A NUTRITION SURVEY OF GIRLS IN RESIDENCE AT THE UNIVERSITY OF MANITOBA

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ABSTRACT

of the thesis entitled

A NUTRITION SURVEY OF GIRLS IN RESIDENCE AT THE UNIVERSITY OF MANITOBA

Lillian Miller

During the spring of 1956, a nutrition survey was carried out with 84 girls from the Women's Residence at the University of Manitoba. The nutritional status of the group was determined by means of 7-day food intake records, blood and urine analyses and measurements of height, weight and skinfold thicknesses. Nutrient levels in the individual diets and the residence food supply were calculated using food composition tables. The nutritional adequacy of the diets and the food supply was judged on the basis of Canada's Recommended Allowances for the age group studied (16 to 23 years).

The analysis of nutrient levels revealed that four-fifths of the girls received inadequate supplies of iron and three-quarters received insufficient calories. The other nutrients in decreasing order of the number of times they were found poorly supplied were: vitamin A, riboflavin, calcium, protein, thiamine, phosphorus and niacin. No diet had less than the recommended amount of ascorbic acid. Since the residence food supply contained each nutrient in

amounts above the requirements of any subject surveyed, each girl could have had an adequate diet if she had selected foods more judiciously. The study of meal patterns and food preferences showed that 10% of the meals were omitted altogether and that less nutritious foods were often selected when there was a choice.

The blood levels of hemoglobin, vitamin A and ascorbic acid were below average in 70% or more of the group while that of carotene was low in 15%. All protein readings were satisfactory. Thirteen to 23% of the girls appeared to have insufficient body stores of thiamine, riboflavin or niacin. Anthropometric measurements revealed that less than half of the group was within the normal weight range and that a larger portion was underweight than overweight. The scapular skinfold measurement correlated best with leanness and fatness.

The results of this survey should assist those responsible for the food servicing and nutrition education of university students.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

During the spring of 1956, a nutrition survey was carried out among the college women living in the Women's Residence at the University of Manitoba. This study was designed to assess the nutritional status and dietary patterns of a group of college women living under conditions of the same available food supply. Information was collected from food intake records, biochemical tests, physical measurements and data on the residence food supply.

The survey was planned to reveal how well college women are able to select an adequate diet and to give information about their food habits. Nutritional status was assessed by correlating food intake data with that of physical and biochemical measurements. No other study of this type has been done in Canada.

Adequate nutrition is especially important during the college years for this is a period of physical demand and considerable tension. Since these are also the pre-marriage and pre-motherhood years for girls, it is very important that nutrition be adequate for the maintenance of good health. It is hoped that the results of this survey will aid in the nutrition education of young women and will be of assistance to those responsible for the food services to college students.

CHAPTER II

REVIEW OF LITERATURE

A. ADEQUATE NUTRITION AND MALNUTRITION

The twofold aim of modern nutriture is to diagnose and prevent malnutrition and to provide for adequate nutrition. No simple system has yet been devised for the assessment of nutritional status but useful information is gathered in nutrition surveys by means of(48):

1. Dietary histories
2. Medical histories
3. Physical examinations
4. Laboratory tests
5. Diagnoses

Emphasis today is placed on the whole organism, the psychobiological individual, and the relationship of an adequate dietary to that individual's well being.

Nutritional inadequacy results whenever sufficient amounts of the essential nutrients are not supplied to the tissues which require them. This inadequacy may result from:

1. A dietary inadequacy or primary nutritional inadequacy.
2. Environmental conditions and body states that interfere with ingestion, absorption and utiliza-

tion of essential nutrients, or from factors that increase the requirements or cause the destruction or abnormal excretion of these nutrients. This is secondary or conditioned nutritional inadequacy.

When nutrient reserves are sufficiently exhausted in nutritional inadequacy, tissue depletion takes place. This is followed in succession by biochemical "lesions", functional changes and, finally, anatomic lesions. One step in this process need not be complete before another begins. The pathogenesis of nutritional deficiency diseases may be illustrated as follows(32):

$$\begin{tikzcd}
\text{Dietary inadequacy} \arrow[d] & & & & \\
\text{Nutritional inadequacy} \arrow[r, "\text{Nutrient reserves}"] & \text{Tissue depletion} \arrow[r] & \text{Biochemical lesions} \arrow[r] & \text{Functional changes} \arrow[r] & \text{Anatomic lesions} \\
\text{Conditioned inadequacy} \arrow[u] & & & &
\end{tikzcd}$$

B. AREAS OF STUDY IN NUTRITION SURVEYS

Each of the instruments used in obtaining information on nutritional status will be discussed separately.

