ANEMIA AMONG CHILDREN AND ADOLESCENTS IN THE KEEWATIN REGION OF THE NORTHWEST TERRITORIES

By

Rajaa Thika

A Thesis

Submitted to the Faculty of Graduate Studies in Partial Fulfilment of the Requirement for the Degree of

MASTER OF SCIENCE

Department of Community Health Sciences

Faculty of Medicine

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DEDICATIONS

This thesis is dedicated to the most important people in my life and to whom I am very grateful: My parents, my brother Mohammed, my sister Fatima, and my husband and best friend Hassan Albar.

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First and foremost, I must thank God for his unlimited help and support without whom this work would not be accomplished. Thank God.

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ABSTRACT

The objective of this study was to determine the prevalence of anemia and its type among the Inuit children and adolescents. During 1990 the Keewatin Health Assessment study (KHAS) was conducted at eight Inuit communities in the Central Arctic. A sociodemographic household survey of every house in the Keewatin region was conducted. Thereafter a random sample of 20% of the individuals living in the region was undertaken. At the time of enrolment the following examinations were carried out: ear examination, weight and height measurements, and fingertip blood samples (to determine hemoglobin, hematocrit, and red cell count--these measurements were then used to calculate the red cell indices in order to identify the type of anemia). For adolescents only, the individual survey included an interview-administered questionnaire.

The prevalence of anemia among Inuit children and adolescents was high, 11.5%. Despite several limitations in the data for the identification of the type of anemia, this study suggests that microcytic anemia may not be as large a problem as expected. On the other hand, macrocytic cells in anemics was a prevalent problem (50%). Predictors of anemia included: (1) age and sex--both children agrd 9M-2 years and females aged 15-17 years had a higher prevalence of anemia compared to the remaining age groups ($p=0.000$); (2) community--children and teenagers from Arviat had a higher prevalence of anemia than the other seven communities combined ($p=0.002$); (3) height-for-age (HAZ)-- children and teenagers who had HAZ $\leq$ -1 SD had a higher prevalence of anemia than those who had > -1 SD ($p=0.01$); (4) ear infections--children and teenagers who had ear infections had a significantly higher prevalence of anemia compared to those who did not ($p=0.03$); (5) socio-economic status--these data suggest that children and teenagers living in houses of low socio-economic status were the most likely to develop anemia. Indicators of socio-economic status included: (a) type of housing--children and teenagers living in public housing or Northern rentals had a significantly higher prevalence of

anemia compared to those in the other type of houses (p=0.005); (b) degree of crowding--children and teenagers living in crowded houses (ie, houses with more than one individual per room) had a significantly higher prevalence of anemia compared to those in non-crowded houses (p=0.000); (c) availability of basic items--children and teenagers living in low-basic items houses had a significantly higher prevalence of anemia compared to those in high-basic items houses (p=0.003); and (d) availability of accessory items--children and adolescents living in low-accessory items houses had a significantly higher prevalence of anemia compared to those in high-accessory items houses (p=0.02).

For adolescents only, the factors that were found to be predictors of anemia included: (1) school attendance--teenagers attending school were at lower risk of having anemia than those who did not attend (p=0.01); (2) English language capability--teenagers speaking English very well or moderately well were at lower risk of having anemia than those speaking very little English or no English at all (p=0.003); and (3) participation in sports--teenagers participating in sports once a week or more, were at lower risk of having anemia than those participating less than once a week (p=0.016).

Further studies of the following topics should be undertaken to clarify the following: (1) the reason for finding high prevalence of anemia among Inuit children and adolescents, especially among participants of Arviat; (2) the type of anemia in Inuit children and adolescents, the possible role of other nutritional anemias (ie, other than iron deficiency) should be considered. These might include: Folate, vitamin B_{12}, and mixed; and (3) importance of income level in the occurrence of anemia.

In summary, macrocytic anemia appears to be a major problem in the Keewatin communities. This study provides useful data for identifying those members at greater risk for developing anemia, and for whom immediate action should be undertaken, especially for the very young children and the female teenage population. This will be the real challenge for the health care planner!

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LIST OF ABBREVIATIONS

BMI	Body Mass Index (Quetelet's Index)
CI	Confidence interval
CV	Coefficient of variation
DF	Degree of freedom
HA	Height-For-Age
HAZ	Height-For-Age Z-Score
HCT	Hematocrit
HGB	Hemoglobin
KHAS	Keewatin Health Assessment Survey
MCH	Mean Cell Hemoglobin
MCHC	Mean Cell Hemoglobin Concentration
MCV	Mean Cell Volume
NCHS	National Centre for Health Statistics
NHANES II	National Health and Nutrition Examination Survey II
OR	Odds ratio
SD	Standard Deviation
TS	Transferrin Saturation
WA	Weight-For-Age
WAZ	Weight-For-Age Z-Score
WH	Weight-For-Height
WHZ	Weight-For-Height Z-Score
X^2	Chi-Square test

PART 1

INTRODUCTION

1.1 The Problem

Anaemia has been defined as a reduction in the circulation of either hemoglobin or erythrocytes.[1] Nutritional anaemia is a condition in which the haemoglobin content of the blood is lower than normal as a result of deficiency of one or more essential hemopoietic nutrients (Vitamin B_{12}, folic acid, and iron), regardless of the cause.[2]

Prevalence studies have established that iron deficiency is the most common micronutrient deficiency in developing countries where cereals are usually the major dietary staple.[3] Economic factors often limit the intake of meats or fish, food that would enhance the absorption of iron from cereal. In tropical parts of the world, hook worm infestation is a common cause.[4] In developed countries, the availability of dietary iron is often restricted by an excessive use of milk among children.[5,6]

Iron deficiency anemia is particularly prevalent among infants and young children because rapid growth imposes large iron needs and because most infant diets contain a marginal supply.[5] In addition, menstrual bleeding as well as pregnancy imposes increased requirements of iron.[7]

The importance of iron deficiency as a public health problem is based ultimately on the seriousness of its consequences for health. The most extensively investigated consequences of iron deficiency involve decreased work capacity,[8,9] immune function[10] and behavioral derangements.[11] These symptoms provide ample justification for preventing and treating a common and easily correctable nutritional disorder.

In the Native populations of Canada iron-deficiency anaemia is believed to be a prevalent health problem, although population-based data are not readily available. During 1990 the Keewatin Health Assessment Study (KHAS) was conducted at eight Inuit communities in the Central Arctic. Among the variety of variables on health status, health service utilization, and health attitude investigated were laboratory data on hemoglobin, hematocrit, and red cell count. The cross-sectional data set afforded an opportunity to investigate the prevalence of anaemia in a representative sample of Inuit children and adolescents.

1.2 Objectives

My dissertation research has the following objectives:

1. To determine the prevalence of anemia and its type among Inuit children and adolescents in the Keewatin Region, NWT.

2. To determine subgroups in this population who are at highest risk for anemia.

3. To determine the association between socioeconomic, household, and environmental factors and the presence of anemia.

4. To answer the question of whether there is an association between anemia and infection (specifically middle ear infection), between anemia and learning ability, and between anemia and performing energy demanding tasks (specifically participation in sports).

5. To establish population norms for Inuit children and to determine if standards established from other population groups are appropriate.

This study should provide useful data for planners in identifying means of preventing iron deficiency in infants and children.

PART 2

LITERATURE REVIEW

2.1 Anemia among Canadian Native Population

An earlier study (1964) reported low hemoglobin levels among Eskimos in Southwestern Alaska. Hematological data suggested that these low levels were due to iron deficiency and a second undesignated factor.[12] For children and adolescents, the 1975 Nutrition Canada Survey for Eskimos,[13] identified the following: Firstly, the median intakes of iron for most age groups were higher than in the national population. Secondly, in spite of somewhat higher iron intakes among Eskimos, the prevalence of anemia among Eskimos based on hemoglobin was generally much greater than those observed in the general Canadian population. It was concluded that other types of nutritional anemia might exist such as anemia due to folacin and ascorbic acid deficiency. Compared with the general Canadian population the Eskimos had much lower serum concentration of folic acid.[13]

Somewhat similar conclusions were reached by Burks et al (1974).[14] They found that a three-month period of iron supplementation in a group of 146 Eskimo children resulted in improved iron stores, as indicated by measuring serum ferritin concentration before and after iron supplementation. However, the prevalence of anemia remained high; this led to the conclusion that other factors, such as coexistence of folate or Vitamin B_{12} deficiency, might account for the relatively high prevalence of anemia after iron supplementation.

Valberg and his associates (1976)[15] found that iron deficiency contributed to the low hemoglobin concentration, but it was not a major factor. A more recent study (1992), conducted in Greenland, found that the Greenlandic hunters generally have high S-ferritin levels and ample body iron reserves, due to consumptions of large quantities of iron-rich meat from marine mammals and/or genetic differences in the regulatory mechanisms for body iron stores.[16]

2.2 Causes of Anemia

Anemia is not a disease but a non-specific sign of diverse, underlying diseases.[17] Three mechanisms may be responsible for the occurrence of anemia (Table 2.1). These included:[18]

1. Deficiency of hemopoietic nutrients. The main hemopoietic nutrients are iron, folate, and Vitamin B_{12}.[2]

2. Increased loss or destruction of red blood cells. Blood loss is caused by acute or chronic hemorrhage. The defect of the red cells may be congenital, or acquired, but in either case the shortened life span frequently results in anemia when red cell production fails to keep pace with red cell destruction.

3. Decreased rate of production. Erythropoiesis may also be depressed by: (a) replacement of marrow by fibrosis or by neoplasm, and (b) hypoplasia of bone marrow, most commonly produced by certain toxic or chemical agents.

In the Keewatin, it was hypothesized that the most important cause of anemia was inadequate dietary intake of iron, at least in infants. Hereditary red cell defects may be considered as a possible cause of anemia in an isolated population like the Keewatin, which draws from a limited genetic gene pool. Population-based data on anemia due to hereditary causes are not readily available for this population, however, many authors have found an association between consanguineous marriage and high prevalence of red cell genetic defects.[18,19].

2.3 Adverse Effects Of Anemia

Several studies have shown that anemia may be associated with both hematologic and nonhematologic adverse effects.

2.3.1 Hematologic Adverse Effects of Anemia

Erythrocyte indices are used to define the size, mean cell volume (MCV), and hemoglobin content, mean cell hemoglobin (MCH) and mean cell hemoglobin concentration (MCHC), of red cells in the peripheral blood. They are useful for providing additional information for the identification of different types of anemia.[21-23] Depending on erythrocyte indices, anemias may be characterized as microcytic, normocytic, or macrocytic. They may be further subdivided according to the average amount of red cell hemoglobin, resulting in hypochromia or normochromia. Table 2.2 lists the more common etiologies.[24] Using a Coulter Counter, many authors found that both MCV and MCH were sufficiently predictive for or against iron deficiency,[25,26] while all agreed that MCHC is the least useful index.

2.3.2 Nonhematologic Adverse Effects of Anemia

There is evidence that anemia is associated with a variety of nonhematological symptoms such as: (1) Weakness, fatigue, lassitude, and exertional dyspnea are common in anem<x patients,[27] many investigators have demonstrated decrease exercise capacity in anemics[8,9]; (2) immune function derangements;[10] and (3) behavioral abnormalities such as impaired attention span and learning ability.[11]

It is generally considered that anemic individuals are more likely to develop infections than non-anemic ones. Data on the influence of iron deficiency on immune function are often perceived as being confusing and contradictory. From reexamination of relevant literature, it seems safe to conclude that abnormalities in cell-mediated immunity,[28-32] antibody-mediated immunity,[32,33] and the ability of neutrophils to kill several types of bacteria[31,34-37] are well established under experimental conditions in iron-deficient patients. Some investigators demonstrated abnormalities in cell-mediated immunity in folic acid deficient patients,[38,39] as well.

It remains uncertain whether these abnormalities result in an increased incidence and susceptibility to infection. Many authors have suggested that anemia predisposes to certain infections.[40-43] There is, however, some evidence that rapid alleviation of iron deficiency may promote certain bacterial[44,45] and parasitic infections.[46] One possible basis for a relationship between the administration of iron and infection is that the microorganisms produce iron-binding substance called siderophers that facilitate the accumulation of iron necessary for their growth and proliferation.[47]

In infants, several investigators used the Bayley Scales (this test is widely used for the evaluation of sensory development, fine and gross motor skills and early language development) of Infant Development to assess their behavior and development. It has been coexistently demonstrated that the scores on Bayley scales of mental and motor development among iron-deficient anemic (IDA) infants, are lower than those among iron-replete infants.[48-56] These deficits are of particular concern because they occur even with relatively mild IDA, and their reversibility remains uncertain. In some studies significant increments in scale scores were observed among IDA infants after iron treatment,[50-52] ie, congruency of the results, those who responded to the iron treatment were also those who responded behaviorally. However, in others [54-56] these improvements were not observed.

It seems possible that iron deficiency during infancy may affect subsequent development.[57,58] However, many studies have shown an association between iron-deficiency anemia and less than optimal behavior in preschool, school-aged children, demonstrated by deficits in attention span, cognitive development and learning ability.[59-61] All studies have shown that supplementation with iron resulted in improvement in the anemic subject's learning achievement scores. At the International Conference on Iron Deficiency and Behavioral Development (1988) it was suggested that IDA is causally associated with less than optimal behavior,[11] and it was recommended that IDA be prevented in all children. In adults, iron deficiency may cause a perversion of taste.[62-64]

Pica is defined as a behavioral disorder characterized by compulsive eating of one particular item.[62]

2.4 Control Policies for Nutritional Anemia

Theoretically, one or more of the following intervention techniques may be employed:

2.4.1 Nutrition Education Programs

The mainstay of preventing iron deficiency might be by educating the public about the methods for preventing deficiency of hemopoietic nutrients,[6] within the scope of unfortified food products (Appendix B), for example, the encouragement of prolonged breast feeding[65-67] and avoidance of fresh cow's milk before one year of age.[68-71] According to Saarinen and Siimes[65] infants absorb up to 70% of the iron present in human milk compared to 30% of the iron in cow's milk and 10% of the iron in iron-fortified proprietary formulas.

2.4.2 Fortification of the Diet

Diet fortification[72,73] is a public health measure aimed at improving and maintaining the health of individuals in the population through the provision of adequate levels of nutrient intake. Selective hemopoietic nutrient supplementation of the diet in age and sex groups at risk is another method for preventing some type of nutritional anemias.[74-76] Olivares and his associates[75] have found that iron deficiency anemia could be eradicated by the use of milk fortified with iron and ascorbic acid. In pregnant women, the enrichment of maize with folic acid was found to produce a significant rise in serum and red cell folate concentration and to prevent the development of anemia.[76]

2.4.3 Supplementation

Supplementation is the term applied when an extra amount of nutrient is given in medicinal form.[77,81] Burks and coworkers[14] demonstrated an improvement in body iron stores in a group of Alaskan Inuit children after 3 months of oral iron supplementation.

In pregnant women, Izak et al[79] demonstrated a significant rise in the hemoglobin concentration following combined iron and folate administration. The administration of iron and folic acid was more effective than the administration of either of these alone.

2.4.4 Special Program for High Risk Groups

Special programs for preventing nutritional anemia,[82-84] such as the WIC program (Special Supplementation Food Program for Women, Infants, and Children), were effective in limiting the development of iron deficiency anemia. School lunch programs are established in many parts of the world and provide an opportunity for supplying additional iron to the diet.[5]

2.5 Hematological Tests

The hematological tests included in the KHAS were: (1) hemoglobin concentration, (2) hematocrit, and (3) red cell count. The red cell indices were calculated from those measurements. Therefore, those tests will be discussed in detail:

2.5.1 Hematological Tests Procedures

Hemoglobin and hematocrit can be determined by using either venous blood or capillary blood obtained from skin puncture. It is technically much simpler to obtain skin puncture blood from a fingertip, particularly during infancy, but also throughout childhood.[85] Data on the difference between venous and capillary hemoglobin levels are perceived as being confusing and contradictory.[86-88] In an early study, Anderson et al (1938)[86] found a close agreement between hemoglobin and hematocrit in venous and capillary blood with a mean difference of 0.03 g/dl and 0.25 %, respectively. However, a later study (1970) showed that venous HGB and HCT values were significantly higher than capillary blood values, with a mean difference of 0.5 g/dl and 1.7%, respectively.[88]

1. Hemoglobin (HGB)

Measurement of the concentration of hemoglobin in blood is probably the most widely used screening test for anaemia.[2,89,90] The SI units is the liter and the appropriate reporting form is g/l.[85] The Cyanmethemoglobin is the most reliable method for clinical hemoglobinometry (measurement of blood hemoglobin concentration).[91,92] The analysis can be performed with a photometer or by an electronic counter.

2. Hematocrit (HCT)

The term "hematocrit" (hemato = blood + kritēs- = to judge) is defined as the volume occupied by erythrocytes in a given volume of blood. The reporting form is (l/l).[85] It could be used as a screening test for anemia.[14,93] Hematocrit is determined either directly or indirectly. Two methods of direct measurement of hematocrit that are in current use are:[92] (1) a macro-method using Wintrobe tubes, and (2) a micro-method using capillary tubes. The indirect method is the product of the mean cell volume (MCV) by the red cell count (RBC) in automated instrument. Fairbanks[94] found that the MCV values calculated from centrifuged hematocrit were less reliable than those obtained by automated methods.

3. Red blood cell count (RBC)

Red cell count is defined as the number of red blood cells in 1μl of whole blood.[92] An inadequate iron supply may retard erythropoiesis. Therefore, a reduction in the number of erythrocyte count is expected in iron deficiency anemia. The reporting form is y x 10^{12}/l.[85] There are two methods of obtaining erythrocyte count that are in current use: (1) visual counting on a hemacytometer, and (2) electronic cell counters, with the latter resulting in improved precision in obtaining the red cell indices.[92]

4. Mean Cell Volume (MCV)

MCV measures the average size of the red blood cell.[95] The units (*fl*) are implied. It is best determined directly with electronic counter. If an electronic counter is not available, the MCV may be estimated by applying the following formula:[96]

$$\text{MCV (fl)} = \frac{\text{Hematocrit (volume fraction)}}{\text{Red blood cell count } (10^{12}\ /\text{L})}$$

The MCV is valuable for the initial separation of anemias into microcytic, normocytic, or macrocytic. Low MCV is associated with microcytosis which is most commonly due to iron deficiency,[97,98] while high MCV is associated with macrocytosis which is a hallmark of folic acid or Vitamin B_{12} deficiency (Table 2.3)[98-101] and may precede anemia by months or years.[102-104]

5. Mean Cell Hemoglobin (MCH)

MCH measures the weight of the hemoglobin contained in an average red blood cell.[95] The units (*pg*) are implied. Again, an electronic counter provides the best measurements. However, If an electronic counter is not available, the MCV may be estimated by applying the following formula:[96]

$$\text{MCH (pg)} = \frac{\text{Hemoglobin (g/L)}}{\text{Red blood cell count } (10^{12}/\text{L})}$$

The MCH is influenced by the size of the RBC; a large RBC with normal hemoglobin content will contain a greater weight of hemoglobin than a smaller cell with a normal hemoglobin content. The MCH also depends on the amount of hemoglobin in relation to the size of the cell; a hypochromic cell has a smaller weight of hemoglobin than a normochromic cell of equal size. In general, the MCH level is increased in macrocytosis and decreased in microcytosis and in hypochromia.[95]

6. Mean Cell Hemoglobin Concentration (MCHC)

MCHC measures the mean concentration of hemoglobin in an average red blood cell.[95] Again, best results are achieved with an electronic counter. However, it is calculated according to the following formula:[96]

$$\text{MCHC (g/L)} = \frac{\text{Hemoglobin (g/L)}}{\text{Hematocrit (volume fraction)}}$$

The MCHC depends on the relationship between the amount of hemoglobin and the volume of RBC. Thus, the MCHC does not depend on cell size alone; a macrocyte with a normal amount of hemoglobin has a normal MCHC.[95] The MCHC is valuable for separation of anemias into hypochromic and normochromic. This index is the last to fall during iron deficiency.[25,105] Therefore, it is the least useful of the red cell indices. However, if using data obtained by manual methods, the MCHC is the most accurate of the indices used to characterize erythrocytes because it does not involve the erythrocyte count, the least accurate of the three indices used to evaluate these cells.[106]

2.5.2 Problems with Hematological Testings

1. Hemoglobin, Hematocrit, and Red Cell Count

Interpretation of the above measurements is complicated by the fact that those tests have several limitations:

A. Insensitivity. HGB and HCT are relatively insensitive for detecting hemopoietic nutrients deficiency, the concentration falling only during the third stage of nutritional anemia.[107] In addition, anaemia refers to a value for hemoglobin concentration either 2 SD[108] or 95%[109] below the reference range for age and sex. The problem with those cut-off values for hemoglobin is that some misclassification might occur.

