liquid intake:

	Milk	Soft drinks	Juices	Water
	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
	_____	_____	_____	_____
Total	_____	_____	_____	_____

Total, all liquids_____

41. When did _____ start eating with the rest of the family? (Vary question with the age of the child; try to get information on family eating pattern.)

42. Does_____ like to eat? Or does he have to be urged? How do you get him to eat more? Would you describe his appetite as good, average or poor?

43. What do you do if he plays with his food rather than eating it?

44. Does _____ eat a variety of foods or does he like the same foods all of the time, like peanut butter and jelly sandwiches for lunch every day?

45. For which meal is _____ most hungry?

46. What are his favorite foods?

47. Which foods does he like least or actively dislike?

48. Is there anything a child _____ age should not be eating?

49. Would you describe _____ as an active child?

50. What does he like to do best? Does he have a favorite toy?

51. Do you make _____ finish what is on his plate?

52. How do you get_____ to try a new food?

53. Would you like him lighter or heavier than he is now?

54. What do you do if _____ misbehaves? What do you do if _____ is very good?

55. Do you check sales in the newspaper before buying your groceries?

56. How would you describe your food buying practices?

57. How often do you market?

58. How much do you spend on food each week?

59. Do you make out a list for shopping?

60. At what type of store do you do most of your shopping? Do you shop alone or with the family? Any particular reason for that store?

61. What mixes or convenience foods do you routinely use?

62. Describe your favorite meal. Naturally since we are talking about it and not eating it, money and diets and such should not be considered.

63. What foods does your family like best?

Least?

64. How many recipe books do you own?_____ Which one is your favorite?_____
Do you clip recipes from the newspaper?_____ Do you pick up or subscribe to magazines which contain food information and recipes?_____

65. How did you learn to cook? Do you enjoy cooking?

66. Do you enjoy keeping house?

67. Do you enjoy eating or just do it to satisfy your hunger?

68. Did you have any classes at school or Girl Scouts concerned with with food and nutrition?

69. If you wanted to know more about the value of certain foods, how would you go about finding out about the nutrient value of foods?

70. Do you think that the public is getting much confusing information about foods from newspapers, etc.?

71. Do you use any so-called "health foods"? If yes, could you tell me your reasons?

72. Do between meal snacks spoil _____'s appetite?

73. If _____ eats poorly at one meal, will he make up at a later meal?

74. Does _____ ask for specific foods?

75. In a few minutes I will give you a questionnaire to determine what you know about foods in general. Would you like me to send you the list of correct answers and mark the ones about which you were misinformed?_____

APPENDIX C

NUTRITION KNOWLEDGE QUESTIONNAIRE

Name_____ Date_____

		True	False	Don't Know
1.	Good eating habits are important to good health.	T	F	_____
2.	You don't have to eat vegetables if you drink lots of milk.	T	F	_____
3.	If a person eats regularly, he should be rated as having good food habits.	T	F	_____
4.	Protein rich foods, such as meat, milk, and eggs provide large amounts of the materials a small child needs to grow.	T	F	_____
5.	It is better to eat a little bit of many different kinds of food than a lot of only a few foods.	T	F	_____
6.	When children eat enough to be full, they are getting enough of the nutrients needed to grow and stay healthy.	T	F	_____
7.	School age children need multiple vitamin pills every day to stay in good health.	T	F	_____
8.	By the end of the first year, babies should be eating a variety of foods besides milk, because milk does not supply everything needed for growth.	T	F	_____
9.	All foods contain protein, carbohydrates and fat, but each food has different amounts of protein.	T	F	_____
10.	Milk is a food needed mainly for infants and growing children.	T	F	_____
11.	Skim milk contains about the same amounts of body building materials as whole milk.	T	F	_____