1. Records of dietary intake.

A record of past and present food intake is of the greatest importance in nutrition surveys. This is used not only to confirm or question other findings but also to form the basis of any advice for improvement.

a) Methods of obtaining dietary intake data.

(1) The intake record.

The subject keeps a detailed report of all the foods eaten during a specified period of time. The amount of each food included may be estimated or weighed. Errors arise if the subject does not estimate or measure carefully the quantities of food actually eaten. The analyst may err in translating the quantitative measures or estimates into units employed in the food table used. Finally, errors arise when the food table is not applicable to the particular case.

The American Research Council has concluded that these records seem to permit a reasonably good characterization of the dieting habits of groups(48).

(2) The dietary history.

This type of study aims to discover the usual food patterns over a relatively long period of time. It is designed to reveal any major deviations from the usual concept of good food habits. Even without calculations of nutrient content, these histories can furnish a basis of classifying individuals into certain broad groups; for example, those whose diets are obviously poor with respect to one or more nutrients, or those whose diets are probably better than average, and those whose diets have nutrients approximating the recommended levels.

(3) The 24-hour recall.

In this study the subject is asked on three or four different occasions to recall the foods eaten in the previous 24-hour period. Errors arise in the reliability of the subject's recall and in his estimation of actual quantities consumed. The 24-hour recall record is valuable in discovering the relative quantities of the different food groups included in the dietary.

b) Comparison of results from these methods.

Young(77) compared the information collected by the three above techniques. She found that the dietary history did not give the same estimate of intake as the 7-day intake record in each of the following groups studied; grade 7, 8 and 9 students, high school and college students, pregnant women and male industrial workers. The difference was smallest when applied to college students.

The results from a 24-hour recall and dietary history were also compared by Young(77) using grade, high school and college students. These two methods did not yield the same results. When compared to the 7-day diet record, Young(78) found the results of the 24-hour recall were closer than those from the dietary history. Young concluded that under certain circumstances, the 24-hour recall may be substituted for the 7-day diet record in the estimation of intakes. Results from surveys done in the Northeast Region of the United States support this conclusion(13).

Trulson(69) compared the results of the same three techniques using 214 out-patients. She found that the 7-day record and dietary history gave comparable information as evidenced by correlation coefficients. Trulson decided that the prediction of individual intake by any one of these three methods varied in accuracy according to the food or nutrient.

c) Length of time for dietary record.

The length of time the dietary record should cover is a matter of considerable dispute. The period must be long enough to furnish an adequate picture of nutrient intake but it must also be short enough to maintain the interest and cooperation of the subjects involved.

Koehne(35) studied five children on weighed diets for 14 to 25 consecutive weeks. He found that 96 to 100% of the weekly averages for calories, protein, fat, carbohydrate, calcium and phosphorus were within 10% of the final averages. Eighty-five to 90% of the weekly averages for iron and acid and base values were within 10% of the final averages.

Widdowson and McCance(71) found widely fluctuating caloric intakes from day to day in a number of children but when seven days of each week were averaged, the figures agreed very closely. They concluded that, while one week is the shortest period advisable for a dietary survey, results of one week are probably fairly representative of the person's customary food intake. Leverton and Marsh(41) agree with this and add that Saturday and Sunday should be included in the 7-day record or it will give a distorted estimate.

Yudkin(81) compared weekly averages with four-week averages for a group of six post graduate dietetic students. He found that weekly intakes of calories and nutrients showed considerable variation. Greatest variations were found for vitamins A and D and ascorbic acid. Yudkin states that a 7-day dietary study could not be considered long enough to give an accurate assessment of calorie and nutrient intake levels.

Young(76) studied the recorded intakes of 18 adults, 23 to 50 years of age, for 28 days. She believed one week was representative of the 28-day period when average intakes for the group were examined. This was true for calories, protein, phosphorus, iron, vitamin A, thiamine, riboflavin and niacin but not for calcium and ascorbic acid. Young decided that the observation period should last more than seven days for most subjects.