B. Low specificity. Both low hemoglobin and hematocrit (ie, anemia), resulted from a variety of causes (Table 2.1).[18] With anemia due to iron deficiency being the most common cause of anemia.[110]

C. Age and sex dependent. Males and females have about the same HGB, HCT, and RBC levels until approximately age 10, after which male values slowly become higher.[109]

2. Red Cell Indices: MCV, MCH, and MCHC

Interpretation of the above measurements is complicated by the fact that red cell indices have several limitations:

A. Low specificity. Each hemoglobin molecule is a conjugate of a protein (globin) and four heme molecules. Any disorder that diminishes either heme (such as iron deficiency anemia, lead poisoning, anemia of infection) or globin (such as thalassaemia syndromes) synthesis will result in microcytosis.[110,111] Iron deficiency anemia is the most common cause of diminished heme synthesis in children.

B. Age and sex. The three red cell indices are less affected by developmental changes and/or sex than the other three measures, HGB, HCT, and RBC.[112,113]

2.5.3 Hematologic Values for Detection of Anemia and its Type

Values for hemoglobin, hematocrit, red cell count, and their indices are susceptible to developmental changes. Therefore, several age and sex specific reference data are available.[3,109,114] These included:

1. National Health and Nutrition Examination Survey II Table of medians and 95% range are available from the National Health and Nutrition Examination II Survey, NHANES II, for hemoglobin, hematocrit, RBC, MCV, MCH, and MCHC levels by age and sex (Table 2.4). This survey was conducted between 1976 and 1980 by the National Centre for health statistics, NCHS. A total of 27,801 persons from 64 sampling areas were selected in the probability sample as representative of the U.S. civilian populations 6 months through 74 years old who were not institutionalized.[109]

2. World Health Organization (WHO), 1959

A table of hemoglobin, hematocrit, MCH, and MCHC by age and sex are available from the WHO (1959), (Table 2.5).[3]

PART 3

METHODS

3.1 Description of the Study Area

The Keewatin region of the NWT is a vast and sparsely populated area of Canada which presents a formidable challenge to the delivery of health services. The 1986 census reported 5,395 people living in eight settlements scattered across 520,000 square km. The vast majority of these are Inuit people. There are no roads in the region and air is the only means of transportation; even this is often hampered by arctic coastal weather. The Town of Churchill, located approximately 150 km south of the Keewatin region's boundary with Manitoba, serves as a transportation and health service referral point for the region and is logically included as part of this study. The town's population is predominantly non-Native, which will provide a useful comparison group for the Keewatin Inuit population.

Health services are primarily provided by community health nurses. Modern, well-equipped nursing stations (offering both preventative and curative services) have been built in each community. Physician services are provided by the University of Manitoba, with general practitioners visiting each community once a month and specialists in paediatrics, ophthalmology, obstetrics and psychiatry visiting twice yearly. Audiology services are provided somewhat less frequently. Hospital services are provided in Churchill, Manitoba, where there is a 32-bed hospital and health centre with tertiary care provided in Winnipeg, Manitoba.

3.2 Sample Selection

A sociodemographic household survey of every house in the Keewatin region, N=1535, was conducted. The household survey was conducted in the spring and fall of 1990. In the Spring the following communities were surveyed: Chesterfield Inlet, Arviat, and Rankin Inlet, while in the Fall, Repulse Bay, Baker Lake, Coral Harbour, Whale

Cove, and Sanikiluaq were surveyed. There were 5666 people living in the Keewatin region, Table 4.1 showed the distribution of the population of the eight communities by age and sex, providing the sampling frame for the individual survey.

A 20% random sample of the individuals living in the region, or 1,330 people (of which 590 would be children and adolescents under the age of 18), were selected and invited to participate in the individual health interview and examination survey. The individual survey for Chesterfield Inlet, Arviat, and Rankin Inlet was carried out from March through the end of May in 1990, while Repulse Bay, Baker Lake, Coral Harbour, Whale Cove, and Sanikiluaq were surveyed from the end of October through to the end of December in 1990. The number of respondents was 495 children and adolescents, yielding a response rate of 83% for this age group. Of the 495, 441 were from the eight communities and 54 from Churchill.

3.3 Data Collection

For the Keewatin Health Study (KHAS), data were collected in two areas: (1) a sociodemographic household survey of every house in the Keewatin region, and (2) a survey of a random sample of individuals.

3.3.1 Household Survey

This included a brief assessment of each household in the region. It provided information on the following: Employment, housing type and quality, crowding, income level, and availability of luxury items.

3.3.2. Individual Survey

A random sampling of 20% of the individuals living in the region was undertaken. The sampling frame was based on the lists generated by the household survey which was performed no more than 6 weeks prior to the individual survey with participation of the local KRHB members and research assistants. The questionnaire design for the Keewatin Health assessment Survey included information on the following groups of variables:

A. Physical Examination

In both the paediatric and adolescent questionnaire the following physical examination was carried out: (1) measurements of both the blood pressure and height and weight; (2) dental examination; and (3) examination of tympanic membrane.

B. Laboratory Procedures

The following laboratory procedures were carried out in both paediatric and adolescent surveys: (1) audiological evaluation (audiogram, tympanogram); and (2) haematological tests as well as other blood tests.

C. Interviewer-Administered Questionnaire

In the adolescent questionnaire only information on the following was obtained: Demographic data, school attendance and performance, frequency of consumption of different food items, smoking, alcohol consumption, physical activity, and satisfaction with health services.

3.4 Hematological Tests

Capillary blood samples were used to measure hemoglobin, hematocrit, and red cell count. The red cell indices were generated by computer.

3.4.1 Determination of Hemoglobin

The introduction of the electronic particle counter made the hemoglobin determination more accurate and highly reproducible. It is considered the best machine for the analysis. However, the purchase of the electronic counter involves a large expenditure and it does not travel well. The analyses were, therefore, performed with a relatively inexpensive, quite easy to use, portable machine called "AMES™ MINILAB". This is a micro processor-controlled photometer weighing 450 g, with allowable ambient temperature ranges for storage and transport from -30° to 60°. The MINILAB is preprogrammed to perform tests for hemoglobin, erythrocytes on whole blood, as well as other tests on serum or plasma.

When the machine was examined and compared to the Coulter STKR or S+V, it was found that the hemoglobin results from the MINILAB compared favourably with the Coulter results, with a coefficient of variation, CV, =5.28 (Appendix C). This might be because the principle of the test, Cyanmethemoglobin, is the same in both Coulter counter and MINILAB. Units of g/l were implied.

3.4.2 Determination of Red Blood Cell Count

The same machine, the MINILAB, was used for measuring the red blood cell count on capillary whole blood. Counting of the red blood cells on the Minilab was found to be lacking in precision, CV=19. According to the hematology laboratory at the Health Science Centre, the problem lies in the principle of the test, measuring the turbidity, and not the actual count of the red cells, of the blood (Appendix C). The reporting form was x 10^{12}/l. The RBC was used for calculation of both MCV and MCH. It was hypothesized that neither MCV nor MCH were a useful diagnostic tool but they can used on a population basis to determine the general frequency of abnormal indices.

3.4.3 Determination of Hematocrit

The instrument used for centrifugation is called the AMES MICROSPIN, weighing 425 g, with a permissible temperature range during storage from -20° to 55°C. This machine was not evaluated by the hematology laboratory at the Health Science Centre. However, hematocrit values measured on this machine were assumed to be accurate because they were estimated by the standard (microhematocrit) method. The units l/l were implied.

3.4.4 Determination of Red Cell Indices

Red blood cell indices: mean cell volume, MCV, mean cell hemoglobin, MCH, and mean cell hemoglobin concentration, MCHC, were generated by computer using Wintrob's formula:[96]

$$\text{MCV (fl)} = \frac{\text{Hematocrit}}{\text{Red blood cell count}}$$

$$\text{MCH (pg)} = \frac{\text{Hemoglobin}}{\text{Red blood cell count}}$$

$$\text{MCHC (g/L)} = \frac{\text{Hemoglobin}}{\text{Hematocrit}}$$

3.5 Outcome Variables

The laboratory tests used in the diagnosis of anemia included the analysis of hemoglobin, hematocrit, and red cell count (Appendix D). Either hemoglobin[2,89,90] or hematocrit[14,93] (but not RBC), were used as a screening test for anemia. Red cell count was not used as a measurement for the prevalence of anemia for two reasons: (1) the coefficient of variation, CV, of the red cell count on the MINILAB =19, and (2) to my knowledge, no studies used the RBC as a measurement for the prevalence of anemia.

Hemoglobin values (not hematocrit values) were used for measuring the prevalence of anemia for three reasons: (1) hematocrit tests were not evaluated by the Health Science Laboratory. In this study, the disadvantage of the hematocrit test lies in the uncertainty about whether the hematocrit is as sensitive an indicator of anemia as the hemoglobin; (2) greater technical errors occur when hematocrit is measured. Fairbanks[94] showed that the results of manual (centrifuged) hematocrit appear to be inherently less reliable than those obtained by automated methods; and (3) Hemoglobin is the most widely used test in screening for anemia.[3,91,92]

3.6 Independent Variables

There were several factors hypothesized to influence the occurrence of anemia and they fall into four categories:

1. Demographic Data

(a) age and sex

(b) race and community (Appendix D)

2. Physical Examination

(a) Height and weight

(b) The ear examination for the presence or absence of otitis media, perforation of tympanic membrane, and ear discharge (Appendix D)

3. Adolescent Interviews

For adolescents only, additional information could be obtained on: Frequency of consumption of different food items, smoking, alcohol consumption, physical activity, and school attendance and performance (Appendix D).

4. Household Survey

The household survey (Appendix E) included several sociodemographic variables which were hypothesized to have an important influence on the prevalence of anemia. These included; information on employment, housing type and quality, crowding, presence of luxury items, sanitation facilities, income level and distribution. The individual survey could be linked to the household survey by household number.

3.7 Coding and Analysis of Data

All data were keypunched and entered into the University of Manitoba main frame computer. Most of the analyses were performed using SAS Software Computer package. Multiple logistic regressions were done using NCSS Software Computer package.

3.7.1 Screening Data Prior to Analysis

Searching for missing values and outliers was an important first step prior to analysis. Subsequently, as many multivariate procedures are based on assumptions; the fit between the data set and the assumptions were assessed before the procedure was applied.

1. Missing Values and Outliers

According to Tabachnick and Fidell[115] the pattern of missing data is more important than the amount missing. Missing values scattered randomly throughout a data matrix rarely pose serious problems. Non-randomly missing values, on the other hand, are serious no matter how few of them there are because they affect the generalizability of results.

Univariate outliers are cases with an extreme value on one variable. Among dichotomous variables, those with very uneven splits between two categories are outliers. Deletion of dichotomous variables with 90-10 splits between categories was suggested. Among continuous variables, cases with standardized scores in excess of ± 3.0 SD are potential outliers. Both missing data and outliers were handled by the standard method.[115]

2. Normality and Linearity

Normality is assessed by either statistical or graphical methods. Frequency histograms and normal probability plot are an important graphical device for assessing normality. Statistically, there are two components to normality, skewness and kurtosis. When a distribution is normal, the values of skewness and kurtosis are zero.

The assumption of linearity is that there is a straight line relationship between two variables. Nonlinearity can be diagnosed from inspection of bivariate scatterplots between pairs of variables. Data transformations, such as logarithm and square root transformation, are recommended as a remedy for outliers and for failure of normality. Continuous variables that did not have a normal distribution and no transformation seemed to help were categorized into two or three levels.[115]

3. Collinearity

Correlation between two continuous variables, as expressed by correlation coefficient r, refers to the strength of the linear relationship between the two variables. The assumption of linearity must be made for valid use of inferential approaches. If it was shown that the variable did not follow the normal distribution, Spearman correlation coefficient (nonparametric test) was used instead. The closer the correlation coefficient is to 1, the stronger the linear component of the relationship between the variables.[116]

According to Tabachnick and Fidell,[115] think carefully before including two variables with a bivariate correlation of 0.70 or more in the analysis.

3.7.2 Prevalence of Anemia

Values for hemoglobin are known to vary to some degree according to age and/or sex. To evaluate such differences systematically, the NHANES II reference ranges[109] were used as a basis for estimates of the prevalence of anemia, ie, the percentage of individuals with hemoglobin values below the 2.5 percentile on the NHANES II reference range for age and sex at a designated time. The prevalence was calculated by dividing the total number of anemic children and adolescents by the total number of children and adolescents (9 month through 17 years), recruited to participate in the survey.

Community-specific prevalences, age-specific prevalences, and sex-specific prevalences were analyzed. Using the NHANES II classification for age and/or sex, children were categorized into four age categories (9M-2 years , 3-5 years, 6-8 years, and 9-11 years), while adolescents were categorized into four age and sex categories (12-14 male, 12-14 female, 15-17 male, and 15-17 female).

Searching for an association between the occurrence of anemia and the age and/or sex variable can be done by either partitioning the eight age and/or sex categories into two groups, high risk and low risk (regardless of the order of the age categories, ie, on the basis of their proportions similarity), or partitioning the eight age and/or sex categories into more than two groups (taking into consideration the order of their age categories, ie, on the basis of both their proportions similarity and the order of age categories). The latter approach can be achieved by creating dummy variables the number of which depends on the number of the age groups created -1. The advantage of the last (and not the first) approach is that the physiological causes of anemia are taken into consideration. However, since our main concern was to detect individuals at risk, it was elected to choose the first approach--that of partitioning into high- and low-risk groups, regardless of the order of age categories.

3.7.3 Type of Anemia

Once anemia is detected, determination of the morphologic characteristics of the erythrocyte was an important step toward the identification of the type of anemia. To classify anemia morphologically, it was necessary to determine the size (from MCV and MCH values) and hemoglobin content (from MCHC values) of the erythrocyte. Based on the NHANES II reference values,[109] if the MCV (or MCH) values were below the 2.5 percentile on the NHANES II reference range for age and sex, the anemia is microcytic; if between the 2.5-97.5 percentile, normocytic; and if above the 97.5 percentile, macrocytic. MCHC has been used to classify anemia further according to chromicity: That is hypochromic, if the MCHC values were below the 2.5 percentile on the NHANES II reference range for age and sex, or normochromic, if equal or over the 2.5 percentile.

Microcytic anemia is most commonly due to iron deficiency[97] and it is characterized by the following: low MCV, MCH, and MCHC (Table 2.3).[117] Macrocytic anemia is most commonly due to folic acid and/or Vitamin B_{12} deficiency[27,98-101] and it is characterized by the followings: high MCV, high MCH, and normal or diminished MCHC (Table 2.3).[92,117]

RBC was used for the calculation of MCV and MCH. Consequently, both MCV and MCH acquired lesser reliability because the accuracy of the calculated indices obviously depends on the accuracy of the primary measurement. In this study, the MCHC was the most reliable of the indices to characterize erythrocytes (although the least useful) because it does not involve the erythrocyte count.[105] However, both MCV and MCH can be used on a population basis to determine the general frequency of high or low indices.

3.7.4 Comparative Analysis of Participant and Non-Participant

A total of 441 children and adolescents from eight sampling communities responded to the individual survey. Respondents younger than 9 months were excluded, N=20, because the prevalence of anemia in these children was not calculated for the following reasons: (1) there are marked changes in hematological values during this period, and (2) there were no reference hematological values for those less than one year in the NHANES II Survey.

In this study, a participant was defined as a child or an adolescent who cooperated for hematological testings. Comparative analysis of participant and non-participant was carried out in order to determine the pattern of missing values. In this analysis children and adolescents of the eight Inuit communities were classified into two groups:

1. Participant group: Children aged 9M-17 years who were recruited to participate in the present study, ie, had hematological values, and

2. Non-participant group: the remaining children of the same age interval who did not take part in the study, ie, did not have hematological values.

The aim of the analysis was to assess the similarity of the two children groups on variables believed to influence the reason for not being tested, such as community, age, and sex of the child. One of the suggested methods for dealing with non-randomly missed values was to compute the hemoglobin mean or median value for each age and/or sex group, substitute these values for the missing values, and then repeat the analysis with and without missing data. If the results were similar, it can assumed that they are reliable. If they differed, however, one would need to investigate the reasons for change, and evaluate which results approximate "reality".[115]

3.7.5 Anthropometric Indices

It was difficult to draw sensible inferences from weight and height measurements because they are age and sex dependent. Therefore, weight-for-age (WA), height-for-age

(HA), and weight-for-height (WH) were obtained through the use of Epi-Info anthropometric software package version 5.0 (1990), in order to replace weight and height variables. This software is based on the NCHS Growth Curves for Children.

These indices can be expressed in terms of standard deviation (SD), percentiles, and percent of median. The WHO[118] and Waterlow[119] favour the use of SD. The SD cutoff point recommended by WHO to classify low anthropometry levels is < -2 SD units from the reference median for the three indices. In general, the prevalence of low anthropometry can be assessed by determining the proportion of the population that falls below some cutoff value.

The two preferred anthropometric indices for determining nutritional status are WH as an indicator of the present state of nutrition and HA as an indicator of past nutrition.[118,119] The third index, WA, is primarily a composite of WH and HA, and has the disadvantage that it does not distinguish between acute, low WH, and chronic, low HA, malnutrition.

HA and WA can be calculated for individuals from birth up to 18 years of age. However, WH indices apply only to prepubescent children.[118] Therefore, despite the fact that body mass index (BMI), weight/height^2 ratio (Quetelet's Index), is validated for adults, it was used as an indirect measurement of obesity among the adolescents. Quetelet Index value of < 20 were regarded as indicative of underweight, while value of > 25 indicative were indicative of overweight.[121]

3.7.6 Univariate Analysis

The outcome of interest was the occurrence of anemia, ie, anemic and non-anemic. Univariate analysis was used to select explanatory variables hypothesized to influence the occurrence of anemia and suitable for inclusion in the multiple regression analysis. For continuous explanatory variables the T-test was used to compare the mean of both anemic and non-anemic groups. The level of significance was set at the 5% level. For dichotomous variables, the likelihood ratio Chi-square X^2, the case-control odds ratio (OR) and the associated confidence limits (CI) for the OR, were employed to estimate the degree of association between the study factor and the explanatory variables. The level of significance was set at 5%.

For categorical variables, having more than two categories, testing for an association between hemoglobin status and variables under consideration was assessed in two steps:

First step: Suppose that *m* independent samples of subjects were studied, with each subject characterized by the presence or absence of anemia. The differences among the *m* proportions were assessed employing likelihood ratio Chi-square test X^2 and the differences were considered significant if the calculated likelihood ratio X^2 value exceeded the tabulated 0.05 critical value (DF=number of categories-1).[122] If the Likelihood Ratio Chi-square test showed no statistical significant differences among the *m* proportions no further step was taken.

Second step: If the likelihood ratio Chi-square test showed statistically significant differences among the *m* proportions, Fleiss' method[123] was employed to identify the groups that contributed to the significant differences. This method involved partitioning the *m* samples into groups (for example two groups, the first containing m_1 samples and the second m_2, where $m_1 + m_2 = m$) and then testing for significant differences employing the likelihood ratio Chi-square test and DF=1. Partitioning of samples into groups was suggested by the data, based on proportion similarity. The next step was to test the significance of the differences among both m_1 proportions in the first group and m_2 proportions in the second group with m_1-1 and m_2-1 degrees of freedom, respectively. The level of significance depended on the number of supplementary tests carried out. It was calculated by dividing the overall error rate (0.05) by the number of supplementary test carried out.

3.7.7 Multivariate Analysis

The main objective of multiple logistic analysis was to examine the interrelationship and association of the variables hypothesized to influence the occurrence of anemia. Multiple logistic regression expresses the logistic function of an outcome variable, the probability of anemia, as a linear function of a set of independent variables.

$$\text{Logit (p)} = a + b_1x_1 + b_1x_2 + ... +b_kx_k$$

Multiple logistic regression was used to select both the interactions and a suitable model able to explain change in the odds of low hemoglobin. For the interactive effects, the initial model consisted of all main effects hypothesized to influence and predict the occurrence of anemia. The model was refitted with all main effects and one first-order interactive effect. The analysis proceeded in this fashion by substituting one interactive effect with another one until all first-order interactive effects were tested. The likelihood ratio test between the initial model and every model containing all main effects and one of the interactive effects was used to select the interactive effects for further consideration. A forward stepwise logistic regression was performed to select the best fitting model.[124]

3.7.8 Establishing Population Norms for Inuit Children and Adolescents

The hematological tests used in the Keewatin Health Assessment Survey were hemoglobin, hematocrit, and red cell count. Results from these tests might provide a reasonable basis for deriving normative data applicable to other laboratory situations. Values for all these laboratory tests are known to vary to some degree according to age and/or sex.[109] Therefore, participants were classified into two age groups: (1) children aged from 9M-11 years, and (2) adolescents aged from 12-17 years. Each group was further classified into four age and/or sex categories, using the same age classification as used by the NHANES II Survey (Table 2.4). In order to estimate the extent to which laboratory values normally differ according to age and sex, it was necessary to exclude, as completely as possible, anemics as well as individuals in whom the laboratory values seemed to be outliers. Searching for outliers was carried out within each age and/or sex category and any hematological value more than +3 SD (-3 SD are already excluded with the anemics) from the mean are excluded. For both hemoglobin and hematocrit, values for the median and the 95% limits from 50th, 2.5th, and 97.5th percentiles, respectively, were computed. The use of the percentile approach, rather than using the mean ± 2 SD, had the distinct advantage of: (1) not requiring the assumptions that the laboratory values under consideration should follow a Gaussian distribution, and (2) the reference values from the NHANES II Survey used this approach.