		True	False	Don't Know
12.	No reducing diet should contain bread or potatoes.	T	F	_____
13.	Everyone should eat some green or yellow vegetables every day.	T	F	_____
14.	What you eat when you are young will make a difference on how healthy you are when you grow up.	T	F	_____
15.	A glass of lemonade can be substituted for a glass of orange juice so far as the vitamin C in the two products is concerned.	T	F	_____
16.	Healthy, active, young children need some concentrated sugar, like a piece of candy each day to give them energy.	T	F	_____
17.	Protein supplies building blocks for the body.	T	F	_____
18.	To be healthy, everyone needs protein and calories.	T	F	_____
19.	Soda pop is a good thing to include in the diet of children about two and older.	T	F	_____
20.	Most fat children and adults have a glandular disturbance.	T	F	_____
21.	Milk, meat and eggs are protein rich foods.	T	F	_____
22.	The term "well balanced" when applied to a meal means only that it is not too starchy or too fatty.	T	F	_____
23.	Meal time is a good time to talk over the day's events with the family.	T	F	_____
24.	A good diet is easy to have if one has enough money.	T	F	_____
25.	If you like a variety of foods, your children will eat a variety of foods.	T	F	_____
26.	People who do not eat meat are bound to be in poor health.	T	F	_____

		True	False	Don't Know
27.	Peanut butter is a good meat substitute.	T	F	_____
28.	Baking soda added to the cooking water destroys some vitamins.	T	F	_____
29.	Colds can be prevented by taking vitamin pills.	T	F	_____
30.	Most children eat table foods by months of age.	T	F	_____
31.	Meat should not be given to children under eight months of age.	T	F	_____
32.	Commercial, so-called "complete dinners" provide enough nutrients for toddlers.	T	F	_____
33.	Infants need more iron per pound of body weight than do adults.	T	F	_____
34.	Children should eat everything they are served before being allowed to have dessert.	T	F	_____
35.	In a family, including a father, mother, son 16 years old and an 18 year old daughter, the father should have the largest serving of meat.	T	F	_____
36.	Women between the ages of 14 and 40 need more iron than do men the same age.	T	F	_____
37.	Chemicals now used to bleach flour are harmful to human beings.	T	F	_____
38.	Vitamins aid the body in making use of its building and maintenance materials; hence, serious vitamin deficiency may affect many parts of the body.	T	F	_____
39.	Healthy adults should take food supplements or vitamin pills to ensure having all the nutrients needed for good nutrition.	T	F	_____
40.	Eggs can completely replace milk in the diet so far as nutrients are concerned.	T	F	_____
41.	Gelatin, or jello, desserts are a good source of protein.	T	F	_____

		True	False	Don't Know
42.	Nuts are hard to digest.	T	F	_____
43.	All people should use a low-fat, low cholesterol diet to prevent heart disease and strokes.	T	F	_____
44.	People who do not eat meat are bound to be in poor health.	T	F	_____
45.	A daily bowel movement is necessary for good health.	T	F	_____
46.	People who are dieting should avoid milk and butter.	T	F	_____
47.	High-protein foods, such as meat and fish, contain practically no calories.	T	F	_____
48.	Dry skim milk powder has the same nutritive value as fresh skim milk.	T	F	_____
49.	Alcohol contains more calories than sugars.	T	F	_____
50.	Diet pills that are sold on drug store counters are harmless.	T	F	_____
51.	"Health foods" have special health-giving properties.	T	F	_____
52.	Eating carrots will guarantee a good complexion and glossy hair.	T	F	_____
53.	The desire for alcohol is passed on from parent to child.	T	F	_____
54.	Toasted bread has fewer calories than untoasted bread.	T	F	_____
55.	People are born with likes and dislikes.	T	F	_____
56.	Pasteurization destroys the vitamins in milk.	T	F	_____
57.	Spring water that is clear and cold is safe to drink.	T	F	_____
58.	Grapefruit will help one reduce.	T	F	_____

		True	False	Don't Know
59.	Frozen orange juice has less nutritive value than fresh orange juice.	T	F	_____
60.	White bread that is enriched with vitamins is just as good as whole wheat bread.	T	F	_____
61.	Margarine has the same nutritive value as butter.	T	F	_____
62.	Enriched bread can be substituted for vegetables and meat.	T	F	_____
63.	Pork liver is just as nutritious as beef or calf liver.	T	F	_____
64.	Vitamins and minerals yield no calories.	T	F	_____
65.	The protein of meat is of better quality than that of fruits and vegetables.	T	F	_____
66.	Rare meat is more nutritious than is well cooked meat.	T	F	_____
67.	Severe mental work greatly increases the caloric need of the body.	T	F	_____

GROUPING OF NUTRITION KNOWLEDGE QUESTIONS

Group I: Food Sources of Nutrients

2, 7, 9, 11, 13, 15, 21, 26, 27, 28, 35, 37, 39, 40, 41, 44, 47, 48, 49, 51, 54, 56, 57, 59, 60, 61, 62, 63, 64, 65, 66