Chalmers(10) experimented with 1-day, 3-day and 11-day records but used these results only to estimate the mean intakes of groups. She pointed out that 11-day records would probably give a truer picture of intake levels but felt that 1-day records gave important savings in time, money and personnel.

d) Nutrients to study in a survey.

In nutrition surveys there is the problem of deciding which of the forty or so nutrients needed by the body should be particularly studied. Whether or not it is desirable to calculate a given nutrient in a diet depends on whether or not it is likely to be deficient and on the intercorrelation of nutrients; for example, many studies have shown that if calcium and protein are adequately supplied, phosphorus will also be supplied in sufficient quantities(12). McLester(42) states that even an American diet of mediocre quality easily supplies the daily copper requirement so that this nutrient need not be specifically calculated in nutrition surveys.

e) Differences between calculated and analyzed values.

Investigators have compared the results derived from computations using tabulated tables with those obtained through chemical analysis of aliquots of the diets being studied in order to find any discrepancies, their extent and direction. They have found that agreement is remarkably good. Comparisons of the mean analyzed caloric value of individual diets with those calculated from modern food tables reveal that, despite differences between corresponding individual pairs, calculated and determined means may differ by less than 10%. Agreement becomes better when the number of meals included is twenty or more and when the intakes are measured on the raw basis. When a single nutrient, protein, was studied, the calculated and determined means showed good agreement, usually within 5%. Calculated values for the fat content of diets generally tend to be higher than the values obtained by analysis(54). Widdowson and McCance(48) found that the calculated means of potassium are in excellent agreement with the analyzed means. The calculated amount of phosphorus exceeded the determined mean of diets by 17% in studies by Hummel *et al.*(30).

The use of calculations for determining the calcium and iron content of diets is somewhat more problematical. Simmons and McHenry(65) found that the calculated means tended to exceed the determined means in the 21 meals they studied. Widdowson and McCance(48) found the opposite tendency but attributed this to the hard water used for cooking. Actual intake of iron may exceed the calculated amounts in the diet because of contamination during the process of food preparation, or because of differences in locality. Kaucher *et al.* (33) reported the calculated values to be approximately two-thirds of the actual intake in an iron-rich locality. On the other hand, for the 21 meals analyzed by Young and McHenry (79), the calculated content exceeded the actual mean content of 6.3 mg. by a difference of 0.6 ± 3.1 mg.

The greatest discrepancies have been found in vitamin values because of wide natural variations and the chance for losses to occur in the handling of foods. Calculated ascorbic acid intakes are likely to exceed the actual determined values, particularly if the food tables employed are based on uncooked foods. When proper allowances for cooking losses are made and the means of a week's meals compared, the agreement between calculated values and determined values is brought within chance error. Comparisons between the calculated and determined values of mixed diets for vitamin A, thiamine, riboflavin and niacin indicate that the mean calculated figures may yield useful information for classifying a population into broad levels of intake(48).

Widdowson and McCance(71) state that, "The results are considered to be sufficiently close to warrant the use of food tables in dietary surveys." This presupposes that the food intake is accurately measured, the length of the period of study is sufficiently long, and the proper food tables are applied.

f) Standards to use for the appraisal of diets.

Some yardstick is necessary in assessing the adequacy of nutrient levels in diets. The standard selected may vary all the way from the minimum to prevent deficiency diseases to the amount needed to promote optimal nutrition. The two standards commonly used in Canada are those of the Nutrition Division, Department of National Health and Welfare, Ottawa, and those of the American National Research Council, Washington. The Canadian standards are based on maintenance living i.e. living that does not involve nutrient expenditure for reproduction, lactation or muscular work other than that associated with an inactive existence. However, the increments required for body activity above the maintenance level are indicated in the tables(8). The recommended allowances for calories, protein, vitamin A, calcium and phosphorus are based on body weight. Those for thiamine, riboflavin and niacin are dependent upon the calorie content of the diet. The requirements for iron, vitamin D and ascorbic acid are not calculated according to weight or calorie intake but are based on experiments in which determinations were made of the levels of these nutrients required for health.