PART 4

RESULTS

4.1 Study Population

A total of 441 children and adolescents from eight sampling communities were selected as representative of the Inuit population 0 through 17 years of age. Children younger than 9 months (N=20) were excluded from the analysis mainly because of the marked changes in hematological values during this period, and because there were no reference hematological values for those less than one year in the NHANES II Survey (Table 2.4). However, children aged 9 months up to one year were included in the first age category, ie, from 1-2 years. Of the remaining 421 children and adolescents, 399 (94.8%) cooperated for hematological testing. Of the 399 participants, 294 (73.7%) were children aged from 9M-11 years and the remaining 105 (26.3%) were adolescents from 12-17 years. Moreover, of the 399 participants, 373 (93.5%) were Inuit and 26 (6.5%) were Non-Inuit, and six (1.5%) were volunteers (ie, subjects who were not randomly chosen but who requested to participate in the study).

4.2 Outcome Variables

Three hematological tests, hemoglobin, hematocrit, and red cell count, were carried out for all children recruited to participate in the survey. Several outliers (ie, > 3 SD and < -3 SD) were identified but they were kept in the analysis because they were considered of clinical interest. Values of the three hematological tests showed departures from normality mainly due to kurtosis, and neither log nor square root transformation seemed to help. The Spearman correlation coefficients between hemoglobin and both HCT and RBC were r= 0.74 and 0.75 (p = 0.0001), respectively. Hence either HGB or HCT could be used as an outcome variable for measuring the prevalence of anemia without serious loss of information. Hemoglobin was selected as the outcome variable mainly because hemoglobin tests appeared to be the method of choice in screening for anemia.[89,90]

Since, there are age and sex related changes in hemoglobin measurements, these must be considered to optimize identification of individuals with anemia. Therefore, the hemoglobin values were dichotomized into anemic and non-anemic individuals by using the NHANES II reference values to identify individuals with hemoglobin values below the 95 percentile on the NHANES II reference range for age and sex, ie, anemic.

4.3 Comparative Analysis of Participant and Non-Participant

In this study, 421 children and adolescents aged from 9 months through 17 years responded to the individual survey. Of these 421 children and adolescents, 399 (94.8%) cooperated for hematological testing and this groups was called "participants" while the remaining were called "non-participants". The similarity of the two groups (ie, participants and non-participants) on variables believed to influence the reason for non-testing, such as: age, sex, and community, was assessed. Because of the small number of subjects in Whale Cove, they were combined with those in Coral harbour. Table 4.2 shows the results of comparative analysis between participants aged from 9M-17 years and the non-participants of the same age. The two groups were similar on the sex and community variables, whereas they differed on the age variable. The non-participation rate for those who were in 9M-2 years and 3-5 years age groups were significantly higher than the non participation rate of the remaining age groups.

Tabachnick and Fidell[115] suggested that if the missing data is not in a random pattern, their deletion will distort the sample. The median for each age and/or sex category was computed and substituted for the missing value and the prevalence of anemia with and without missing data was computed, being 11.1% and 11.5%, respectively. Since, the two prevalences were similar, therefore, the missing values were deleted.

4.4 Prevalence Of Anemia

The overall prevalence of anemia among participants of the eight Keewatin communities was 11.5%. The community-specific prevalences were: 22.4% for Arviat, 12.7% for Baker Lake, 12.5% for Whale Cove, 8.3% for Rankin Inlet, 8.7% for Repulse Bay, 8.3% for Coral Harbour, 7.0% for Sanikiluaq, and 4.3% for Chesterfield inlet (Fig 4.1).

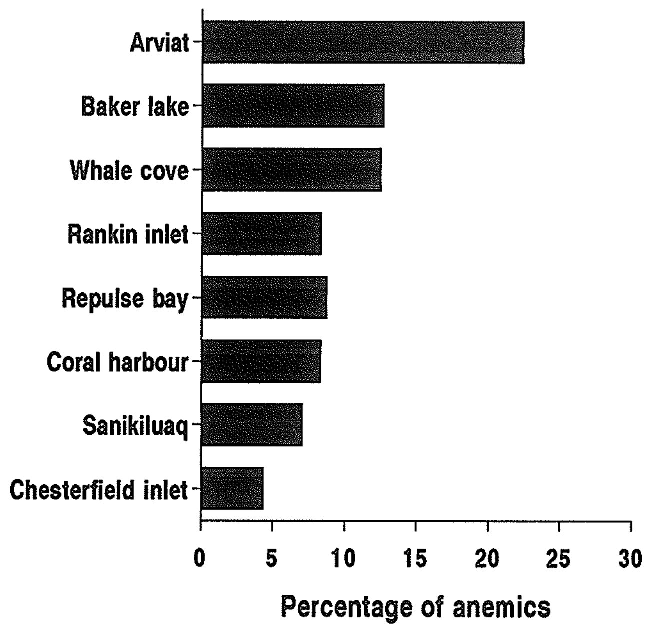


Figure 4.1 Prevalence of Anemia, by Community

4.5 Type of Anemia

The Spearman correlation between HGB and MCHC was r=0.36 (p=0.0001), whereas the correlation between HGB and both MCV and MCH were r=-0.09 (p=0.06) and r=0.23 (p=0.0001), respectively. As mentioned, MCH values parallel those of MCV because small cells contain less hemoglobin and large cells contain more, the correlation between MCV and MCH was r=0.61, (p=0.0001). In addition, there were significant correlations between MCHC and both MCV (r=-0.55, p=0.0001) and MCH (r=0.24, p=0.0001).

With about one-tenth of the children and adolescents being anemic in this study, there was a need to further explore the type of anemia. The red blood cell indices: MCV, MCH, and MCHC, could be used to demonstrate certain characteristics of RBC. A very low prevalence of reduced MCHC, MCV, and MCH was found in anemics. Of the 46 children and adolescents found to be anemic according to HGB measurements, 11 (24%) had low MCHC, 1 (2%) had low MCV, and none of them had low MCH (Fig 4.2). Furthermore, abnormal red cell indices were evident in the non-anemics. Of the 353 non- anemics, 21 (6.0%) had low MCHC, 17 (4.8%) had low MCV, and 4 (1.1%) had low MCH (Fig 4.3).

Direct measurements of iron stores were not available, but of the 46 children and adolescents with apparent anemia, 23 (50%) had high MCV and 13 (28.3%) had high MCH (Fig 4.2). These findings make microcytic anemia in these children and adolescents highly unlikely. Moreover, of the 353 non-anemics, 85 (24.1%) had high MCV and 126 (35.7%) had high MCH (Fig 4.3).

Both children aged from 9M-2 years and female teenagers aged from 15-17 years were found to have the highest prevalence of anemia when compared to other age groups. The type of anemia among both age groups, therefore, was analyzed. A somewhat similar findings were found in these two age groups. Of the 86 children aged from 9M-2 years, 18 (26.7%) were anemic. Of the 18 anemics, 5 (27.8%) had low MCHC (Fig 4.4) and 11 (61.1%) had high MCV values (Fig 4.5). On the other hand, of the 29 females teenagers aged 15-17 years, 6 (20.7%) were anemic. Of the 6 anemics, 2 (33.3%) had low MCHC (Fig 4.6) and 3 (50%) had high MCV (Fig 4.7).

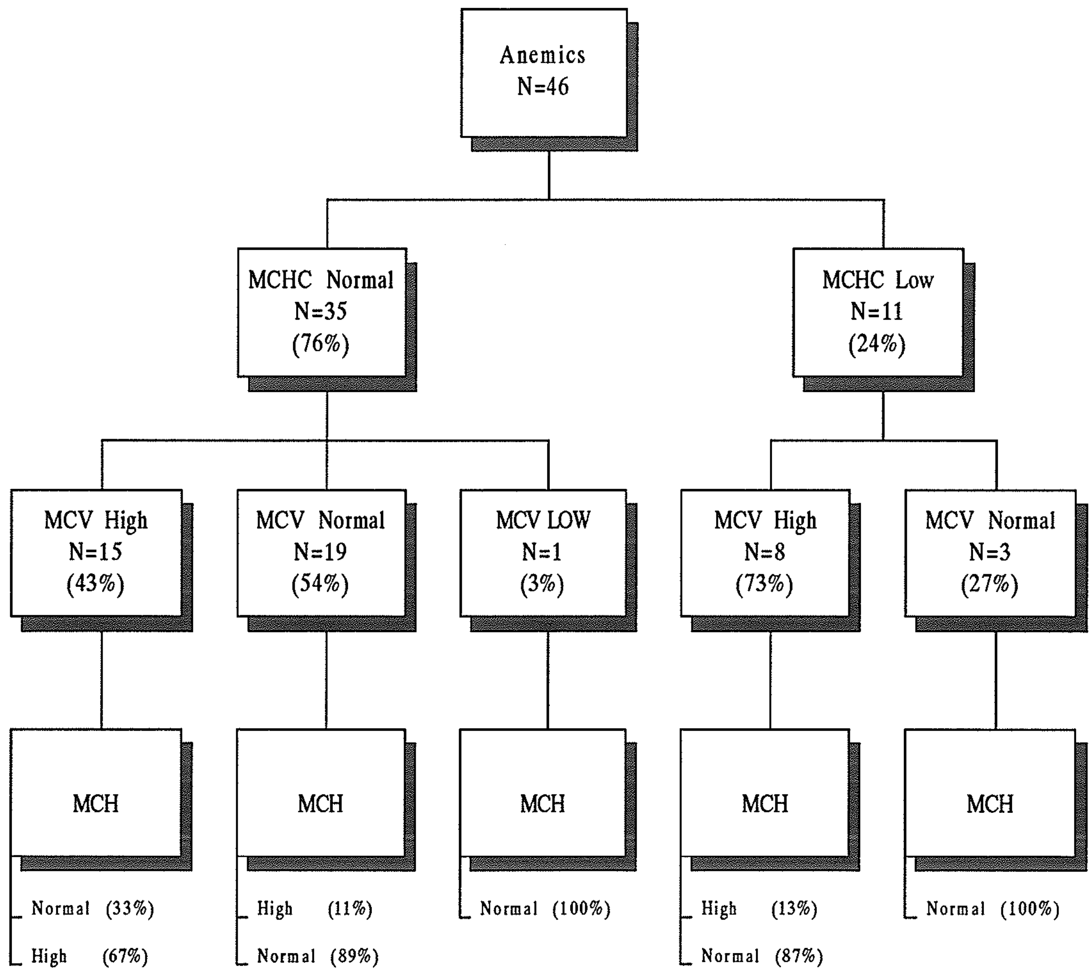


Figure 4.2 Distribution of Red Cell Indices among Anemics

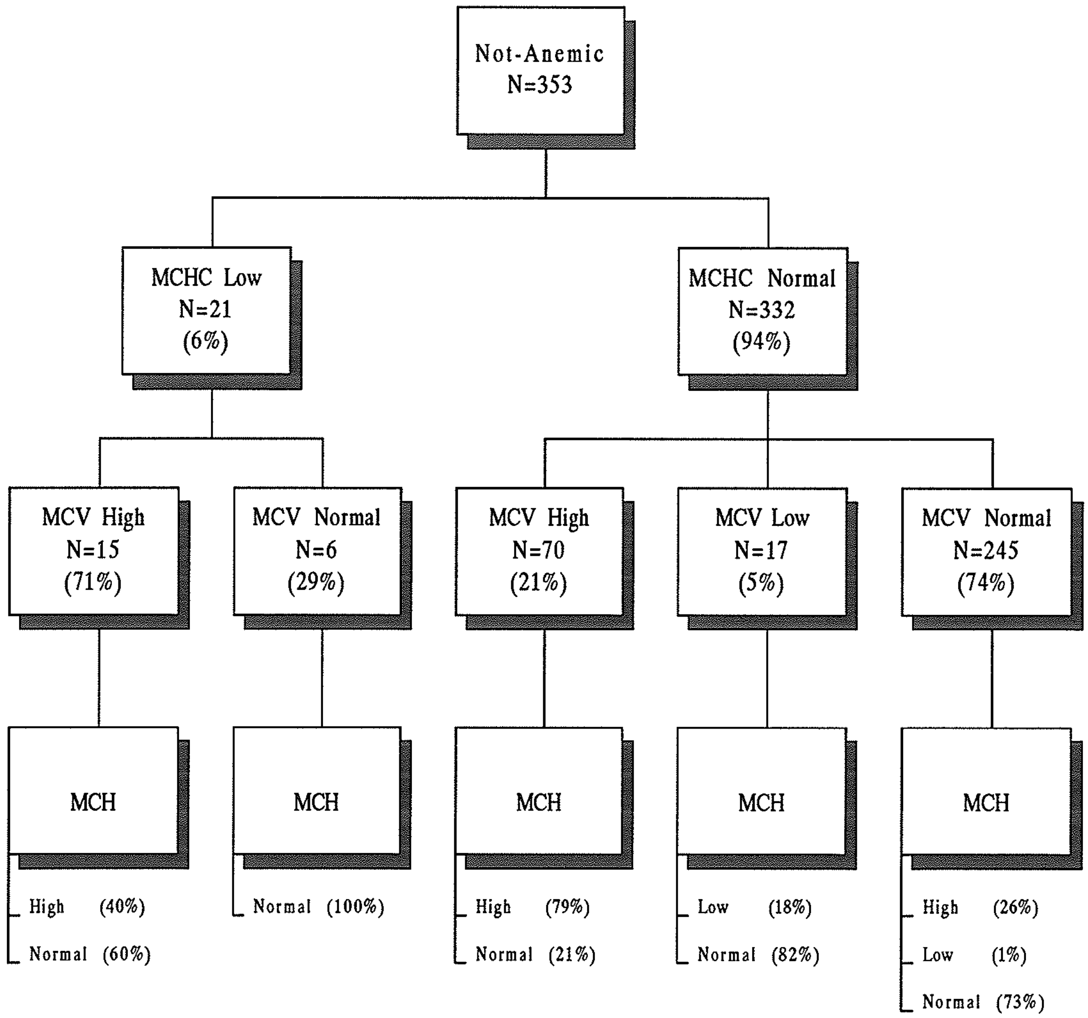


Figure 4.3 Distribution of Red Cell Indices among Non-anemics

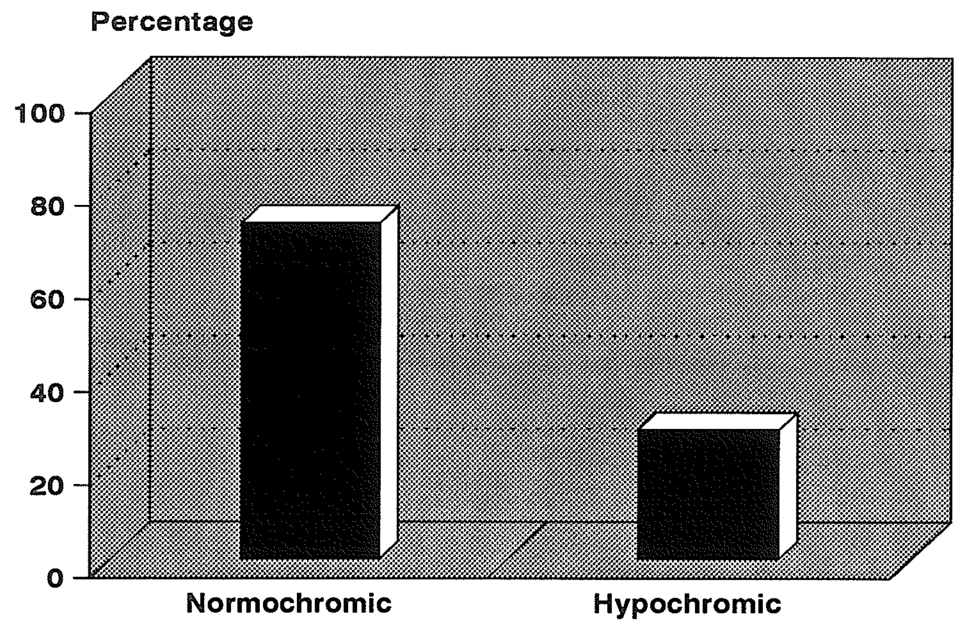


Figure 4.4 Distribution of MCHC for Anemic Children Aged 9 Months - 2 Years

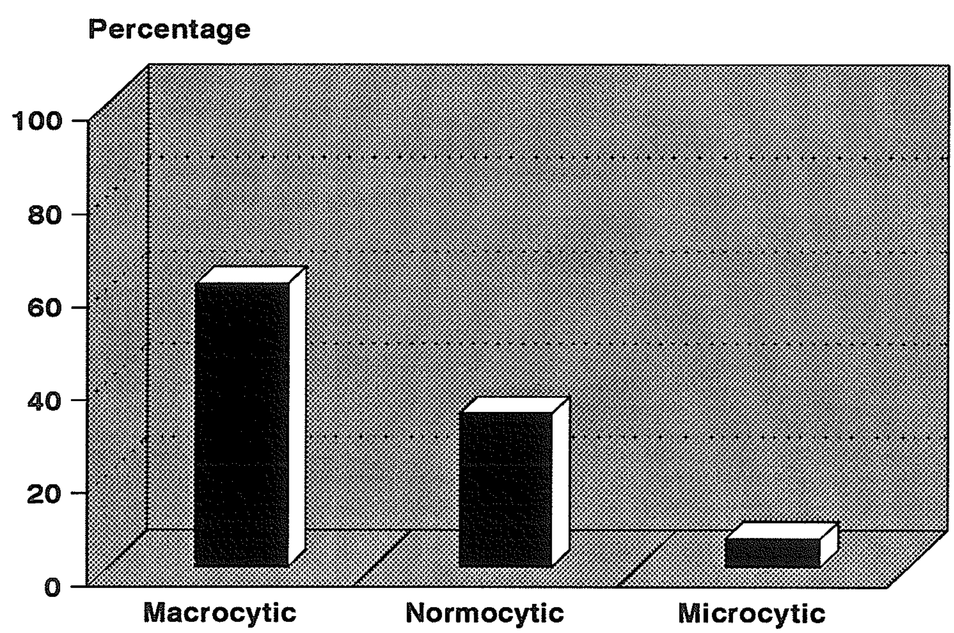


Figure 4.5 Distribution of MCV for Anemic Children Aged 9 Months - 2 Years

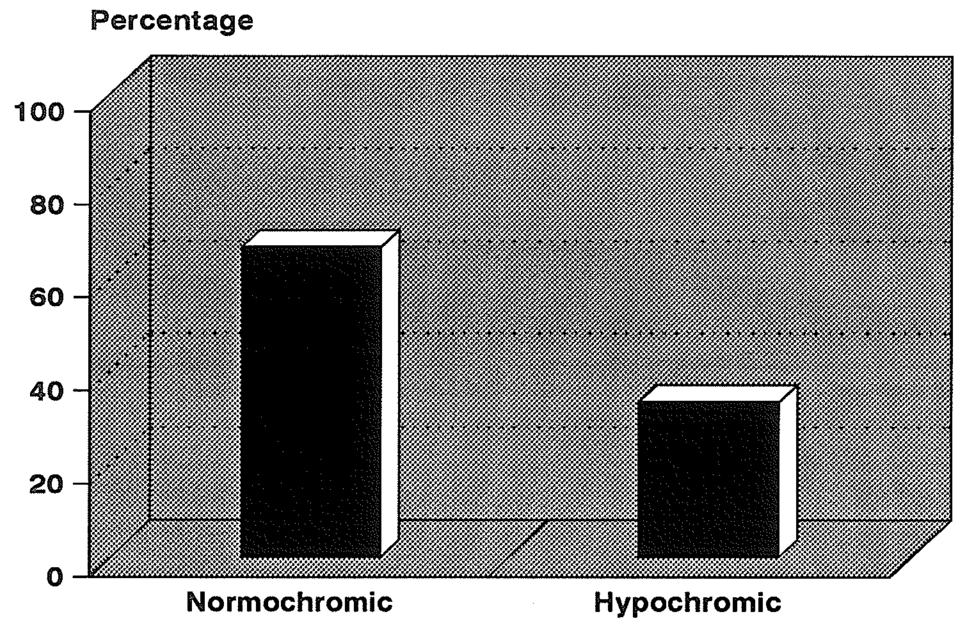


Figure 4.6 Distribution of MCHC for Anemic Females Aged 15-17 Years

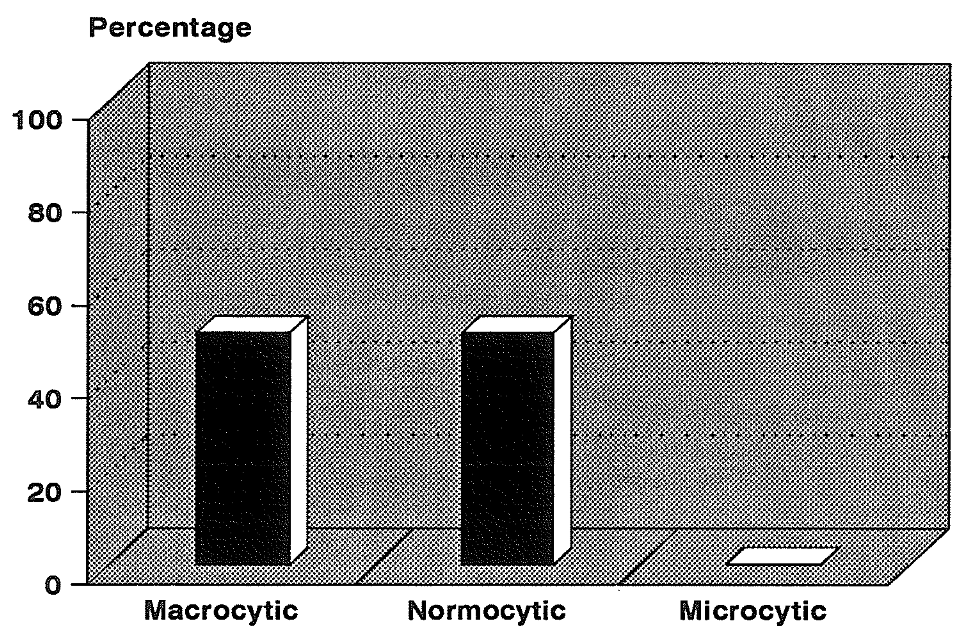


Figure 4.7 Distribution of MCV for Anemic Females Aged 15-17 Years

4.6 Anthropometric Indices

Different techniques were employed to estimate age. When information on the birth date was available, ages were calculated using birth dates and survey dates. On the other hand, when there was no information on birth date or birth date was miscoded (an example of the latter problem is an individual whose recorded birth date follows the survey date) the attained age was used. This approach was selected for two reasons: (1) the anthropometric indices are best calculated when the exact age is available, and (2) the mean difference between the *floor* of both the calculated and the attained ages was only 0.07 year. Of the 399 participants, 330 (82.7%) had information on date of birth.