Group II: Function of Nutrients

10, 12, 17, 18, 29, 36, 38, 46, 52, 58, 67

Group III: Food Needs of Infants and Children

4, 6, 8, 16, 19, 30, 31, 32, 33

Group IV: Eating Patterns

1, 3, 5, 14, 22, 23, 24, 25, 34, 42, 45, 50, 53, 55

QUESTIONS ANSWERED CORRECTLY MOST AND LEAST FREQUENTLY

A. Questions Answered Correctly by Most Respondents

1, 2, 4, 5, 8, 10, 13, 14, 18, 21, 23, 30, 35, 36, 53

B. Questions Answered Correctly by Less Than Half the Respondents

15, 26, 28, 41, 47, 58, 60, 62, 63, 64, 66

APPENDIX D

FOOD ATTITUDE QUESTIONNAIRE

FOOD	Never Eat	Like Very Much	No Feeling	Do Not Like	Reason For Dislike
MEAT Brains					
Liver					
Heart					
Tongue					
Veal					
Lamb					
TOTAL					
FRUIT Cranberries					
Blueberries					
Strawberries					
Grapefruit					
Oranges					
Cantaloupes					

FOOD	Never Eat	Like Very Much	No Feeling	Do Not Like	Reason For Dislike
Watermelon					
Apples					
Apricots					
Bananas					
Avocado					
Grapes					
Papaya					
Peaches					
Raisins					
Rhubarb					
TOTAL					
VEGETABLES					
Beets					
Carrots					
Sweet Potato					
Turnips					
Asparagus					

FOOD	Never Eat	Like Very Much	No Feeling	Do Not Like	Reason For Dislike
Greens					
Brussel Sprouts					
Sauerkraut					
Kohlrabi					
Spinach					
Lettuce					
Kidney Beans					
Corn					
Egg Plant					
Okra					
Peas					
Pumpkin					
Squash					
Tomatoes					
TOTAL					

FOOD FREQUENCY

How often do you serve your child some food from each of the following food groups?

FOOD GROUP	Everyday	3 or 4 times/week	Once or twice a week	Seldom
1. Eggs				
2. Meat, fish, or poultry				
3. Liver, liverwurst				
4. Casserole, main dishes				
5. Potatoes				
6. Pinto, kidney, navy beans				
7. Yellow vegetables				
8. Other vegetables				
9. Citrus fruit or juices, tomatoes or juice				
10. Other fruits or juices				
11. Milk, cheese, cottage cheese, ice cream				
12. Bread, cereal				
13. Sweets- candy, desserts				
14. Other liquid- pop, Kool-Aid				
15. Peanut butter				

APPENDIX E

PARENT ATTITUDE QUESTIONNAIRE

Read each of the statements below and then rate them as follows:

A	a	d	D
Strongly agree	Mildly agree	Mildly disagree	Strongly disagree

Indicate your opinion by drawing a circle around the "A" if you strongly agree, around the "a" if you mildly agree, around the "d" if you mildly disagree, and around the "D" if you strongly disagree.

There are no right or wrong answers, so answer according to your own opinion. It is very important to the study that all questions be answered. Many of the statements will seem alike, but all are necessary to show slight differences of opinion.

		Agree		Disagree	
1.	A child has a right to his own point of view and ought to be allowed to express it.	A	a	d	D
2.	Having small children is enough for any woman without having to look for things to do outside of the home.	A	a	d	D
3.	A good whipping now and then never hurt any child.	A	a	d	D
4.	Children should realize how much parents have to give up for them.	A	a	d	D
5.	Staict discipline develops a fine strong character.	A	a	d	D
6.	It's natural for a parent to "blow his top" when children are selfish and demanding.	A	a	d	D
7.	Children should never learn things outside the home which make them doubt their parents' ideas.	A	a	d	D
8.	The child should be taught to revere his parents above all other grownups.	A	a	d	D
9.	A child should be taught to avoid fighting no matter what happens.	A	a	d	D