The American food allowances have a factor of safety added to the nutrient levels required for maintenance(74). This factor of safety may vary from 30 to 100% of the maintenance level depending on the nutrient considered, but is included so that even healthy people with greater than average requirements in some nutrients will be provided for in the standards. Whether or not a factor of safety should be included in the standards used to assess diets is a matter of much dispute. It does not seem justifiable to determine the adequacy of intakes with the use of any standards which are higher than necessary to promote good health in average persons.

Recommended dietary allowances serve as a means of description but should not replace the more basic data - the quantities of various kinds of foods consumed or available for consumption and the quantities of nutrients provided by the food. Too often results of dietary studies are reported only in terms of the percentage of some standard of adequacy. Thus, they are tied to a measure which is itself subject to revision.

g) Place of dietary studies in investigations of nutritional status.

The ultimate test of the adequacy of diets is the long-term nutritional health of the persons consuming them. Lack of correlation between dietary intake and clinical condition may mean inadequate data or wrong interpretation or both. Points to be borne in mind in such a comparison include the following(74):

(1) The state of nutritional health at any one time represents the cumulative effect of food consumption over a long period as well as the recent intake of certain nutrients.

(2) Errors are introduced when tables of average food values are applied to an individual's diet which has been studied for too short a time. These errors are magnified if values for foods as they enter the kitchen are applied to foods as eaten. The methods of obtaining food consumption data from individuals also vary in reliability.

(3) Only within broad limits can a judgment be made as to the adequacy of a calculated or determined dietary intake for a given individual. Wide individual variations in requirements are known to exist and, in

fact, they may vary from time to time in the same individual.

For these reasons one cannot expect to find complete correlation between an individual dietary intake over a short period of time, and clinical or laboratory findings. For groups of persons, on the other hand, and for certain nutrients or aspects of nutrition, results may show fairly good correlation.

2. Value of laboratory data and its interpretation.

A presumptive diagnosis of nutritional inadequacy by a clinician should be confirmed by therapeutic trial or by laboratory examinations of the blood, tissues, urine and feces(32). Nutritional disturbances adversely affect every tissue in the body and are reflected in morphological changes, functional changes and alterations in the chemically analyzable constituents(74). It is difficult to interpret the findings from microbiological and chemical tests with respect to the adequacy of nutrition because data concerning human nutritional requirements are insufficient, knowledge of what constitutes optimal health is lacking, and neither standards or methods of precision for measuring normal health are available.

The diagnosis of malnutrition is made more difficult because there is much metabolic adaptation to malnutrition, emaciation and starvation(32). The rate of development of malnutrition determines the end results since the adaptive mechanisms differ in slow and fast developed malnutrition. There is the further problem of knowing when changes are critical enough to become a hazard to health and/or interfere with the economic usefulness of the individual to his community or to himself.

Specific nutrients which have been studied in nutrition surveys with the use of biochemical methods include protein, iron, calcium, vitamin A, thiamine, riboflavin, niacin, ascorbic acid, vitamin D, and occasionally certain other substances. These nutrients will be considered individually along with an appraisal of the existing methods for their determination and the interpretation of findings.

a) Protein.

Plasma proteins are in continuous metabolic equilibrium with other proteins and amino acids of the body(36). They are subject to the continuous influence of dietary and metabolic factors.

The only chemical test which has been widely applied in the evaluation of protein nutrition has been the determination of total serum or plasma protein(48). Kolmer _et_ _al_.(36) state that the normal total protein level for adults is 6.03 gm. per 100 ml. plasma. Williams and coworkers(72) give the range of 6.0 to 8.0 gm. per 100 ml. as being normal. At the Provincial Laboratory in Winnipeg, the normal range of plasma protein is considered to be 6.5 to 7.5 gm. per 100 ml. plasma.

The level of total serum protein is not as significant as that of albumin in evaluating protein nutrition, since serum protein is influenced by the globulin fraction which may be increased in a number of pathologic states(20). Hypoproteinemia occurs when the protein in the diet is severely curtailed for long periods of time, or in a number of disorders including those involving the liver, certain types of renal pathology, and conditions involving loss of protein from the body.

There is a considerable time lag between a deficient protein intake and an actual decrease in serum concentration(66). If circulating blood proteins drop below 6.0 gm. per 100 ml. of blood, one can conclude a long standing protein deficiency is present but edema can develop long before blood proteins reach this level.