Out of the 399 participants, 6 (1.5%) had no height measurements, and 4 (1.0%) had no weight measurements. Of the remaining participants 9 outliers were identified and these were deleted, as their values were presumed to represent incorrect data entry (an example of this problem would be a two years old girl with a height of 55 cm).

The distribution of height-for-age Z-scores (HAZ) were shifted to the left of the normal distribution of the reference population with 31% of the children and adolescents ≤ -1 SD as compared to the expected value of 15.87% (Table 4.3). The distribution of weight-for-height Z-scores (WHZ) for children only was shifted to the right of the normal distribution of the reference population with 66.4% of the children ≥ 1 SD as compared to the expected value of 15.87% (Table 4.4).

For children only, Table 4.5 represents a classification of nutritional status proposed by Waterlow et al[119] in which the independent distributions of HAZ and WHZ were combined in a cross tabulation. When ≤ -2 SD of the reference median was the cutoff point for undernutrition in relation to both these indicators, none was found to be both stunted and wasted. Conversely, when high WHZ (≥ 1 SD) was considered as overnutrition, then a large number of children, ie, 160 (66.4%), fell in this category;

82 (34.0%) of these children could have been considered obese (WHZ ≥ 2 SD), and the remaining 78 (32.4%) appeared to be overweight (1 to 1.99 SD).

4.7 Univariate Analysis

Two separate univariate analyses were generated, one for combined children and adolescents and the other one for adolescents only. The main reason for this separation was the inclusion, for adolescents only, of an interviewer-administered questionnaire in the individual survey.

4.7.1 Univariate Analysis for Children and Adolescents

I. Factors Influencing the Occurrence of Anemia

There were several factors hypothesized to influence the occurrence of anemia and for which a significant association was found. These included:

1. Age and sex. Males and females have about the same HGB levels until approximately age ten, after which male values slowly become higher.[109] Therefore, the prevalence of anemia was stratified by age for children and adolescents (Figure 4.8) and by age and sex for adolescents only (Figure 4.9).

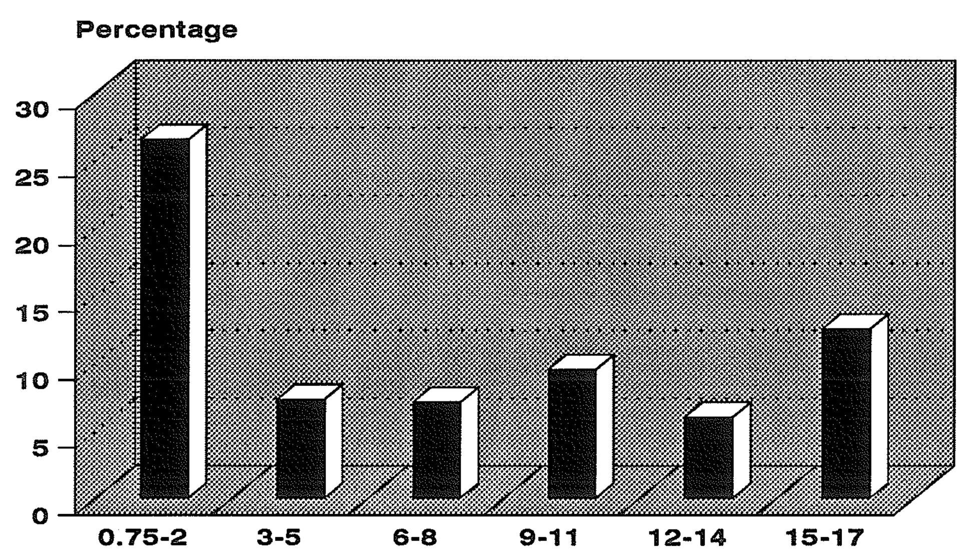


Figure 4.8 Prevalence of Anemia, by Age

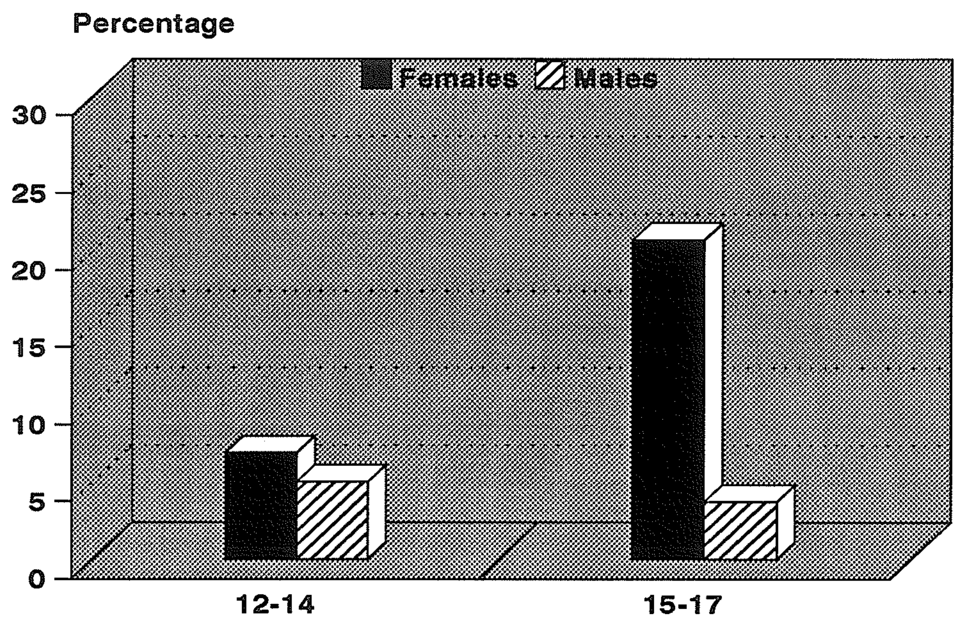


Figure 4.9 Prevalence of Anemia among Adolescents, by Age and Sex

Testing for an association between the occurrence of anemia and the eight different age and/or sex categories, it was found the proportions differed significantly, Likelihood Ratio X^2=20.7 (p=0.004, DF=7). One would next proceed to identify the categories which contributed to the significant difference. Of the above eight age-and sex-categories (Table 4.6), the first (9M-2 years) and the last (15-17 years females) categories appeared, on the basis of their proportion similarity, to stand by themselves and formed one homogenous group called Group A, N=97 (24.7%), whereas the six remaining categories appeared to form another homogenous group called Group B, N=302 (75.7%). The prevalence of anemia was 24.7% for Group A and 7.3% for Group B. The Likelihood Ratio X^2=19.1, p=0.000 (OR=4.2, 95% CI=2.2-2.7) indicated highly significant differences between Groups A and B, but there were no significant differences either between the proportions in Group A, Likelihood Ratio X^2=0.37 (p=0.54), or among the proportions in Group B, Likelihood ratio X^2=1.27 (p=0.94).

2. Community. Table 4.7 shows that Arviat appeared to have a high prevalence of anemia when compared to the other seven communities. Therefore, the eight communities were categorized into 2 rather than 8 categories. One category included Arviat, N=76 (19.1%), and the second category included the other 7 communities N=323 (80.1%). The prevalences of anemia were 22.37% for Arviat and 8.98% for the other seven communities combined. The Likelihood Ratio Chi-Square value of X^2=9.32, p=0.002 (OR=2.9, 95%CI=1<x-5.6) indicated highly significant differences in the prevalence of anemia between Arviat and the other seven communities combined; however, there were no differences among the proportions in the six communities (Coral Harbour and Whale Cove were combined) Likelihood Ratio X^2=2.08 (p=0.84).

3. Height-for-age (HAZ). Of the 399 participants, 384 (96.2%) children and adolescents had HAZ values. Testing for an association between the occurrence of anemia and the 5 different SD scores suggested by Waterlow,[119] it was found the proportions differed significantly, Likelihood Ratio X^2=10.05 (p=0.04, DF=4).

Inspection of the cross tabulation between the 5 SD score categories and the occurrence of anemia revealed that HAZ (Table 4.8) can be categorized into 2 rather than 5 categories, on the basis of their proportions similarity and because of the small number in the first category, ie, ≤ -2 SD. One category (Group 1) included the first two categories, ie, all those who had HAZ ≤ -1 SD units from the reference median, and the second one (Group 2) included the three remaining categories, ie, all those who had HAZ > -1 SD units from the reference median. The prevalence of anemia was 17.7% among those in "group 1" and 8.3% among those in "group 2". The Likelihood Ratio Chi-square value of X^2=6.7, P=0.01 (OR=2.4, 95%CI=1.2-4.5) indicated highly significant difference in the prevalences of anemia between the two groups, but there were no significant differences either between the proportions in "Group 1",ie, the first two categories, Likelihood Ratio X^2=0.89 (p=0.34, DF=1), or among the proportions in Group 2 ie, the three remaining categories, Likelihood ratio X^2=2.38 (p=0.30, DF=2).

4. Otitis media and its complication. Out of the 399 participants, 357 (89.5%) had an ear examination. The ear examination included the presence/absence of otitis media, perforation of tympanic membrane, and ear discharge. If the participant had either otitis media and/or one of its complications (mentioned above) the participant was considered to have an ear infection. Of the 357 children and adolescents, 96 (26.9%) had ear infections. The prevalence of anemia was 17.7% among those who had ear infections and 9.2% among those who did not. The Likelihood Ratio Chi-square value of X^2=4.53, p=0.03 (OR=2.1, CI=1.1-4.1) indicated significant difference in the prevalences of anemia between those who had an ear infection and those who did not.

5. Household data. Of the 399 participants, two individuals could not be linked to the household data because their household numbers could not be matched with the household number of the household data, and 57 (14.3%) individuals had missed household data, resulting in 340 individuals with household data. From the household data, several factors were used as an indicator of socio-economic status. These included:

A. <u>Type of Housing</u>

Testing for an association between the occurrence of anemia and the different type of housing (Appendix E), it was found the proportions differed significantly, Likelihood Ratio X^2=11.36 (p=0.045). An inspection of the cross tabulation between the six types of houses and the occurrence of anemia (Table 4.8) showed that this variable can be categorized into 2 rather than 6 categories, on the basis of the similarity of their proportions. One category included people living in both public housing and northern rentals, N=268 (79.3%), and the second one included those living in privately owned, private rented, government staff housing, and private staff housing N=70 (20.7%). The prevalence of anemia was 13.4% among those living in the first house category and 2.8% among those living in the second house category. The Likelihood Ratio Chi-square value X^2=8.02, p=0.005 (OR=5.3, CI=1.2-22.5) indicated significant differences between those living in the first and the second house categories.

B. Degree of Crowding

This was indicated by number of person (s)per room. Dwellings with more than one person per room were defined as crowded.[125] Hence, the variable was dichotomized into two categories: ≤ 1, N=47 (14.3%), and > 1, N=282 (85.7%), individual per room. It was found that people living in crowded houses were significantly at a higher risk of developing anemia compared to those living in non-crowded houses, Likelihood Ratio Chi-square X^2=12.16, P=0.000 (Table 4.9).

C. The Availability of Luxury Items

Of the 340 individuals with household data, 336 (98.8%) had information about the availability of luxury items. Luxury items were grouped into basic and accessory items. The basic items included the presence/absence of fridge, washer and/or dryer, television and telephone. A house with the four basic items was considered to be high basic-item house. The prevalence of anemia was 19.4% among those living in low basic-item houses and 7.7% among those living in high basic-item houses. The Likelihood Ratio Chi-Square value of X^2=9.02, P=0.003 (OR=2.9, 95% CI=1.5-5.7) indicated highly significant differences in the prevalence of anemia between those living in low and high basic-item houses (Table 4.9).

The accessory items included the presence of freezer, microwave oven, VCR, game computer, and personal computer. A house with ≥ 3 accessory items was considered to be high accessory-item house. The prevalence of anemia was 15.1% among those living in low accessory-item houses and 7.0% among those living in high accessory item houses. The Likelihood ratio Chi-Square value X^2=5.63, P=0.018

(OR=2.4, 95%CI=1.1-4.9) indicated highly significant differences in the prevalences of anemia between those living in low and high accessory-item houses (Table 4.9).

II. Factors Not Influencing the Occurrence of Anemia

There were several factors hypothesized to influence the occurrence of anemia but for which no association was found. These included:

1. History of chronic diseases. Of the 399 participants, 369 (92.5%) responded with a parent-reported history of presence or absence of chronic diseases. There were only 12 (3.25%) children and adolescents reported to have chronic disease, however none of them was anemic.

2. Race. Of the 399 participants from the 8 communities, 373 (93.5%) were Inuit, and 26 (6.5%) were non-Inuit. Because of the small number of the non-Inuit participants, participants from Churchill--there were 38 participants from Churchill and all except one were non-Inuit N=37--were included with the participants from the eight communities. This resulted in 374 (85.78%) Inuit and 62 (14.2%) non-Inuit participants. The prevalence of anemia among Inuit (12.0%) was higher than non-Inuit (4.84%). The Likelihood Ratio Chi-square test value of X^2=3.37 (p=0.067) indicated that there was no significant difference in the prevalences of anemia between the Inuit and the non-Inuit. However, the power of this Chi-Square test was only 35.5%.

3. Weight-for-height (WHZ). Of the 399 participants, 241 (60.4%) children had WHZ values. An inspection of the cross tabulation between the different SD score WHZ and the occurrence of anemia (Table 4.10) showed: (a) there was only one child in the first category (ie, ≤-2 SD); (b) none was found in the second category (ie, -1.99 SD to -1 SD); and (c) the Chi-square test showed no association between the three remaining categories and the occurrence of anemia, Likelihood Ratio X^2=4.36 (P=0.11, DF=2).

4. Body Mass Index (BMI). For those for whom the WHZ could not be calculated, the BMI was calculated instead. Of the 399 participants, 138 (34.5%) had

body mass index values. Values for BMI of < 20 were regarded as indicative of underweight.[121] Therefore, the BMI variable was dichotomized into two categories: < 20 and ≥ 20 (Table 4.11). No association was found between the two BMI categories, < 20 and ≥ 20, and the occurrence of anemia, Likelihood ratio X^2=0.50 (P=0.48).

5. Household data. From the household data, several factors were believed to influence the occurrence of anemia and no association was found between the studied factor and the occurrence of anemia which included: (a) total income (b) employment status (c) availability of sanitation facilities, (d) availability of rifle and dog teams.

(a) Total Income

Of the 340 individuals with household data, 320 (94.1%) had information about the total income. In this survey the total income of each house surveyed could only be estimated. This was because the average annual income of each adult in the house was given as a range and was coded separately (Appendix E). The total income values showed a skewness of 0.82 (Z=598, P=0.000) and Kurtosis of 1.07 (Z=3.96, P=0.000), ie, not following the normal distribution. However, square root transformation normalized its distribution, and the values of both skewness and kurtosis were 0.07 (Z=0.51, P=0.61) and -0.25 (Z=0.92, P=0.34), respectively. It was found that the square root of the mean total income for anemic children and adolescents (=2.0) did not differ significantly from non-anemics (=2.1), T-Test= -0.91 (P=0.36).

(b) Employment Status

Of the 340 individuals with household data, 334 (98.2%) had information about employment status. The total number of employed individuals in each household was calculated. A house with no individual employed was considered to be of low employment status. Therefore, the status variable was categorized into two categories: 0, N=41 (12.3%), and 1+, N=293 (87.3%), employed individuals and the resulting Likelihood Ratio X^2=2.43 (p=0.12) showed no significant differences.

Moreover, the analysis was repeated with a different cut-off value of 0-1, N=177 (53.0%), and 2+, N=157 (47%), employed individuals and showed no difference Likelihood Ratio X^2=2.22 (p=0.14), again.

(c) Availability of Sanitation Facilities

This was indicated by the presence/or absence of a tap water system, and Hamlet sewage system. However both variables were a dichotomous variable with uneven split 97-3 and 91-9, respectively.

(d) Availability of Rifle and Dog team

This was indicated by the presence or absence of rifle and dog team. The rifle variable was a dichotomous one, yes/no, with uneven split 90-10, with 90% of houses having rifle in it, reflecting the hunting background of most people. Therefore, this variable was deleted. No association was found between the presence /or absence of dog team and the occurrence of anemia (Table 4.9), Likelihood Ratio X^2=0.70 (P=0.40).

4.7.2 Univariate Analysis for Adolescents only

I. Factors Influencing the Occurrence of Anemia

The questionnaire included information hypothesized to influence the occurrence of anemia and for which a significant association was found. These included:

1. School attendance. Of the 105 adolescents, 99 (94.3%) adolescents responded to only one out of three answers: No, full time, and part time (Table 4.12). Because only a small number answered part time, they were combined to those who answered full time. The prevalence of anemia was 25% for adolescents attending school and 5% for those who did not attend school. Likelihood Ratio Chi-square value of X^2=6.16 (p=0.01) indicated significant difference between adolescents attending school and those who did not attend school.

2. English language capability. Of the 105 adolescents, 98 (93.3%) responded to only one out of four answers: Very well, moderate, very little, and not at

all (Table 4.12). The last two categories were combined due to the small number in the last category. Testing for an association between English speaking capability--very well, moderate, and very little--and the occurrence of anemia, it was found the proportions differed significantly, Likelihood Ratio X^2=9.63 (p=0.008).

One would next proceed to identify the categories which contributed to the significant difference. Those who speak very little English seemed to have a high prevalence of anemia when compared to the others, very well or moderately. Therefore, the answers were categorized into 2 rather than 4 categories. One category included adolescents who speak English very little or not at all, N=23 (23.5%), and the second category included those who speak English very well or moderately, N=75 (76.5%). The prevalence of anemia was 26.1% for the first category and 4.0% for the second category. The Likelihood Ratio Chi-Square value of X^2=8.53, p=0.003 (OR=8.5, 95%CI=1.9-37.0) indicated highly significant difference in the prevalence of anemia between the two categories, but there was no significant difference between those who speak English very well or moderately, Likelihood Ratio X^2=1.10, (p=0.29).

3. Participation in Sports. Of the 105 adolescents, 96 (93.3%) responded to only one out of five answers about the frequency of sports: Daily, 3-6 times per week, 1-3 times per week, less than once per week, and never (Table 4.12). The frequency of participation in sports was compiled into two groups: (a) participant, if the individual participated in sports once a week or more, ie, the first three categories; and (b) non-participant, if the individual participated in sports less than once per week, ie, the last two categories. The proportion of anemic adolescents was 5.3% for the participants and 25.0% for the non-participants. The Likelihood Ratio Chi-square value of X^2=5.81, p=0.016 (OR=5.9, 95%CI=1.3-24.4) indicated significant difference in the prevalence of anemia between the two groups.

II. Factors Not Influencing the Occurrence of Anemia

The questionnaire included information hypothesized to influence the occurrence of anemia but for which no association was found. These included:

1. Health compared to other people of the same age. Of the 105 participant adolescents, 97 (92.4%) individuals responded to one out of three answers, better, same, and worse (Table 4.12). However, this variable showed no association, Likelihood Ratio Chi-square $X^2=1.97$ ($p=0.37$).