		Agree		Disagree	
10.	One of the worst things about taking care of a home is a woman feels that she can't get out.	A	a	d	D
11.	A child's ideas should be seriously considered in making family decisions.	A	a	d	D
12.	Raising children is a nerve wracking job.	A	a	d	D
13.	A child should not question the thinking of his parents.	A	a	d	D
14.	Husbands should know how "hemmed in" a woman feels staying in the home a great deal.	A	a	d	D
15.	Children are too often asked to do all of the compromising and adjustment and that is not fair.	A	a	d	D
16.	Parents should teach their children that the way to get ahead is to keep busy and not waste time.	A	a	d	D
17.	If you let children talk about their troubles they end up complaining even more.	A	a	d	D
18.	Children and husbands do better when the mother is strong enough to settle most of the problems.	A	a	d	D
19.	A mother should make it her business to know everything her children are thinking.	A	a	d	D
20.	If parents would have fun with their children the children would be more apt to take their advice.	A	a	d	D
21.	A child should be weaned away from the bottle or breast as soon as possible.	A	a	d	D
22.	Spanking a child makes it impossible for him to love and respect his parents.	A	a	d	D
23.	Showing affection openly does not set a example for children.	A	a	d	D
24.	Children should be given a chance to try out as many things on their own as possible.	A	a	d	D

		Agree		Disagree	
25.	As much as it is reasonable, a parent should try to treat a child as an equal.	A	a	d	D
26.	The earlier a child is weaned from its emotional ties to its parents, the better it will handle its own problems.	A	a	d	D
27.	A child's character can easily be weakened by parents who are too soft and tender with him.	A	a	d	D
28.	Parents are generally too busy to answer all a child's questions.	A	a	d	D
29.	The best way to get a child to behave is to make him feel he is wanted and needed.	A	a	d	D
30.	Children should be "babied" until they are several years old.	A	a	d	D
31.	Slapping a child immediately for getting into mischief is the best way to stop it.	A	a	d	D
32.	Handling a baby too much makes him spoiled and demanding.	A	a	d	D
33.	A child will do what he wants to do no matter what you think you are teaching him.	A	a	d	D
34.	Playing with a baby too much should be avoided since it excites them and they won't sleep.	A	a	d	D
35.	Some children are so naturally headstrong that a parent can't really do much about them.	A	a	d	D

GROUPINGS OF PARENT ATTITUDE ITEMS

I Mother Role
- A. Seclusion of mother- #2
- B. Martydom- #4
- C. Deification- #8
- D. Rejection of homemaker role- #10, 14
- E. Ascendency of mother- #18
- F. Abdication of parent role- #33, 35
- G. Irritability- #6, 12

II Mother-Child Relationship
- A. Equalitarianism- #15, 25
- B. Intrusiveness- #19
- C. Comradeship and sharing- #20
- D. Excluding outside influences- #7, 13
- E. Avoidance of communication- #17
- F. Infantilization- #30
- G. Ignoring the baby- #32, 34
- H. Ignoring the child- #28
- I. Avoidance of tenderness- # 23, 27
- J. Expressing love and affection- #29

III Development of Child
- A. Encouraging verbalization- # 1, 11
- B. Approval of activity- # 16
- C. Acceleration of development- #21, 26
- D. Autonomy of child- #24

IV Discipline
- A. Breaking the will- #3
- B. Strictness- #5
- C. Supression of agression- #9
- D. Non-punishment- #22
- E. Harsh punishment- #31

APPENDIX F

PARENTAL EXPECTATIONS QUESTIONNAIRE

Parents have different ideas about the ways children should be raised. In this questionnaire, we are interested in your ideas about how to bring up children. There are no right or wrong answers, since every set of parents and children is different.

To begin with, here is a list of things that parents expect children to be able to do. Parents have different ideas about when children should be able to do these things. For each item, please indicate the age at which you expect your children to be able to do these things. Since parents sometimes have different expectations for boys and for girls, there are two columns for your answer, one for boys, and one for girls. For each item please indicate the age at which you would expect a boy and a girl of yours to be able to do the thing.

		Age for Boys	Age for Girls
Example:	Pick out own clothes at a store	_____	_____
1.	Be fully toilet trained	_____	_____
2.	Eat grownup food and not baby food	_____	_____
3.	Drink from a cup and not a bottle	_____	_____
4.	Be left at home alone in the evening	_____	_____
5.	Be fully dry at night	_____	_____
6.	Take care of younger children in the family	_____	_____
7.	Put on own clothes correctly	_____	_____
8.	Eat at the table with parents	_____	_____

Children act differently at different ages. Everyone usually has some ideas about what age children they like best. Please check which age child you like best.