2. Cigarette Smoking. Several studies have shown an association between smoking, alcohol consumption and the occurrence of macrocytic anemia.[126-128] Of the 105 participant adolescents, 97 (92.4%) individuals responded to one out of three answers: Yes, no, and occasionally. Because only a small number answered occasionally (Table 4.12), they were combined to those who answered yes. However, no association was found between the smoking status, yes/no, and the occurrence of anemia, Likelihood Ratio $X^2=3.34$ ($p=0.07$).

3. Alcohol consumption. Of the 105 participant adolescents, 98 (93.3%) individuals responded to one out of two answers, yes, no (Table 4.12). However, no association was found between alcohol consumption and the occurrence of anemia, Likelihood Ratio $X^2=0.003$ ($p=0.95$).

4. History of different food items intake. Of the 105 adolescents, 14 (13.3%) had no information about food intake at all. Of the remaining N=91 (86.7%), 88 adolescents responded to all questions about number of times each food item was consumed. For each food item variable, each individual responded to one out of four answers: Number of times per day, or week, or month, and never. Each food item was transformed into a continuous variable using the following equation:

Number of times/month = no. of times/day x 30 + no.of times/week x 4 + no. of times/month

Food items were then compiled into groups according to their similarities: (a) meat group which included: store-bought meats, country meats from land, and processed meat; (b) fish group which included: country meats from the sea, store bought fish, and local fish; (c) vegetables; (d) eggs; (e) milk and dairy group which included: milk, cheese-product, yogurt, and ice cream; (f) starchy food group which included the consumption of both bread (bread/bannock/cereal) and pasta (pasta/macaroni/spaghetti/craft dinner/etc.); and (g) Snacking food group which included: cake (includes: cookies, cake, pies, doughnuts), potato chips, jello, honey, chocolate bars, and popcorn. Snacking is a characteristic adolescent food habit.[129] Snacking can also add to the total nutrient intake. Popcorn, potato chips, and chocolate bars are foods with intermediate iron content,[130] therefore, they were included together as another group and called fast food group, ie, excluding cake, honey, and jello from the snack food group.

The frequency of consumption/month of each food group was computed for each adolescents. None of the above food groups followed the normal distribution. Both log and square root transformation were tried to normalize their distributions. The log transformation normalized the distribution of fast food group. Square root transformation normalized the distribution of meat and starchy food group. Neither transformation seemed to help with snack food, milk and dairy, and fish groups. Both eggs and vegetables groups showed a spiky distribution. This is because both eggs and vegetable groups were singular food items.

For the sake of simplicity and consistency, all the above food group variables, except the snacking food category, were dichotomized into two categories: (a) not enough, if the individual consumed the corresponding food group < 30 times/month; (b) enough, if the individual consumed the corresponding food group ≥ 30 times/month. This categorization was based on the following reason: Since, the daily total intake of each food group could not be calculated, from the given information, it was assumed that if the individual consumed the corresponding food item every day as recommended in the Canada food guide then he/or she was considered to have enough intake.[131] As the snacking food group was not considered an essential food group, it was categorized into low intake and high intake, ie < 30 times/month ≥ 30 times/month, respectively. None of the above food groups showed an association between the intake status of "enough/not enough", and the occurrence of anemia (Table 4.13).

Among the above food groups, the median intake of vegetables per month was the lowest when compared to the other food groups (Table 4.14). Vegetables are folate-rich. It was evident from the analysis that 50% of the anemics had macrocytic cells, most commonly due to folic acid deficiency. Therefore, the vegetable intake per month was divided into quartile in order to account for biologic variability. Testing for an association between the occurrence of anemia and the different level of vegetable intake per month with and without the inclusion of non-Inuit showed no significant association, Likelihood Ratio X^2=5.2 (p=0.16) and X^2=5.4 (p=0.14), respectively.

4.8 Multivariate Analysis

For both children and adolescents, all the explanatory variables with a p-value of 0.1 or less were selected for a multiple logistic regression model. This was not done for the adolescents due to the small number.

4.8.1 Factors Included in Multivariate Analysis

Univariate analysis for children and adolescents were used to select factors able to predict the occurrence of anemia. The initial logistic model was developed following the results of the univariate analysis and included all explanatory variables showed a significant association with the occurrence of anemia (Table 4.15). These included: age and/or sex, community, height-for-age, otitis media and its complications, type of housing, degree of crowding, availability of basic items, and availability of accessory items. Out of the 399 participants, 293 (73%) were included in the logistic regression.

4.8.2 Interactions

The initial model was used to test separately for interactions between explanatory variables, ie, those variables which were considered for inclusion in the initial logistic model. None of the interactive effects was significantly associated with the occurrence of anemia.

4.8.3 Final Model

The forward stepwise elimination procedures resulted in a final model (Table 4.16) which included: (a) age and/or sex, both children aged from 9M-2 years and female aged from 15-17 years were at higher risk of having anemia than the other age and/or sex groups combined; (b) height-for-age, participants had height-for-age ≤ -1 SD were at higher risk of having anemia than those had height-for-age > 1 SD; (c) the availability of basic items, participants living in a house with < 4 basic items were at a higher risk of having anemia than those living in a house with 4 basic items; (d) degree of crowding, participants living in a house with more than one individual per room were at higher risk of having anemia than those living in a house with one or less individual per room.

4.9 Population Norms

For both HGB and HCT, all anemic participants and two outliers were identified, ie, > +3 SD, were identified and they were excluded. Values for the median and the 95% limits was computed. Table 4.17 showed that the median HGB and HCT values derived from this survey were lower than the NHANES II survey results at all levels of age- and/or sex-groups. However, the age and/or sex changes were in general accord with published NHANES II results.

PART 5

DISCUSSION

The major findings of this survey were that the overall prevalence of anemia among the hematologically tested children and adolescents between 9M-17 years of age was 11.5%. The prevalence of anemia among Inuit children and teenagers is high. In the 1975 Nutrition Canada survey, the national sample for children and adolescents showed a prevalence of anemia ranging from 0.2%-0.5%.[13] Moreover, children aged from 9 months through 2 years showed a very high prevalence of anemia, 26.5%. In contrast, Brault-Dubuc et al (1983) showed that the prevalence of anemia among children in Montreal aged from 3-36 months ranged from 0.0%-4.2%,[132] and a more recent study in Carleton, Ottawa (1991), showed the prevalence of anemia among infants 6-18 months to be 3.5%.[133]

For both children and adolescents, the prevalence of anemia was influenced by age and/or sex, community (Arviat versus the other seven communities), height-for-age, otitis media and/or its complication, type of housing, degree of crowding, availability of basic items, and availability of accessory items. For adolescents only, the prevalence of anemia was influenced by school attendance, English language capability, and participation in sports. Neither total income nor employment status variables showed a significant association with the occurrence of anemia. This might be a result of imprecise or incomplete information about the total income (as shown below).

5.1 Generalizability of the Study

When interpreting the results of this survey, the emphasis must be on the following major question "How well does the study population represent children and adolescents of the same age group of the eight selected Inuit communities?".

Subjects were selected to produce a sample that was representative of the Inuit population. In this way the observed results could be generalized to provide estimates of the prevalence of anemia among the Inuit. However, the inclusion of a volunteer subpopulation and the non-participation in hematological testings made it mandatory to consider the possibility of significant bias. The analyses carried out both with and without the volunteers did not differ, possibly due to their small number, N=6 (1.5%). Therefore, they were included in the analyses.

Some characteristics were selected to compare the study children and adolescents with the remaining children and adolescents of the eight communities. A crude estimate of the similarity revealed that both participants and non-participants, of the eight communities were similar in sex (p=0.15) and community variables.

It should be pointed out that the groups of preschool-aged children (9M-5 years) showed a significantly higher non-response rate than the groups of school-aged children and adolescents (6-17 years), Likelihood Ratio X^2=13.6, p=0.000 (OR=5.6, 95% CI=2.0-15.6). If the results above were because preschool children were afraid of the procedure, or they were too young to understand the reason for doing it, generalization of the study may be justified; the results present in this case would be representative of the Inuit children and adolescents. However, another reason for these results might be that the mothers who were not willing to push their children for testing were more likely to have anemic children. In this case generalization of the study may not be justified.

5.2 Epidemiologic Importance of the Prevalence of Anemia

Of the 399 hematologically tested children and adolescents, 46 (11.5%) met the criteria for the presence of anemia, ie, low hemoglobin. The prevalence of anemia was found to rage from 3.7% to 26.5%. This range of prevalence is perceived as being high when compared with the results of the 1975 Nutrition Canada Survey for the general Canadian population in which the prevalence of anemia for children and adolescents was found to range from 2%-5%.[13] Moreover, Dallman et al[89] found the prevalence of anemia in the United States (from 1976-1980) to range from 2.3% to 5.8%.

There was concern about the interpretation of the hemoglobin results in the Keewatin Health Assessment Survey. Accordingly, the prevalence of anemia might be underestimated or overestimated. The NHANES II reference ranges for hemoglobin were used as a basis for estimation of the prevalence of anemia. The conditions under which blood samplings were done in the KHAS survey were not comparable to the conditions of the NHANES II Survey. In the NHANES II Survey, venous blood was used to determine the measurements for HGB, HCT, and RBC. In the KHAS survey, capillary blood was used to determine the same measurements. The non-comparability in the source of blood in the NHANES II Survey and in this survey may introduce error in estimating the prevalence of anemia. For example, Moe[88] found that venous hemoglobin values were significantly higher than capillary values. To my knowledge, there is no standardized hematological reference data for capillary blood sampling.

5.3 Limitations of the Study

5.3.1 Limitations in Assessing Type of Anemia

Hypochromic, low MCHC, and microcytic, low MCV, red cells are characteristic features of microcytic anemia[117] which is commonly due to iron deficiency.[97,98] Of the 46 anemics, 11 (24%) had low MCHC, 1 (2.0%) had low MCV, and none had low MCH. On the other hand, 23 (50%) met the criteria for macrocytic anemia,[92,117] ie, had both low hemoglobin and high MCV values. However, it cannot be concluded that macrocytic anemia, and not microcytic anemia, is the most common cause of anemia in this study population for the following reasons:

1. Limitations in the MCV and MCH indices

The AMES MINLAB was used for measuring the erythrocyte count through measuring the turbidity of the blood. Counting of red blood cells on the AMES MINILAB was found to be lacking in precision (CV=19) when compared to the results of the Coulter Counter. In this study, the MCV has likewise acquired lesser reliability for predicting the type of anemia because the MCV included the erythrocyte count in its calculation. Similar considerations apply to MCH. The advantage of both MCV and MCH lies in their ability to differentiate between microcytic and macrocytic anemias. They tend to be low in microcytic anemia and high in macrocytic anemia.

Abnormal MCV and MCH values were found among non-anemics. These might be due to: (a) some misclassification due to the chosen cutoff values,[2] (b) error in measuring red blood cell values which was used for both MCV and MCH calculations, and (c) abnormal MCV and MCH values with normal hemoglobin might also be explained on the basis that macrocytic[102-104] or microcytic[134] red cells appeared in the circulation before a significant decrease in hemoglobin concentration had occurred.

2. Limitations in the MCHC index

The MCHC was calculated by dividing the hemoglobin value by the microhematocrit value. Both hemoglobin and hematocrit were measured by the standard methods, ie, the cyanmethemoglobin and microhematocrit methods, respectively. Therefore, in this study, the MCHC was the only reliable index used for detecting the type of anemia.

Microcytic anemia is characterized by microcytic and hypochromic cells. On the other hand, macrocytic anemia is characterized by macrocytic and either normochromic or hypochromic, ie, either normal or low MCHC, cells.[92,117] Therefore, low MCHC only could be found in both microcytic and macrocytic anemia. In this study, it was hypothesized that low MCHC is due to microcytic anemia which is most commonly due to iron deficiency. The prevalence of hypochromic anemia, ie, both low HGB and MCHC, was lower than what was expected. There are some reasons hypothesized to be responsible for this finding:

A. Pathophysiologic reason. MCHC is the last of the indices to fall during the progression of iron deficiency.[25,105] This might explain the reason for finding the low prevalence of hypochromic cells among anemics.

Low MCHC values were found among non-anemics. This might be due to: (a) some misclassification due to the chosen cutoff values,[2] (b) technical error in measuring the hematocrit values which was used for the MCHC calculation, and (c) low MCHC with normal hemoglobin might also be explained on the basis that hypochromic cells appeared in the circulation before a significant decrease in hemoglobin concentration has occurred.[134]

B. Iron deficiency could be a cause for anemia but might not be a major problem in this population. Coexistence of folate or Vitamin B_{12} deficiency might also account for the occurrence of anemia. In the Keewatin, the lack of fresh greens in the winter diet might cause folate acid deficiency anemia, especially among those with the greatest demands, ie, such as infants and teenage girls.[135] For example, the individual survey for Arviat community (which had the highest prevalence of anemia) was carried out in April 1990, at which time locally grown vegetable are lacking.

Individuals in this study had the lowest median intake of vegetables when compared to the median intake of other food groups (Table 4.14), and 31% of the adolescents consumed no vegetables during the last month, ie, last month from the survey date (Table 4.14). In addition, parasitic infestation with fish tapeworm may also be a potential cause of Vitamin B_{12} deficiency.[135,137] It was evident from this data that local fish was a common food source. For instance, in the Northwest Territories (between 1969 and 1978) parasitic fish tapeworm infestation was a prevalent problem.[138]

To further elucidate whether folic acid and/or Vitamin B_{12} could be a potential cause for the occurrence of anemia in this population, hematological test data for an additional 34 Inuit children aged from 9M-9 years from the eight communities (and who came to Churchill Hospital for medical reasons in 1991) were collected. Despite the fact that these children were not healthy and were not randomly selected, both the prevalence of anemia and its type were analyzed in those children because the hemoglobin and the MCV index was measured on a Coulter Counter. There were some children with repeated hematological tests; those with the lowest hemoglobin values were selected. The hematological tests included: HGB, HCT, RBC, and MCV; they were measured on a Coulter Counter and the remaining indices, MCH and MCHC, were calculated. The NHANES II reference ranges were used to predict the occurrence and type of anemia.

Of the 34 children, 14 (41%) were anemic. Of these anemic children, 1 (7%) had both high MCV and MCH, 3 (22%) had low MCH, and 10 (71%) normal indices. Of the 3 children with low MCH, 2 had low MCV and 2 had low MCHC. None of the non-anemic children had abnormal red cell indices. From these results it could be concluded that macrocytic anemia might exist and folic acid and/or Vitamin B_{12} deficiency could be a cause for some anemia in this population. The possibility is further supported by conclusions reached in both the Nutrition Canada Survey for Eskimos[13] and Burks' study in Alaska.[14]

Nutritional habits, faulty food preparation, or inaccurately stated intake of iron-rich food (such as meat) or folate-rich food (such as vegetables) may be responsible for the lack of differences in the occurrence of anemia between those who are taking enough and those who are not taking enough iron-rich food or folate-rich food.

C. The data presented in Table 5.2 demonstrates that hematocrit and hemoglobin tests were not comparable in detecting anemia in the study population. The hematocrit tests detected higher rates of anemia than the hemoglobin 20.3% and 11.5%, respectively. On the other hand, Graitcer et al[139] found that HGB tests detect higher rates of anemia than the HCT, ie, the opposite of what was found in this study. There are two factors which might explain the reasons for this finding: (a) technical error, the colorimetric methods for HGB determination rely primarily on the photometer, while HCT methods require more individual judgement and skill by the technician and this may introduce error; (b) environmental factors, a study was conducted to examine the effect of repeated experimental cold air exposure and extended arctic winter field operations on red cell morphology and hemoglobin content. It was found that HGB was unchanged, HCT was decreased, and MCHC was increased.[140] Since HCT is used in calculating MCHC, it is possible that one will tend to be high if the other is low, and vice versa.

5.3.2 Limitations in Assessing the Total Income

It is generally accepted that anemia is more prevalent among those from low income class.[141-143] However, no significant difference was found between the mean total income of anemic and non-anemic subjects. There are three reasons for these findings: (a) those from a low income class might rely on hunting and fishing, a good source for iron and/or Vitamin B_{12}. However, a significant association was found between the occurrence of anemia and other indicators of socio-economic status such as: type of housing, degree of crowding, and availability of luxury items. (b) imprecise information about the total income. The income of each individual was coded as a range, ie, < 10,000, 10,000-20,000 etc. (c) incomplete information about the total income. There were 36 individuals with incomplete information about the total income of their house. Some houses had missing information about the income for some individuals. Therefore, total income calculations might not accurately represent the total earnings of the family. Thus incomplete/imprecise income information could have lead to inaccurate estimation of the total income and consequently lack of significant differences of the total income between anemics and non-anemics.

5.3.3 Limitations in Assessing the Anthropometric Indices

It was found that individuals with HAZ $\leq$ - 1 SD units from the reference median had a significantly higher prevalence of anemia than those who had > - 1 SD units from the reference median. There was no association for WHZ or BMI. There are two reasons for these findings: (a) low WHZ develops rapidly, while low HAZ is a long-term, slower process, and anemia might not occur immediately after an individual has started to lose weight; (b) WHZ and BMI are relatively age independent (in that they do not require age to be calculated) and as mentioned (see the method) that ages were calculated using different methods. Thus when making a comparison to a reference, under- or overstating a child's age will cause his/her nutritional status to be inaccurately classified.[144] For example, if a child's age is overstated, the nutritional status will be underestimated and recorded as poorer than it really is.

5.4 Factors Influencing the Occurrence of Anemia

5.4.1 Factors Influencing the Occurrence of Anemia in both Children and Adolescents

When multivariate analysis was carried out, there were some individuals with missing information on some variables and consequently the sample included was significantly reduced. Therefore, the results of both multivariate and univariate analyses were used to identify the variables believed to influence the occurrence of anemia. These variables were: age and sex, community, height-for-age, otitis media, type of housing, degree of crowding, availability of basics, availability of accessories.

1. Age and sex. Both children aged from 9M-2 years and females aged from 15-17 years were found to be at a greater risk of having anemia, in both multivariate and univariate analyses than the other age groups. These finding were expected because those two age groups also have the highest prevalence of anemia in other studies.[5,7,89] This could be attributed to the following reasons: (a) physiological changes which are normal concomitants of development, such as rapid growth; (b) poverty and ignorance leading, to inappropriate weaning practices in infancy and inappropriate diet; and (c) menstruation and in some cases pregnancy, in adolescent females.[145,146] The tendency to learn hunting

skills at an early age, particularly for adolescent males, might be responsible for the low prevalence of anemia among adolescent males.

2. Community. Univariate analysis showed that participants from Arviat had a higher prevalence of anemia compared to participants from the other seven communities combined. It worth mentioning that the community variable did not remain in multivariate analysis because Arviat community showed a significantly higher prevalence of low basic-items compared to the other seven communities combined, Likelihood ratio X^2=15.2 (p=0.000). Since, the availability of basic items variable was included in multivariate analysis (see below), Consequently, no explanatory power was left for the community variable to be included in the multivariate analysis.

3. Height-for-age. In both univariate and multivariate analyses, children with HAZ ≤ -1 SD units from the reference median showed a significantly higher prevalence of anemia compared to those had > -1 SD units from the reference median. This was expected because stunting is frequently found to be associated with poor overall economic conditions, as well as inadequate nutrient intake.[120]

4. Otitis media. Univariate analysis showed that children and adolescents with middle ear infection and/or its complications, specifically perforation of tympanic membrane or ear discharge, were found to have a significantly higher prevalence of anemia compared to those who did not have these problems. This was expected because several authors showed an association between anemia and immune function derangements[28-39]. Also otitis media is probably associated with low socio-economic status, as is anemia.

5. Type of housing. Univariate analysis showed that children and adolescents living in both public housing or northern rentals had a significantly higher prevalence of anemia than compared to those living in the other type of houses. This was expected

because both public housing and northern rentals houses were considered to be less affluent type of housing.

6. Degree of crowding. In both univariate and multivariate analyses, it was shown that individuals living in crowded houses, ie, houses with more than one individual per room, had a significantly higher prevalence of anemia than compared to those living in non-crowded houses.

It is worth mentioning that type of housing did not remain in multivariate analysis because there was a very highly significant association between type of housing and degree of crowding, Likelihood ratio X^2=10.89 (P=0.001). Consequently no explanatory power was left for this variable, ie, type of housing, to be included in multivariate analysis.

7. Availability of basic items. Basic items included: fridge, washer and/or dryer, television, and telephone. In both univariate and multivariate analyses, it was found that individuals living in low basic-item houses, ie, houses with the ≤ 3 basic items, had a significantly higher prevalence of anemia compared to those living in high basic-item houses, ie, = 4 basic items. This was expected because anemia is known to be more common among less affluent families.

8. Availability of accessory items. Accessory items included: freezer, microwave, VCR, game computer, and personal computer. In univariate analysis, it was found that individuals living in low accessory-item houses, ie, houses with ≤ 2 accessory items, had a significantly higher prevalence of anemia compared to those living in high accessory-item houses, ie, ≥ 3 accessory items.

It is worth mentioning that the availability of accessory items did not remain in multivariate analysis because there was a very highly significant association between the availability of basic and accessory items, Likelihood Ratio X^2=23.2 (P=0.000).

Consequently no explanatory power was left for this variable, ie, Availability of accessory items, to be included in multivariate analysis.

5.4.2 Factors Influencing the Occurrence of Anemia in Adolescents

1. School attendance. Univariate analysis showed that adolescents attending school, full time or part time, had a significantly lower prevalence of anemia compared to those who did not attend school.

2. English language capability. Univariate analysis showed that adolescents speaking English very well or moderately well had a significantly lower prevalence of anemia compared to those who speak very little English. Anemic children may benefit less from early education compared to their non-anemic classmates, as anemic children might be less active and less attentive.[57,58] However, English skills are acquired during early school years, long before adolescence. This is a cross-sectional study, ie, we do not know how long the adolescents have been anemic.

3. Participation in sport. Univariate analysis showed that adolescents who participated in sports less than once a week had a significantly higher prevalence of anemia compared to those participated in sports once a week or more. Many authors demonstrated decreased exercise capacity in anemic[8,9]. However this is a cross sectional study, we do not know which comes first.

5.5 Future Research

1. The prevalence of anemia is about three-fold higher among the hematologically tested children and adolescents of Arviat versus those of the other seven communities. An epidemiologic investigation is recommended to identify the cause(s) of anemia and to treat anemics.

2. To determine the proportion of low hemoglobins that actually represents either iron or folic acid deficiency anemia, additional tests would be required. Ideally, measuring serum ferritin concentration and folic acid in red cells has the advantage of

assessing iron and folic acid stores, respectively.[135,147-149] Such procedures are quite cumbersome, costly, and might not be suitable for epidemiological studies. To facilitate the decision regarding detecting the type of anemia with lower cost and effort, measuring the red cell indices, MCV, MCH, and MCHC, on the Coulter Counter might provide another good alternative.[26] However, there is a concern that use of the Coulter Counter is limited by cold weather and its size makes travel difficult. Therefore, it is important to develop a technique to collect, store blood samples, and send them to Churchill hospital or another laboratory for analysis, within a very short time period.

3. Special programs should be developed for high-risk groups, including: (a) children aged from 9 month through 2 years, (b) teenage girls aged from 15-17 years, and (c) children and adolescents from less affluent families.

4. Lack of other associations (such as employment status and income level) is likely due to imprecise and incomplete information on those variables, or lack of association. Further research should be conducted to clarify the importance of the suspected risk factors in the etiology of anemia in Inuit children and adolescents.

5. In a survey, it is much easier to perform Hemoglobin, hematocrit, and red cell count determinations on capillary blood, especially for children. However, all available reference values are derived from venous blood samples. Therefore, further study is required in determining the extent to which the HGB concentration might differ in capillary and venous samples. If there is a difference, it might be important to have reference values from capillary blood samples, if possible.

5.6 Conclusion

Overall, there appeared to be a high prevalence of anemia among the Inuit children and adolescents participating in this study. This high prevalence of anemia, and the lower than expected prevalence of microcytic anemia (which is most commonly due to iron deficiency) in the study population, suggested that: (1) either the method employed to measure the number of red blood cells (or the use of capillary sampling) may have introduced error in detecting the type of anemia, or more likely, (2) iron deficiency anemia was not the major cause for anemia in this population.

Macrocytic anemia (commonly due to folic acid deficiency)[98-101] is believed to be the most likely cause of anemia in this population, for the following reasons: (a) in this study, a high percentage of anemics had macrocytic cells (50%), ie, had both low hemoglobin and high MCV, (b) sufficient iron-rich food intake but insufficient folate-rich food intake. In adolescents, for example, the median meat intake was 42 times per month, compared to a median vegetable intake of five times per month (Table 5.1), and (c) similar conclusions were reached in both the Nutrition Canada Survey for Eskimos[13] and Burks' study.[14] It is further recommended that the possible role of other nutritional anemias be considered as well. These should include folate, Vitamin B^{12} and mixed. Some urgency in determining the prevalence of these problems seems appropriate.

The prevalence of anemia was not evenly distributed across the eight communities. Anemia was three-fold higher among the children and adolescents of Arviat than among those of the other seven communities. An epidemiologic investigation to identify the cause(s) of anemia in the Arviat community is recommended. Additional tests (such as measuring red cell folate, serum ferritin concentration, and serum Vitamin B_{12}) would be required for this community to identify the type of anemia for further treatment and follow-up. Any follow-up testing should access variability by age, time of year, and community, to rule out any possible biases.

In the Keewatin communities, community health nurses provide most primary health services. Adjunct physician services have been provided by visiting general practitioners and pediatric specialists (once a month and twice yearly, respectively). Because of sporadic physician visitation, there is concern that the Keewatin communities may not be receiving optimal health benefits (especially in relation to children).

Therefore, it is recommended that these services be re-evaluated for their effectiveness. Moreover, as additional hematological testing would require additional laboratory facilities, improved access in this regard would also be helpful.

Of primary concern are the children less than 2 years of age, who were at high risk of developing anemia. It is essential that immediate remedial action be taken to allow these children to develop to their full physical and intellectual potential. It was felt that the only way of improving the situation within a reasonable time period was to conduct an epidemiological investigation for those children aged less than two years, to identify the cause(s) of anemia. This should be followed by administration of the deficient hemopoietic nutrient(s) and/or improved diet.

Steps should be taken to provide the missing nutrients (wherever possible), either by (a) improving the supply and distribution of foods rich in the deficient nutrient(s), or (2) diet fortification. Because of their geographic isolation and limited consumer food choices, solutions may be limited for the Keewatin communities. The only practical option may be food fortification, to maintain the vulnerable groups (or the majority of the population) in balance for the hemopoietic deficient nutrient(s).[74-76]

Different measurement of socio-economic status showed an association with the occurrence of anemia. It was found that children and adolescents living in: (a) public housing or northern rentals, (b) houses with more the one individual per room, and (c) houses with low luxury items, represent another area that bears further consideration. Those individuals were considered to be nutritionally at risk because of poor socio-economic status. Therefore, for those members of the community of poor socio-economic status, additional measures involving socio-economic changes and/or improvement in the distribution of the deficient nutrients, either through distribution of coupons (redeemable for a specific food item) or distribution of the food item itself, are necessary.

It was found that as many as one-fifth of the adolescent population did not attend school. Lack of education puts these adolescents at a distinct disadvantage in improving their job marketability, their future economic status, as well as learning about proper nutrition, especially in relation to anemia. Thus, adolescents should be encouraged to continue their education because of the many positive impacts of education on their life.

It is essential that parents (especially parents of children less than 2 years) receive information on how to access rich sources of the essential hemopoietic nutrients (including folic acid), as well as the value of breast feeding, and appropriate weaning practices. We should avail ourselves of the opportunity to educate mothers visiting medical facilities such as nursing stations for antenatal care or Well-Baby Clinics. For school children, educational programs should be strengthened to encourage proper eating habits. As well, teenage pregnancy in the Keewatin communities was found to be five times that of the general Canadian population. Therefore, further measures, including educational programs, should be initiated to address this problem.

Employment status and income level were found to have no association with the occurrence of anemia. These findings might be due to the less reliable measures which were used for coding both variables. However, other more reliable measures of the socio-economic status showed an association with the occurrence of anemia. These included: type of housing, degree of crowding, and availability of luxury items. Further research on employment status and income level variables should be conducted to clarify the importance of the suspected risk factor in the etiology of anemia.

In summary, macrocytic anemia appears to be a major problem in the Keewatin communities. This study provides useful data for identifying those members at greater risk for developing anemia, and for whom immediate action should be undertaken, especially for the very young children and the female teenage population. This will be the real challenge for the health care planner!

APPENDIX A

TABLES PERTINENT TO THE LITERATURE REVIEW

Table 2.1 Some common Causes of Anemia, According to the Mechanism of Its Production

I. Deficiency of vital hematopoietic nutrients, such as:

1. Iron
2. Folic acid and or vitamin B^{12}

II. Increased loss of red blood cells, such as:

1. Acute hemorrhage
2. Chronic hemorrhage, for example, Hook worm infestation

III. Increased destruction of red blood cell

1. Intracorpuscular or intrinsic defect, usually hereditary such as:
   a. Spherocytosis
   b. Sickle cell anemia
   c. Thalassemia syndromes
   d. Glucose-6-phosphate dehydrogenase (G-6-PD)
2. Extracorpuscular factors
   a. Infectious agent, such as malaria
   b. Chemical agent

IV. Decreased rate of production, such as:

1. Replacement of marrow by fibrosis or by neoplasm
2. hypoplasia of bone marrow, most commonly produced by certain toxic, physical agent, immune mechanisms

Source: Adopted from reference no. 18

Table 2.2 Causes of Red Cell Indices Abnormalities

Microcytic		
	Hypochromic	
		Chronic iron deficiency (most frequent cause)
		Thalassemia
	Normochromic	
		Very uncommon; may be simulated by spherocytosis
Normocytic		
	Hypochromic	
		Some cases of anemia due to systemic diseases
		Many cases of lead poisoning
	Normochromic	
		Acute blood loss
		Hemolytic anemia
		Bone marrow replacement or hypoplasia
		Anemia of Chronic disease
Macrocytic		
	Hypochromic	
		Some cases of macrocytic anemia with superimposed iron deficiency
	Normochromic	
		Pernicious
		folic acid and/or vitamin B_{12} deficiency
		Some cases of aplastic anemia

Source: Adopted from reference no. 24

Table 2.3 Expected Changes in Red Cell Indices During Iron-deficiency Anemia, Macrocytic Anemia, and Anemia of Chronic Disease

Red cell index	Iron deficiency anemia (microcytic hypochromic)	Macrocytic anemia (normochromic)	Anemia of chronic disease (normocytic normochromic)
MCV	Low	High	Normal
MCH	Low	Normal	Normal
MCHC	Low	High	Normal

Source: Adopted from reference no. 117

Table 2.4 Age Related Changes in Hematological Values by Age and Sex: Median Values and 95% Ranges (in Parentheses) Are Shown

Sex	Age (Yrs)	HGB (g/l)	HCT (l/l)	MCV (fl)	MCH (pg)	MCHC (μg/l)
M& F	1-2	123 (107-138)	0.359 (.32-.40)	79 (67-88)	27.4 (22-30)	344 (320-380)
	3-5	125 (109-144)	0.363 (.32-.42)	81 (73-91)	28.1 (25-31)	345 (320-370)
	6-8	128 (110-143)	0.372 (.33-.41)	82 (74-92)	28.6 (25-31)	345 (320-370)
	9-11	132 (114-148)	0.384 (.34-.43)	84 (76-94)	28.7 (26-32)	345 (320-370)
M	12-14	140 (120-160)	0.405 (.35-.45)	85 (77-94)	29.1 (26-32)	344 (320-370)
	15-17	148 (123-166)	0.430 (.37-.48)	87 (79-95)	29.9 (27-32)	344 (320-360)
F	12-14	134 (115-150)	0.390 (.34-.44)	86 (73-95)	29.4 (26-32)	341 (320-360)
	15-17	135 (117-153)	0.395 (.34-.44)	88 (78-98)	30.0 (26-34)	339 (320-360)

Source: Adopted from reference 109

Notes: Individuals with hemoglobin (or hematocrit) values below 95% are considered to be anemic. The associated hematological values are used to identify type of anemia.

Table 2.5 Hemoglobin Values Below Which Anemia Can Be Considered to Exist, and Associated Hematological Values

Years	sex	HGB g/100 ml	RBC M/mm^3	PCV %	MCH mm^3	MCHC %
0.6-4		10.8 } 11.5	4.1	32	79	33
5-9		11.5 } 11.5	4.1	33	80	34
10-14		12.5 } 11.5	4.5	37	82	34
Adults	Male	14.0	4.7	42	87	34
	Female	12.0	4.0	35	87	34
	pregnant female	10.0	3.3	29	87	34

Source: Adopted from reference no. 3

APPENDIX B

BIOAVAILABILITY OF HEMOPOIETIC NUTRIENTS

BIOAVAILABILITY OF HEMOPOIETIC NUTRIENTS

I. Sources of Iron

There are two major pools of food iron: haem iron and non-haem iron. Haem iron is highly bioavailable, as it is absorbed intact within the porphyrin ring and is not therefore exposed to the inhibitory ligands in the diet which affect the absorption of non-haem iron. In contrast, the absorption of non-heme iron is highly variable. It is enhanced by concurrent ingestion of meat,[150] ascorbic acid,[151,152] and inhibited by tea[153] coffee, milk, egg yolk,[154] and bran, which contains both fibre and phytate. Rich sources of iron are the organ meats (liver, kidney, and heart), egg yolk, legumes, and parsley. Foods of intermediate iron content are the muscle meat, fish, and poultry, nuts, green vegetables. Poor sources include milk (which is the reason for an early use of iron enriched food in infant feeding) and milk products, white sugar, white flour and bread (enriched), polished rice, sago, potatoes, and most fresh fruits.[130]

II. Sources of Folate

All folate in the food chain can be traced to vegetable sources. Green leafy vegetables, legumes, citrus fruits, organ meats, nuts, and yeast are rich dietary sources of folate. Cooking and storage losses of the vitamin may range up to 50%.[130]

III. Sources of Vitamin B_{12}

Vitamin B_{12} is found almost exclusively in foods of animal origin. Liver and kidney are excellent source. Muscle meat, fish, eggs, and milk supply it in moderate amount. The vitamin is normally quite stable during cooking, but severe heating of meat and meat products may cause its degeneration.[130]

APPENDIX C

AMES MINILAB EVALUATION

AMES MINILAB EVALUATION

TESTING OF HEMOGLOBINS AND ERYTHROCYTE COUNTS

The purpose of this evaluation is to examine the performance of the hemoglobins and red cell counts on the Ames Minilab. Eighty-nine patient samples were examined and compared to the Coulter STKR or S+V in our lab. The two Coulter instruments have a comparison check three times weekly to ensure their compatibility. They also have reproducibility checks and multiple runs of control material daily.

The testing of the samples was done throughout the month of February 1990. The Ames Minilab instrument was quite easy to use and takes up very little space. The hemoglobin cuvette/capillary tube system worked well. The blood could be aspirated into the capillary tube either from a whole blood sample or from a finger poke. The blood was evacuated from the tube with a few brisk swirls of the cuvette. The red cell count cuvettes contain more fluid than the hemoglobin cuvettes and I, as well as the other three technologists that assisted me, had a very difficult time to get all of the blood out of the capillary tube. We were unable to completely evaluate the capillary tubes on two pediatric samples with hemoglobins in excess of 200 g/L.

The hemoglobin results from the Minilab compared favorably with the Coulter results. There was a slight (3.3%) average bias with the Minilab showing the higher results. The R^2 value was 0.98 showing excellent correlation. A scattergram with an ideal slope showing the comparison is enclosed.

The erythrocyte counts on the Minilab varied widely from the Coulter results. When the patients MCV was around 88 the red counts compared favorably. As the MCV decreased the red count on the Minilab also decreased proportionately. Also as the MCV increased the Minilab red count increased. A scattergram is enclosed showing the variability of the counts. The correlation R^2 value was 0.70 which shows that it is not simply a bias problem.

The four pages following this report contain a listing of the hemoglobin and red count comparison data, the regression figures, the means and CV (differences) and the scattergrams.

I conclude that the hemoglobin parameter has a sound principle, cyanmethemoglobin, and the system produced very good results. I believe that this instrument would be an acceptable tool for performing hemoglobins on a small scale. I believe, however, that the erythrocyte count is unacceptable. If you were to perform a hemoglobin and an erythrocyte count using the Ames Minilab on a patient with a low or high MCV you may suspect the wrong clinical condition. Eg. Patient X has a hemoglobin of 145, an MCV of 70.5 and a RBC of 6.19 with the Coulter. The patient produced a hemoglobin of 148 and an RBC of 4.8 on the Minilab. Looking at the Minilab results the parameters are both normal and match with each other. In reality the patient has either an anemia or a polycythemia condition which should warrant further workup.

The problem lies in the principle of the test. A microcyte will stop less light than a normal or macrocytic cell, thereby producing an erroneously reduced count based on turbidity. Macrocytic cells stop more light per cell than normal red cells so the red count would be falsely elevated. Knowing this, I will say that the erythrocyte count on the Ames Minilab is not a useful screening tool.

Stewart Coutts

Stewart Coutts, R.T.

AMES HGB	COULTER HGB	AMES RBC	COULTER RBC
225	221	7.6	5.46
62	56	1.6	1.78
66	66	2.2	2.15
116	107	3.8	3.04
72	69	2	2.26
100	107	3.3	5.1
90	91	3.3	4.96
123	123	3.3	4.57
137	154	5	6.14
76	74	2.1	2.49
88	91	2.9	2.61
108	109	3.1	3.78
72	66	2.3	2.46
258	226	8	6.33
210	208	7.8	5.82
55	58	1.7	1.76
67	63	1.6	2.04
148	145	4.8	6.19
95	92	3	4.24
121	119	4	4.68
84	82	2.7	2.77
159	153	5.5	6
96	94	3	3.52
101	98	3.1	2.97
150	143	4.8	5.04
134	129	4.1	3.42
168	163	5.5	5.69
125	121	4.1	4.29
113	110	3.8	4.48
165	148	5	4.67
73	72	2.6	2.08
78	76	2.6	2.56
95	94	3.1	3.55
146	141	4.4	4.53
84	81	2.6	2.59
121	116	3.6	3.89
158	152	5.1	5.27
130	123	3.8	4.58
127	122	3.5	4.03
107	103	3.1	3.14
88	82	2.9	5.21
128	125	3.8	4.16
107	105	3	3.56
121	111	3.3	3.34
106	95	2.7	3.06
60	56	1.5	1.81
93	87	2.7	3.07
122	114	3.8	3.86
99	93	3.2	3.23
139	135	4	4.43
96	94	2.6	3.07
110	107	3.4	3.47
113	109	3.5	3.45

MEAN AMES HGB =	116.24
MEAN COUL HGB =	112.51
HGB SD =	6.14
HGB CV =	5.28
MEAN AMES RBC =	3.66
MEAN COUL RBC =	3.85
RBC SD =	0.70
RBC CV =	19.00

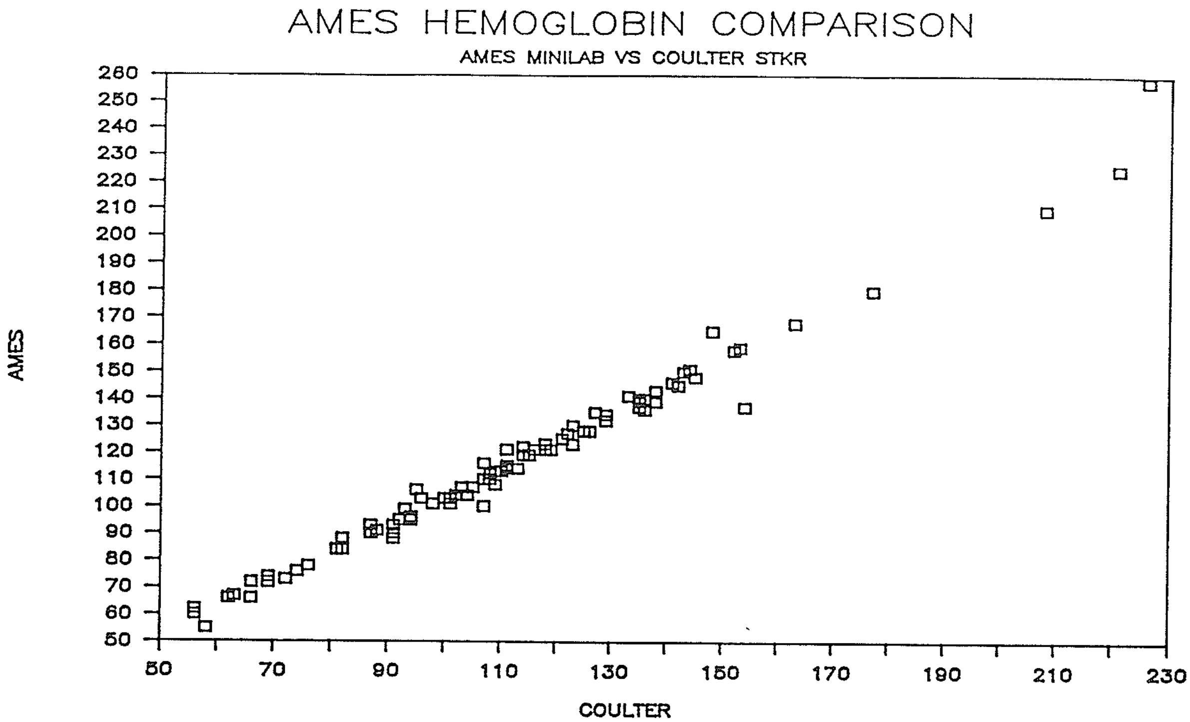
Regression Output: HGB

Constant		2.9131215
Std Err of Y Est		4.4730037
R Squared		0.9815794
No. of Observations		89
Degrees of Freedom		87
X Coefficient(s)	0.9428450	
Std Err of Coef.	0.0138474	