_____ Infants less than one year old

_____ Toddlers between one and three

_____ Preschoolers- between three and six

_____ Children- between six and twelve

_____ Teenagers- between twelve and eighteen

What do you think is the most important thing a mother can teach a girl?

_____

How would you teach it to a girl of yours?_____

_____

What do you think is the most important thing a mother can teach a boy?

_____

How would you teach it to a boy of yours?_____

_____

What would you like your child to be when he grows up?_____

_____

Do you think_____'s lot is life when he is grown up will depend more on what he does himself, or on luck?_____

_____

APPENDIX G

CONSENT FORMS

IRON DEFICIENCY ANEMIA STUDY CONSENT FORM

I hereby consent to the participation of my child in a study of iron deficiency anemia. I understand that this will be designed to yield significant information about the causes and effect of iron deficiency anemia and may include sociological, nutritional, and psychological interviews, observations, and tests in excess of those associated with the usual medical history and physical examination. Laboratory studies, however, will be of standard type and frequency. I understand that the study will be carried out under the supervision of Theresa B. Haddy, M.D., Dorice C. Narins, Ph.D., and David J. Kallen, Ph.D. I further understand that my child will receive necessary treatment, in the case that he has iron deficiency anemia, regardless of whether or not I consent to his participation in the total study.

Name_____

Relationship_____

Witnesses_____

_____

Date_____

IRON DEFICIENCY ANEMIA STUDY CONSENT FORM FOR CONTROLS

Child's Name_____

Date_____

I hereby agree to my child's taking part in a study of iron deficiency anemia. I understand that the study will give information about the causes and effects of iron deficiency anemia. It will include questions aimed at finding out how I feel about feeding and raising children as well as the usual medical history, physical examination, and laboratory studies. The study will be carried out under the supervision of Theresa B. Haddy, M.D., Dorice D. Narins, Ph.D., and David J. Kallen, Ph.D.

Name_____

Relationship_____

Witnesses_____

_____

APPENDIX H

TEXT OF IRON DEFICIENCY PAMPHLET

What is iron deficiency anemia?

Iron deficiency anemia is a deficiency or lack of enough iron in our bodies. There are other kinds of anemia, but iron deficiency anemia is the most common kind.

Why do our bodies need iron?

Our bodies need iron to build red blood cells which carry oxygen to all parts of the body.

What happens when we have iron deficiency anemia?

The red blood cells do not contain enough iron and cannot carry oxygen as well as normal blood cells.

We may feel tired and find it harder to work and play well.

Why do we get iron deficiency anemia?

We don't get enough iron in our diets to meet our body needs, especially during periods of rapid growth.

Who gets iron deficiency anemia?

Anyone who does not get enough iron in his diet may develop iron deficiency anemia.

Who is most likely to develop iron anemia?

Infants and small children, ages 6 months to 2½ years old often develop iron anemia.

Teenage boys and girls, and women, especially pregnant women are also likely to develop iron anemia.

How can you tell if you or your child has iron anemia?

Only a blood test can tell you for sure if you or your child has iron anemia.

But here is a check list to help you decide if your child is likely to develop iron anemia.

_____ is between 6 months and 2½ years old

_____ drinks about 1 quart or more of milk each day

_____ eats little or no meat

_____ eats few green vegetables or beans

If you have three or four checks, your child may need more iron. Only a blood test will tell you for sure if your child has iron deficiency anemia.

Where can you get a blood test for your child?

You can take your child to your own doctor for a check up and a blood test.

Or you can call the Ingham County Public Health Well-Baby Clinic for an appointment to have your child exaimed. The examination at the clinic is free. Your child will be exaimed by a nurse or doctor to see if he has iron anemia or other illness. You will be given advice on feeding your child to help him grow and develop normally.

How can you help prevent iron deficiency anemia in your family?

Make sure your child, and all members of your family, get enough iron in their diets. Feed your family some foods rich in iron every day.

What foods are rich in iron?

Best foods for iron:

Liver and liverwurst, kidney, heart.

Very good foods for iron:

Meats, such as beef, pork, bacon, ham, lamb, chicken, turkey.

Good foods for iron:

Spinach and greens such as mustard greens, turnip greens;

Beans such as pinto and navy beans.

Fair foods for iron:

Cereals, such as breakfast cereals which say fortified with iron on the package.