Regression Output: RBC

Constant		1.1686050
Std Err of Y Est		0.5871213
R Squared		0.6986654
No. of Observations		89
Degrees of Freedom		87
X Coefficient(s)	0.7341343	
Std Err of Coef.	0.0516899	

145	142	4.4	4.96
140	136	4	4.1
141	133	4.1	4.48
74	69	2.2	2.56
114	113	3.7	3.97
123	118	3.8	3.72
128	126	4.1	4.13
90	87	2.9	4.13
103	96	3.2	3.88
151	144	4.8	4.98
112	108	3.5	3.24
119	114	3.6	3.79
137	135	4.3	4.57
107	103	3.4	3.72
139	138	4.5	4.34
121	118	4	3.7
104	104	3.5	3.48
136	136	4.6	4.11
135	127	4.1	4.31
180	177	6.7	5.18
119	115	3.5	3.44
103	101	3.2	3.23
99	93	3.3	3.75
128	125	4	4.16
115	111	3.7	3.6
91	88	2.9	3.13
140	135	4.5	4.65
143	138	4.6	4.97
101	101	3.4	3.8
103	100	3.3	3.39
110	108	3.7	4.44
132	129	4.1	4.34
66	62	2	2.13
93	91	3	2.72
114	111	3.7	3.62
104	102	3.5	3.67


AMES HEMOGLOBIN COMPARISON
AMES MINILAB VS COULTER STKR
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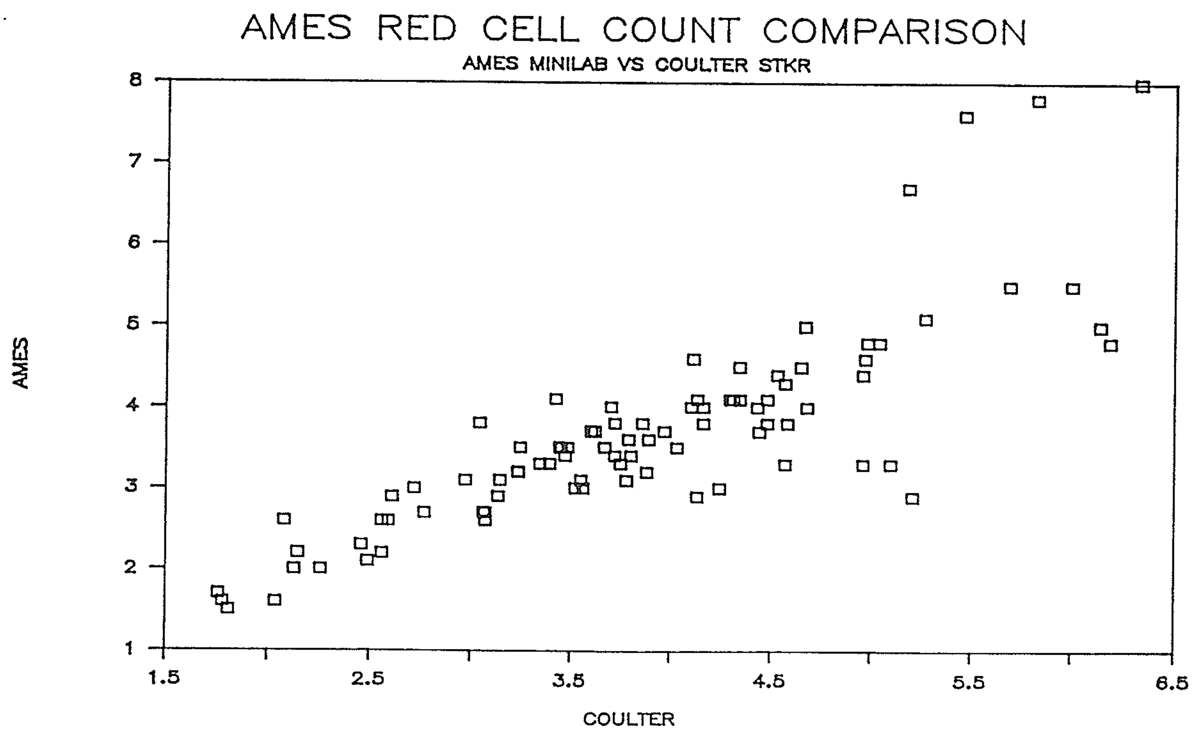
COULTER


AMES RED CELL COUNT COMPARISON
AMES MINILAB VS COULTER STKR
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COULTER

APPENDIX D

INDIVIDUAL SURVEY

Content:

1. Nurse/Lab Form
2. Adolescent English Interview

EXAMINATION AND LABORATORY DATA FORM

DATE: __ __ - __ __ - 1990

INDIVIDUAL MEMBER NUMBER: __ - __ __ __ __

HOUSEHOLD NUMBER: __ - __ __ __ __

AGE ________

Does the individual have any chronic diseases or handicaps?
If yes, please list:

____

____

____

Blood Pressure

1. First blood pressure reading (after at least five minutes of rest):

   Systolic __ __ __

   Diastolic (5th) __ __ __

2. Second blood pressure reading:

   Systolic __ __ __

   Diastolic (5th) __ __ __

Anthropometrics

3. Standing height (without shoes) ________ (cm)
4. Weight (without shoes and light indoor clothes) ________ (kg)
5. Waist circumference ________ (cm)
6. Hip circumference ________ (cm)
7. Skin Fold Measurements
   Arm ________ (cm)

   Scapula ________ (cm)

Glucose Tolerance Test

8. Fasting plasma glucose ________ (mmol/litre)
9. 2-Hour post-challenge plasma glucose ________ (mmol/litre)

Haematology

10.	Hgb	______ g/l	RBC	______ x 10^12/l
	Hct	______ l/l	MCH	______ pg
	MCV	______ fl	MCHC	______ g/l

Lipids

11. Total Cholesterol ______ (mmol/litre)
    HDL-cholesterol ______ (mmol/litre)
    LDL-Cholesterol ______ (mmol/litre)
    Triglycerides ______ (mmol/litre)

ELECTROCARDIOGRAM

Date Test Conducted: ___ - ___ - 1990

Date Record Transmitted: ___ - ___ - 1990

Transmission Confirmed: 1. Yes 2. No

PLEASE ATTACH HARD COPY OF ECG

EAR EXAMINATION

1.	Irrigation	1. Yes	2. No
2.	If irrigated,	1. Water	2. Peroxide
3.	Ruptured Tympanic Membrane	1. Yes	2. No
4.	Otitis Media	1. Yes	2. No
5.	Discharge	1. Yes	2. No
6.	Comments		

____

____

____

____

____

____

____

COMMUNITY MEMBER SURVEY
KEEWATIN COMMUNITY NEEDS' SURVEY
ADOLESCENTS

1. Date of present interview

___ day ___ month ___ Year

2. ID Number (MEMBER master list)

__ - __ __ __ __
comm.#

3. ID Number (HOUSEHOLD master list)

__ - __ __ __ __

4. Date of Birth

___ day ___ month ___ Year

5. Sex **[MALE=1, FEMALE=2]**

6. (a) Are you presently attending school (including correspondence courses)?
[CHECK ONE]

No= 1
Part time= 2
Full time= 3

6. (b) How confident are you that you will be able to find a good job in your community? would you say,
[LIST]

1. very confident
2. Somewhat confident
3. not at all confident

7. Please tell me how well you think you speak and understand English. Would you say,
[LIST]

1. very well
2. moderate
3. very little
4. not at all

8. Please tell me how well you think you speak and understand Inuktitut. Would you say,
[LIST]

1. very well
2. moderate
3. very little
4. not at all

9. Please tell me how well you read Inuktitut syllabics. Would you say,
[LIST]

1. very well
2. moderate
3. very little
4. not at all

10. Please tell me how well you read English? Would you say,
[LIST]

1. very well
2. moderate
3. very little
4. not at all

NOW I WOULD LIKE TO ASK YOU SOME GENERAL QUESTIONS REGARDING YOUR HEALTH.

11. Compared to other people your age, would you say that your health is,
[LIST]

1. better
2. same
3. worse

12. What are the 3 most important things a person can do to be healthy?
[WRITE IN - DO NOT CODE]

(1) ____________________

(2) ____________________

(3) ____________________

13. What are the main problems facing teenagers today in this community?
[WRITE IN - DO NOT CODE]

(1) ______________________________ ☐

(2) ______________________________ ☐

(3) ______________________________ ☐

14. The Keewatin Regional Health Board needs advice to decide how to improve health in this region. Think for a few minutes. What would you suggest they do?

(1) ______________________________ ☐

(2) ______________________________ ☐

(3) ______________________________ ☐

(4) ______________________________ ☐

15. Could you please tell me how often, per day, week <u>or</u> month you eat the following sweets?
[WRITE IN RESPONSE IN ONE COLUMN ONLY]

Sweets	# Times/ Day	# Times/ Week	# Times/ Month	Never	
Cookies, Cakes Pies, Doughnuts					☐
Potato Chips/Cheezies					☐
Popcorn					☐
Jello					☐
Maple Syrup, Honey					☐
Chocolate Bars					☐

16. (a) I would like to know how often you have eaten different kinds of foods in the past month. For each question, please estimate how many servings (eg. glass, plate) you usually eat in a day, week or month? Please think back over the past day, week or month before answering each question. **[WRITE IN RESPONSE IN ONE COLUMN ONLY]**

Food	# Times/ Day	# Times/ Week	# Times Month	Never	
MILK, MILK SUBSTITUTES Fresh Milk (Fresh and Evaporated)					☐
Cheese-Products					☐
Yogurt					☐
Ice-Cream					☐
MEATS, STORE-BOUGHT (eg. porkchops, hamburger, chicken, beef)					☐
COUNTRY MEATS FROM LAND (eg. caribou, Waterfowl)					☐
COUNTRY MEATS FROM THE SEA (seal, walrus)					☐
PROCESSED MEATS (eg. luncheon meats, salami)					☐
STORE BOUGHT FISH (eg. canned tuna, shrimp)					☐
LOCAL FISH (eg. char, grayling, lake trout)					☐
EGGS					☐
VEGETABLES (canned or frozen)					☐
BREAD, BANNOCK, CEREAL					☐
PASTA, MACARONI, NOODLES, SPAGHETTI (eg. Kraft Dinner)					☐

16. (b) How often do you engage in sporting activities? By "sports", I mean <u>vigorous</u> activities (for example, hockey, jogging, square dancing, fast walking, bicycling, swimming, curling, skating, softball, soccer, paddling, basketball, volleyball, aerobics, skiing, weight lifting, practicing Inuit games such as high kick). How many times per week do you do these kinds of activities? Would you say,
[LIST]

1. daily
2. 3 - 6 times per week
3. 1 - 3 times per week
4. less than one per week
5. never

<u>THESE NEXT FEW QUESTIONS DEAL WITH SMOKING</u>.

17. Do you smoke cigarettes now?

    1. yes, regularly **[SKIP TO #21]**
    2. no, **[GO TO #18)**
    3. occasionally **(SKIP TO #21)**

18. Did you ever smoke cigarettes in the past?

    1. yes, regularly **[GO TO #19 THEN SKIP TO #23]**
    2. no, never **[GO TO #23]**
    3. occasionally **[GO TO #19 THEN SKIP TO #23]**

19. What year did you stop smoking cigarettes? 19 __ __

20. On average, how many cigarettes do you smoke a day? __________

21. At what age did you begin to smoke? __________

22. If you started to smoke in the last 12 months, did you start,

    1. less than a month ago
    2. between 1 and 6 months ago
    3. between 6 and 12 months ago
    4. not applicable

23. How many cigars/cigarillos did you smoke per WEEK? _______

24. How many bowls of pipe tobacco do you smoke per WEEK? __________

25. How many tins of chewing tobacco have you used in the past month? __________

THESE NEXT FEW QUESTIONS ASK YOU ABOUT YOUR KNOWLEDGE OF THE AIDS DISEASE.

26. Are you aware of the AIDS disease?

    1. yes   2. no **[GO TO #30]**

27. What has been your <u>main</u> source of information regarding AIDS?

    1. talking to family
    2. talking to friends
    3. talking to school teachers
    4. talking to nurse / doctor
    5. media (TV, radio, newspaper)
    6. reading pamphlets, posters
    7. other (specify __________________)

28. Did you ever attend a community meeting to learn about AIDS?

    1. yes   2. no

29. Do you think that the following rules will help prevent the spread of AIDS.
    [LIST]

	1. yes	2. no	3. don't know
- wash hands before eating			
- don't share toothbrush			
- wear a condom during sex			
- don't sit on public toilets			
- have only one sex partner			
- don't touch a homosexual			
- know your sex partner well			
- don't touch an AIDS victim			
- avoid "casual" sex			
- don't share IV needles			
- don't kiss an AIDS victim			

YOU HAVE BEEN VERY PATIENT WITH ME ASKING AS MANY QUESTIONS AS I HAVE. WE ARE NOW ALMOST FINISHED. THE LAST FEW QUESTIONS WHICH I AM ABOUT TO ASK ARE REGARDING HOW YOU FEEL ABOUT YOURSELF. REMEMBER THAT ALL OF THESE QUESTIONS WHICH I HAVE BEEN ASKING ARE KEPT IN STRICT CONFIDENTIALITY WITH ME, AND ANY OF MY CO - WORKERS WHO LOOK AT THESE ANSWER FORMS DO SO WITHOUT ANY KNOWLEDGE OF YOUR NAME. WITH ALL THAT IN MIND, PLEASE TRY TO BE VERY TRUE TO YOURSELF IN YOUR FOLLOWING ANSWERS. THESE QUESTIONS ARE VERY PERSONAL BUT IT IS VERY IMPORTANT THAT WE KNOW WHAT PEOPLE'S PROBLEMS ARE SO WE CAN TRY TO PLAN SERVICES AND PROGRAMS WHICH CAN HELP THE PEOPLE. I WILL SHOW YOU HOW TO ANSWER THE LAST FEW QUESTIONS. THEN I WILL SEPERATE THE LAST TWO PAGES SO YOU CAN ANSWER THE QUESTIONS WITHOUT ME KNOWING WHAT YOU ANSWER. WHEN YOU ARE FINISHED, I WILL PLACE YOUR ANSWERS INTO A SEALED ENVELOPE THAT WILL NOT BE OPENED UNTIL IT GETS TO WINNIPEG. THE PERSON WHO OPENS IT IN WINNIPEG WILL HAVE NO KNOWLEDGE OF YOUR NAME.

30. Below is listed a number of statements regarding how you are feeling about yourself. Please read each one carefully and then check the most appropriate space.

Have you recently:

	Yes	No	
a. been able to concentrate on whatever you are doing?	___	___	☐
b. lost much sleep over worry?	___	___	☐
c. felt that you are playing a useful part in things?	___	___	☐
d. felt capable of making decisions about things?	___	___	☐
e. felt constantly under strain?	___	___	☐
f. felt you couldn't overcome your difficulties?	___	___	☐
g. been able to enjoy your normal day-to-day activities?	___	___	☐
h. been able to face up to your problems?	___	___	☐
i. been feeling unhappy and depressed?	___	___	☐
j. been losing confidence in yourself?	___	___	☐
k. been thinking of yourself as a worthless person?	___	___	☐
l. been feeling reasonably happy, all things considered?			☐

PLEASE CIRCLE THE CORRECT ANSWER FOR THE REMAINING QUESTIONS

31. Have you ever thought of, or planned to commit, suicide?

    1. yes 2. no 3. can't answer

32. Have you ever attempted suicide?

    1. yes 2. no 3. can't answer

33. Have you ever, either as a child or an adult, been the victim of sexual abuse?

    1. yes 2. no 3. can't answer

THESE NEXT FEW QUESTIONS DEAL WITH THE USE OF ALCOHOL AND DRUGS

34. In the past 12 months, have you taken a drink of beer, wine, liquor or other alcoholic drink?

    1. yes
    2. no
    3. won't answer

35. If yes, how often did you have an alcoholic drink?

    1. 2 or more times a day
    2. once a day
    3. 4-6 times a week
    4. 2-3 times a week
    5. about once a week
    6. 2-3 times a month
    7. about once a month
    8. less often than once a month
    9. won't answer

36. Which of the following drugs have you used? Circle the number of times you have used each drug.

Marijuana
1. Never
2. Once or twice
3. Occassionally (once a month)
4. Regular Use (several times per week)
5. Can't answer

Narcotics (eg. cocaine, Heroin, Crack)
1. Never
2. Once or twice
3. Occassionally (once a month)
4. Regular Use (several times per week)
5. Can't answer

Sniffing Gasoline, Glue, Propane, Etc.
1. Never
2. Once or twice
3. Occassionally (once a month)
4. Regular Use (several times per week)
5. Can't answer

THANK YOU VERY MUCH FOR YOUR COOPERATION. YOU HAVE BEEN VERY PATIENT.

APPENDIX E

HOUSEHOLD DATA

CHURCHILL HEALTH ASSESSMENT
HOUSEHOLD SURVEY
FACE SHEET

Name	Age	Sex	Household #	Individual #
MALES				
1. ________________	____	____	_-_ _ _ _	_-_ _ _ _
2. ________________	____	____	_-_ _ _ _	_-_ _ _ _
3. ________________	____	____	_-_ _ _ _	_-_ _ _ _
4. ________________	____	____	_-_ _ _ _	_-_ _ _ _
5. ________________	____	____	_-_ _ _ _	_-_ _ _ _
6. ________________	____	____	_-_ _ _ _	_-_ _ _ _
7. ________________	____	____	_-_ _ _ _	_-_ _ _ _
8. ________________	____	____	_-_ _ _ _	_-_ _ _ _
9. ________________	____	____	_-_ _ _ _	_-_ _ _ _
10. ________________	____	____	_-_ _ _ _	_-_ _ _ _
FEMALES				
1. ________________	____	____	_-_ _ _ _	_-_ _ _ _
2. ________________	____	____	_-_ _ _ _	_-_ _ _ _
3. ________________	____	____	_-_ _ _ _	_-_ _ _ _
4. ________________	____	____	_-_ _ _ _	_-_ _ _ _
5. ________________	____	____	_-_ _ _ _	_-_ _ _ _
6. ________________	____	____	_-_ _ _ _	_-_ _ _ _
7. ________________	____	____	_-_ _ _ _	_-_ _ _ _
8. ________________	____	____	_-_ _ _ _	_-_ _ _ _
9. ________________	____	____	_-_ _ _ _	_-_ _ _ _
10. ________________	____	____	_-_ _ _ _	_-_ _ _ _

The Churchill Health Centre Board has the full responsibility for the planning of health care programs in Churchill. One of the first steps, is to document the level of health in Churchill. They are also interested in knowing how the people in Churchill feel about the health services they are presently being offered, and what changes you would like to see.

I have a group of questions which I would like to ask you regarding your house and the people who live here. The information will be helpful in assessing the quality and availability of housing. All information which you give me will be strictly confidential and will only be used to create a summary picture. Your name will not be a part of the data or any reports that come from the data. You are free to choose not to participate or, if you agree to assist us in this survey, you are free to not answer certain questions if you so choose. Your participation in this survey will be of great assistance in helping our Health Centre to better understand the wishes of the people of Churchill before they embark on any large scale planning for our community.

Household # ___ - ______________________

Household Member Signature ______________________

Print Name: ______________________

Date: ______________________

Interviewer Signature: ______________________

Date: ______________________

HOUSEHOLD DATA

1. HOUSEHOLD # ____ - __ __ __ __
comm.#

2. Type of Housing ____

Public Housing (after 1974)	= 1
Northern Rentals (before 1974)	= 2
Private Owned	
Home Ownership Assisttance	= 3
Totally Private	= 4
Private Rented	= 5
Government Staff Housing	= 6
Private Staff Housing	= 7

3. Date of Present Interview |__|__|__|__|__|__|
d d m m y y

4. Total # of people living in house (fill in number)
female |__|__|
male |__|__|

5. How many rooms are there in your house? (not counting bathroom or kitchen) |__|

6. How many rooms in your house are regularly used for sleeping? |__|

7. How many people sleep in each bed (or on each sleeping surface, eg. couch, mattress, floor area)?
"bed" 1 |__|
"bed" 2 |__|
"bed" 3 |__|
"bed" 4 |__|
"bed" 5 |__|
"bed" 6 |__|
"bed" 7 |__|
"bed" 8 |__|
(If there are more than eight "beds", write them in the space above.)

8. How many families live in this house? |__|

9. Household possessions:
(mark with an X)

	YES	NO
refrigerator that works	___	___
freezer	___	___
washer and/or dryer	___	___
telephone	___	___
television How many? ____	___	___
video cassette recorder (VCR)	___	___
Atari game computer	___	___
personal (home) computer	___	___
microwave oven	___	___
car/truck/van that works	___	___
snowmobile that works List year and make of each one, eg.1976 Elan ______________________________ ______________________________.	___	___
3 or 4 wheeler that works	___	___
motorbike that works	___	___
boat and motor that work List year and make of each one: __________ ______________________________.	___	___
rifles	___	___
dog teams How many dogs? _____	___	___

10. Please answer each question below, regarding what type of water system and sewage disposal your house has: (mark with an X)

	YES	NO
pressurized water system (from a tap)	___	___
water barrel (no water at the taps)	___	___
sewage pumpout tank	___	___
honey bucket	___	___
sinks drain onto the ground under the house	___	___
sinks drain into the Hamlet sewage system	___	___
bathtub or shower that works	___	___

11. What is the <u>primary</u> way in which money is earned by each of the adults (over age 15 years) in this household?

ON THE LINE PROVIDED, WRITE IN EXACTLY WHAT EACH ADULT TELLS YOU THEIR WORK IS (eg. truck driver, store clerk, housewife, student, etc). Also write in the identifying # of that person (from the Face Sheet)
For example, if on the Face Sheet "male #3" is 42 years old and their job is a store clerk, below you would write for MALES # "3 - store clerk".

	# from Face Sheet		# from Face Sheet
<u>MALES</u>	#___-________________	<u>FEMALES</u>	#___-________________
	#___-________________		#___-________________
	#___-________________		#___-________________
	#___-________________		#___-________________
	#___-________________		#___-________________

<u>FOR CODER'S USE ONLY</u>:

<u>MALES</u>	#___- ¦___¦___¦	<u>FEMALES</u>	#___- ¦___¦___¦
	#___- ¦___¦___¦		#___- ¦___¦___¦
	#___- ¦___¦___¦		#___- ¦___¦___¦
	#___- ¦___¦___¦		#___- ¦___¦___¦
	#___- ¦___¦___¦		#___- ¦___¦___¦

12. What has been the main employment status of the adults of this household over the past 12 months?

unemployed	= 1
seasonal	= 2
casual / part time	= 3
full time	= 4
disabled	= 5
retired	= 6
homemaker/housewife/mother	= 7
other	= 8
don't know	= 9

ENTER ONLY ONE CODE NUMBER FROM THE ABOVE LIST FOR EACH ADULT IN THIS HOUSEHOLD - THE NUMBER WHICH BEST DESCRIBES THE PAST YEAR'S EMPLOYMENT OF THE INDIVIDUAL. IF THE ANSWER IS #8 "OTHER", PLEASE WRITE IN EXACTLY WHAT THEY GAVE YOU FOR AN ANSWER (beside that block). Here again, please add the identifying # which was used on the Face Sheet

MALES		code	FEMALES		code
	#¦__¦ -	¦__¦		#¦__¦ -	¦__¦
	#¦__¦ -	¦__¦		#¦__¦ -	¦__¦
	#¦__¦ -	¦__¦		#¦__¦ -	¦__¦
	#¦__¦ -	¦__¦		#¦__¦ -	¦__¦
	#¦__¦ -	¦__¦		#¦__¦ -	¦__¦

13. What is the average annual income from any source for each adult over age 15 years in this household (after deductions have been taken from any pay cheques)?

less than $10,000. = 1
10,000. - 19,999. = 2
20,000. - 29,999. = 3
30,000. - 39,999. = 4
40,000. and up = 5
don't know = 6

Here again, please add the identifying # which was used on the Face Sheet

	code		code
MALES #¦__¦ -	¦__¦	FEMALES #¦__¦ -	¦__¦
#¦__¦ -	¦__¦	#¦__¦ -	¦__¦
#¦__¦ -	¦__¦	#¦__¦ -	¦__¦
#¦__¦ -	¦__¦	#¦__¦ -	¦__¦
#¦__¦ -	¦__¦	#¦__¦ -	¦__¦

14. What amount of costs must be paid per month for your house, averaged over a one year period (eg. rent or mortgage, utilities, property taxes)? Please tell me just what house bills must be paid after the income has come into the house.

If some of these costs are familiar to you as a yearly amount eg. taxes, you can quote that amount and we will compute the monthly amount later. (Write any yearly amounts in the available empty space, with clear instructions as to how the final calculations should be done.)

monthly average in $ ________

15. Are there presently any foster children placed in your home?

no ___ (GO TO #18)
yes ___

16. How many foster children are presently placed in your home?

¦__¦ children

17. For each foster child who is presently placed in your home, please give me their present age (in years and months) and for how long (in years and months) they have been staying with you.

	present age	how long has stayed here
foster child 1	______	______
foster child 2	______	______
foster child 3	______	______
foster child 4	______	______
foster child 5	______	______

18. How many families living in this house are "single parent"? |__|

WE ARE VERY INTERESTED IN KNOWING HOW MANY PEOPLE IN THE COMMUNITY KNOW HOW TO DRIVE AN ATV. BECAUSE WE ARE NOT ASKING QUESTIONS TO CHILDREN UNDER THE AGE OF 15 YEARS, WE WOULD APPRECIATE IT IF YOU WOULD ANSWER FOR THOSE LIVING IN YOUR HOUSE AND UNDER THE AGE OF 15 YEARS.

19. How many children under the age of 15 years live in the same house with you? |__|__| children

(If none, enter "00" and END OF QUESTIONS - THANK YOU!) Otherwise,

20. How many children under the age of 15 years, living with you, know how to drive an ATV?
____ children

21. How many children under the age of 15 years, living with you, do drive an ATV?
____ children

22. Of those children under 15 years who do drive an ATV (as the driver, not a passenger), please tell me how often they wear a helmet.

never = 1
sometimes = 2
always = 3

CHILD 1 ___
CHILD 2 ___
CHILD 3 ___
CHILD 4 ___
CHILD 5 ___
CHILD 6 ___

THAT IS ALL OF THE QUESTIONS WHICH I HAVE TO ASK YOU AT THIS TIME. THANK YOU VERY MUCH FOR YOUR TIME AND ATTENTION.

APPENDIX F

RESULTS PERTINENT TO THIS STUDY

Table 4.1 Distribution of the Inuit population of the Eight Communities, by Age and Sex

		Age							
		0-4	5-14	15-24	25-34	35-44	45-54	55+	All
		N	N	N	N	N	N	N	N
Community	Sex								
Rankin Inlet	Male	109	181	142	181	89	46	47	745
	Female	125	165	136	182	74	47	35	714
	All	234	346	278	263	163	93	82	1459
Arviat	Male	102	165	124	82	43	32	29	577
	Female	686	162	134	75	53	29	27	567
	All	188	327	259	157	96	61	56	1144*
Chesterfield Inlet	Male	22	32	22	25	9	10	7	127
	Female	21	28	29	25	7	7	9	126
	All	43	60	51	50	16	17	16	253*
Repulse Bay	Male	42	72	52	37	16	11	13	243
	Female	52	62	50	34	17	10	7	232
	All	94	134	102	71	33	21	20	475
Coral Harbour	Male	51	64	57	39	22	16	16	265
	Female	50	66	61	30	28	12	13	258
	All	101	130	118	69	48	28	29	523
Whale Cove	Male	17	25	30	15	12	5	8	112
	Female	21	26	28	18	7	7	5	112
	All	38	51	58	33	19	12	13	224
Baker Lake	Male	93	109	114	107	47	32	45	547
	Female	77	96	101	87	44	34	52	491
	All	170	205	215	194	91	66	97	1038
Sanikiluaq	Male	42	61	57	33	33	19	17	262
	Female	40	55	64	38	24	22	9	252
	All	82	116	121	71	57	41	26	514
ALL	Male	522	792	672	591	356	217	231	3381
	Female	521	731	696	558	317	216	199	3238
	All	1043	1523	1368	1149	673	433	430	6619

* = The enumerated number of individuals for Arviat and Chesterfield Inlet were 1179 and 254 instead of 1144 and 253, respectively. The difference of 35 and 1, respectively, individuals is due to the fact that their ages were not known.

Table 4.2 Comparison Between Hematologically Tested and Non-tested Children and Adolescents, by Sex, Age, and Community

Variable	Category	N	Tested (row%)	X^2	P
Sex	Male....................	196	95.0		
	Female..................	204	98.0	2.06	0.15
Age	15-17yrs................	56	100.0		
	9M-2 yrs................	75	90.7	3.85	0.05
	3-5 yrs................	92	89.1	4.92	0.02
	6-8 yrs................	71	98.6	0.00	1.00
	9-11yrs................	75	98.7	0.00	1.00
	12-14yrs................	52	94.2	1.53	0.22
Community	Chesterfield............	23	100.0		
	Rankin Inlet............	100	96.0	0.11	0.75
	Arviate.................	80	95.0	0.23	0.63
	Repulse Bay.............	47	97.9	0.00	1.00
	Coral Harbour & Whale Cove..........	49	89.8	1.19	0.28
	Baker Lake..............	78	91.0	1.05	0.31
	Sanikiluaq..............	44	97.7	0.00	1.00

Table 4.3 Observed and Expected Distribution of SD Score of Height-for-Age of Participants Aged from 9M-17 years

SD Score of height-for-age*	The observed HAZ**	The expected HAZ
≤ -2 SD.................	35 (9.1 %)	2.28 %
-1.99 TO -1 SD...........	84 (21.9 %)	13.59 %
-0.99 TO 0.99 SD.........	216 (56.3%)	68.23 %
1 SD TO 1.99 SD.........	38 (9.9 %)	13.59 %
≥ 2 SD..................	11 (2.8 %)	2.28 %
TOTAL	384 (100%)	

* Adopted from Waterlow classification, reference no. 117

** Based on Values of Standard Deviations Above and Below the NCHS Medians

Table 4.4 Observed and Expected Distribution of SD Score of Weight-for-Height of Participant Aged from 9M-11 years

SD Score of weight-for-height*	The observed WHZ**	The Expected WHZ
≤ -2 SD..................	1 (0.4 %)	2.28 %
-1.99 TO -1 SD............	00 (0.0 %)	13.59 %
-0.99 TO 0.99 SD..........	80 (33.2 %)	68.23 %
1 SD TO 1.99 SD..........	78 (32.4 %)	13.59 %
≥ 2 SD...................	82 (34.0 %)	2.28 %
TOTAL	241 (100%)	

* Adopted from Waterlow classifications, reference no. 117

** Based on Values of Standard Deviations Above and Below the NCHS Medians

Table 4.5 Cross Tabulation of Weight-for-Height and Height-for-Age for Children

	SD score of height-for-age (%)*					
SD Score of Weight-for-height*	≤ -2	-1.99 to -1.00	-0.99 to 1.99	1.00 to 1.99	≥ 2	Total
≤ -2	0 (0.0)	0 (0.0)	1 (0.4)	0 (0.0)	0 (0.0)	1 (0.4)
-1.99 to -1	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
-0.99 to .99	4 (1.7)	17 (7.1)	50 (20.8)	7 (2.9)	2 (0.8)	80 (33.2)
1.00 to 1.99	3 (1.2)	15 (6.2)	50 (20.8)	9 (3.7)	1 (0.4)	78 (32.4)
≥ 2	5 (2.1)	7 (2.9)	49 (20.3)	14 (5.8)	7 (2.9)	82 (34.0)
Total	12 (5.0)	39 (16.2)	150 (62.2)	30 (12.5)	10 (4.1)	241 (100)

* Based on the values of standard deviation above and below the NCHS medians

Note: The figures in parentheses are percentages

Table 4.6 The Median Level of Hemoglobin and the Prevalence of Anemia, by Age and/or Sex*

Age (Y)	Median HGB (g/l)	N	Anemics (%)
9M-2 Years............	114	68	26.5
3-5 Years............	118	82	7.3
6-8 Years............	122	70	7.1
9-11 Years............	125	74	9.5
12-14 Years,			
Male.................	134	20	5.0
Female..............	127	29	6.9
15-17 Years			
Male.................	144	27	3.7
Female..............	127	29	20.7
Total		399	11.5

* Age categories adopted from the NHANES II survey.

Table 4.7 Prevalence of Anemia, by Community

Communities	N	Anemics (row %)
Rankin Inlet....................	96	8.3
Arviate.........................	76	22.4
Chesterfield Inlet..............	23	4.3
Repulse Bay.....................	46	8.7
Coral Harbour...................	36	8.3
Whale Cove......................	8	12.5
Baker Lake......................	71	12.7
Sanikiluaq......................	43	7.0

Table 4.8 Prevalence of Anemia, by the Distribution of SD score of Height-for-Age

SD score of height-for-age*	N	Anemic (%)
≤ -2 SD..................	35	22.9
-1.99 TO -1 SD............	84	15.5
-0.99 TO 0.99 SD..........	216	9.3
1 SD TO 1.99 SD..........	38	2.6
≥ 2 SD...................	11	9.1
TOTAL N	384	

* Adopted from Waterlow Classification, reference no. 117

Table 4.9 Prevalence of Anemia, by Characteristics Of the Environment

Characteristics of the Environment	N	Anemics (%)
Type of Housing		
Public housing (before 1974)...	207	13.5
Northern rental (after 1974)...	61	13.1
Private owned..................	31	6.4
Private rented.................	2	0.0
Government staff housing........	24	0.0
Private staff housing...........	13	0.0
Number of individual/room		
≤ 1 individual/room.............	47	0.0
> 1 individual/room.............	282	13.1
Availability of basics*		
= 4 Basic items..................	233	7.7
< 4 Basic items	103	19.4
Availability of accessory**	157	7.0
≥ 3 Accessory items.............	179	15.1
< 3 Accessory items.............		
Availability of dog team		
Yes.............................	70	8.6
No	266	12.0

* Basics included: Fridge, washer and/or dryer, television, and phone.
** Accessory included: Freezer, VCR, atari game computer, PC computer, and microwave oven
Note: Since data were not available for all variables on all individuals, there is disparity in the totals

Table 4.10 Prevalence of Anemia, by the Distribution of the SD score of Weight-for-Height

SD Score of weight-for-height*	N	Anemic (%)
≤ -2 SD.....................	1	0.0
-1.99 TO -1 SD................	0	0.0
-0.99 TO 0.99 SD.............	80	15.0
1 SD TO 1.99 SD.............	78	6.4
≥ 2 SD......................	82	15.9
TOTAL	241	

* Adopted from Waterlow Classification, reference no. 117

Table 4.11 Prevalence of Anemia, by the Distribution of the Body Mass Index

Body Mass Index*	Evaluation	N	Anemic (%)
< 20............	Underweight	42	12.2
20-25.........	Ideal	72	9.7
> 25............	Overweight	25	4.0
Total		138	

* Adopted from reference 119

Table 4.12 Prevalence of Anemia, by Characteristic of the Individual

Characteristics of the individual	N	Anemics (%)
Presently attending the school		
No........................	20	25.0
Full time..................	75	5.3
Part time..................	4	0.0
English language capability		
Very well..................	28	7.1
Moderate...................	47	2.1
Very little................	21	28.6
Not at all.................	2	0.0
Frequency of sports		
Daily......................	30	3.3
3-6x/week..................	16	6.2
1-3x/week..................	29	6.7
< once/week.................	7	14.3
Never......................	13	30.8
Health compared to other people of the same age		
Better.....................	30	6.7
Same.......................	58	10.3
Worse......................	9	0.0
Smoke cigarettes		
Yes........................	38	15.8
No.........................	49	4.1
Occasionally...............	10	10.0
Drink alcohol in past 12 months		
Yes........................	23	8.7
No.........................	66	9.1

Note: Since data were not available for all variables on all individuals, there is some disparity in the totals

Table 4.13 The Distribution of Anemics and Non-anemics, by Food Groups

Food groups	N	Anemics (row %)	Likelihood Ratio Chi-square	P-Value
Meat Group				
< 30 times/month.....	27	14.8		
≥ 30 times/month.....	61	6.6	1.43	0.23
Sea Meat Group				
< 30 times/month.....	74	10.8		
≥ 30 times/month.....	12	0.0	2.53	0.11
Vegetables				
< 30 times/month.....	74	10.8		
≥ 30 times/month.....	15	0.0	3.11	0.08
Eggs				
< 30 times/month.....	53	13.2		
≥ 30 times/month.....	35	2.9	3.16	0.07
Milk and Dairy				
< 30 times/month.....	39	12.8		
≥ 30 times/month.....	48	6.3	1.11	0.29
Starchy Food				
< 30 times/month.....	21	9.5		
≥ 30 times/month.....	68	8.8	0.01	0.92
Snack food				
< 30 times/month.....	00			
≥ 30 times/month.....	90	8.9		
Fast food				
< 30 times/month.....	38	7.9		
≥ 30 times/month.....	52	9.7	0.08	0.77

Meat group included: Meats from land, store-bought, and processed meats.

Sea meat group included: Mountry meats from sea, local fish, and store-bought fish.

Milk and dairy group included: Milk, cheese, yogurt, and ice cream.

Starchy food group included: Bread and pasta

Snack food group included: Potato chips, popcorn, chocolate bars, cake, jello, and honey. Fast food included the first three food items

Note: Since data were not available for all variables on all individuals, there disparity in the totals

Table 14.4 Median Intake/month of Each Food Groups, and the Number of Individuals Who Never Consumed Each Food Group in the Past Month

Food group	Median intake per month	No. (%) never Consumed
Meat group......................	42	0 (0.0)
Sea meat group..................	5	15 (16.0)
Vegetables group................	4	28 (31.0)
Eggs group......................	12	19 (21.0)
Milk and dairy group............	36	3 (3.0)
Starchy food group..............	42	0 (0.0)
Snack food group................	72	0 (0.0)
Fast food group.................	34	0 (0.0)

Meat group included: Country meats from land, store-bought meats, and processed meat.

Sea meat group included: Country meats from sea, local fish, and store-bought fish.

Milk and dairy group included: Milk, cheese product, yogurt, and ice cream.

Starchy food group included: bread (bread/bannock/cereal) and pasta (pasta/macaroni/spaghetti/craft dinner/etc).

snack food group included: Potato chips+ popcorn+ chocolate bars+ cake+ jello + honey.

Fast food group included: Potato chips+ popcorn+ chocolate bars

Table 4.15 Factors Included in the Initial Model

Risk factor	N	Anemic (%)	Likelihood Ratio Chi-Square	P-value
Age and/or sex				
9M-2Y & 15-17F...........	97	24.7		
3-14Y & 15-17M...........	302	7.3	19.08	0.000
Community				
Arviate only.............	76	22.4		
The other 7 communities..	323	9.0	9.32	0.002
Height-for-Age SD Score				
≤ -1 SD..................	119	17.7		
> -1 SD..................	265	8.3	6.69	0.010
Otitis media				
Yes......................	96	17.7		
No.......................	261	9.2	4.53	0.033
Type of housing*				
Type I...................	268	13.4		
Type II..................	70	2.9	8.02	0.005
Number of individual/room				
> 1 individual/room......	282	13.1		
≤ 1 individual/room......	47	0.0	12.16	0.000
Availability of Basics**				
< 4 Basic items..........	103	19.4		
= 4 Basic items	233	7.7	9.02	0.003
Availability of accessory***				
< 3 Accessory items......	179	15.1		
≥ 3 Accessory items......	157	7.0	5.63	0.02

* Type of Housing: (a) Type I= Public Housing and Northern rentals; (b) Type II= Private owned & rented, Government staff housing, and Private staff housing

** Basics included: fridge, washer and/or dryer, television, and phone.

*** Accessory included: freezer, VCR, atari game computer, PC computer, and microwave oven

Note: Since data were not available for all variables on all individuals, there is disparity in the totals

Table 4.16 Logistic Regression Analysis of Anemia by Factors Influencing the Prevalence of Anemia among Children and Adolescents

Effect	β-estimate	Odds ratio (and 95% CI)	Likelihood Ratio Chi-Square	P-value
Age and sex	1.27	3.56 (2.06-5.06)	9.27	<.005
Height-for age	0.91	2.48 (1.10-3.96)	4.98	<.05
Degree of crowding	4.27	71.5 (48.894.1)	11.14	<.001
Availability of basic items	1.26	3.52 (2.03-5.01)	9.86	<.005

Table 4.17 Age-related Changes in HGB and HCT for Inuit Children and Adolescents by Age and Sex: Median Values and 95% Ranges (in Parentheses) Are Shown

Sex	Age	N	HGB (g/l)	HCT (l/l)
Males & Females	9M-2 yrs	50	116.5 (107-134)	0.34 (0.28-0.40)
	3-5 yrs	76	119.0 (109-135)	0.34 (0.30-0.39)
	6-8 yrs	65	123.0 (110-140)	0.35 (0.31-0.39)
	9-11 yrs	67	126.0 (115-142)	0.35 (0.31-0.40)
Males	12-14 yrs	19	136.0 (120-153)	0.38 (0.33-0.43)
	15-17 yrs	26	144.5 (129-158)	0.40 (0.33-0.47)
Females	12-14 yrs	27	128.0 (116-135)	0.38 (0.31-0.39)
	15-17 yrs	22	129.0 (117-141)	0.36 (0.32-0.44)

Table 5 Comparison of Hemoglobin and Hematocrit Test Results for Detection of Anemia for Inuit Children Aged from 9M-17yrs

		Hemoglobin test		
Hematocrit test		< 95%*	≥ 95%**	Row total
	< 95%*............	34	47	81 (20.3%)
	> 95%**...........	12	306	318
	Column total	47 (11.5%)	353	400

* Individuals with hemoglobin or hematocrit values < 95% of NHANES II reference range for age and sex, ie, anemic

** Individuals with hemoglobin or hematocrit values ≥ 95% of NHANES II reference range for age and sex, ie, non-anemic

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