Malnutrition is frequently accompanied by a diminution in extra-cellular space volume, especially that of the circulating blood. Then the total amount of plasma proteins in circulation may be greatly reduced with little or no change in concentration. In this case, normal values give a false feeling of security(32).

Serum protein concentrations reflect adequate intake in only the broadest sense. However, in the light of available evidence, it seems fair to interpret a low concentration of protein in the blood, particularly of the albumin fraction, as indicative of dietary protein deficiency(20). Most observers agree that it is better to determine the adequacy of protein intake by a nitrogen balance study but this is a time-consuming, expensive procedure.

b) Iron and hemoglobin.

The measurement of hemoglobin is one of the most widely used methods for appraising nutritional status. Hemoglobin levels are much affected by adverse environmental conditions, several dietary factors, and numerous pathologic states, particularly infections and diseases related to the loss of blood(20). The quantity of hemoglobin in the blood has often been used as a measure of the prevalence of iron deficiency. This is not justifiable unless improvement can be demonstrated following iron therapy(74). Iron deficiency is the most common dietary factor leading to anemia, but deficiencies of protein, folic acid, and other less well defined nutrients such as the "extrinsic factor", may be of etiologic importance(48). Furthermore, there are added effects of hormones, vitamins and other substances before the final level of hemoglobin is reached(70).

Hemoglobin values vary for normal people according to age, sex, occupation, climate, altitude and other environmental circumstances. The level is also influenced by the red cell count of the blood and the factors which cause normal variation in this respect(36).

Various levels of hemoglobin have been stated as being average for normal young women. Haworth studied the hemoglobin levels in the blood of 44 young women who were in a normal state of health. She found the mean hemoglobin value to be 13.58 ± 0.46 gm. per 100 ml. blood(25). Other stated normal values are: 13.16 gm. by Everett(25), 13.10 gm. by Myers and Eddy(47), 12.08 to 12.58 gm. by Leichsenring *et al.*(39), 12.4 ± .338 gm. by Sheets and Barrentine (64), 13.4 gm. by Ohlson *et al.*(52), 10.58 to 11.74 gm. by Abbott *et al.*(1), and 13.08 ± .911 gm. by Milan and Muench (46). In a study done on 300 female students at the Provincial Normal School, Winnipeg, in the fall of 1955, it was found that 93.4% of the girls fell within the range of 12.6 gm. to 16.3 gm. with the peak(34%) at 14.5 gm.

In general, it may be stated that determination of the concentration of hemoglobin in the blood is a valuable technique in appraising nutritional status if the method used is carefully applied, if its limitations are sufficiently appreciated, and if findings are interpreted with full realization of the variability consistent with normal health.

c) Vitamin A.

A relationship exists between the amount of vitamin A and carotene in the blood and the clinical evidence of vitamin A deficiency, but wide individual variations occur and a given level must be interpreted with caution(74). When the intake of vitamin A is decreased in adults, blood levels decrease slowly because the natural body stores of vitamin A must be depleted before the blood level is affected. A low measure of this vitamin in the blood may mean vitamin A deficiency, decreased reserve stores, or the presence of some disease which affects vitamin A metabolism(32). Castor (9) has concluded from his work that the concentration of vitamin A in the serum is a characteristic of the individual, rather than a reflection of the intake of vitamin A.

The normal range of values for vitamin A and carotene in the blood have not been completely determined(48). Williams et al.(72) and Joliffe(32) have found blood carotene levels to range from 50 to 400 mcg. per 100 ml. serum and vitamin A levels to range from 30 to 70 mcg. per 100 ml. serum. Haworth(25) states the mean carotene level to be 120.58 ± 34.18 mcg. per 100 ml. serum and the mean vitamin A level to be 40 mcg. per 100 ml. serum. In patients with clinical signs of vitamin A deficiency, averages were 6 I.U. for vitamin A and 24 mcg. for carotene(48).

Determination of vitamin A and carotene in the blood would appear to be more meaningful in group studies than in individual nutritional appraisal. Low levels suggest deficiency but should be correlated with other findings before a definite diagnosis is made.

d) Vitamin B complex.

Chemical tests for three members of the B complex; thiamine, riboflavin and niacin, have been extensively studied and applied to surveys. Excretion of other B vitamins such as pyridoxine, pantothenic acid, biotin, etc. have been included in some investigations, but their importance in nutritional appraisal has not been clearly demonstrated.

(1) Thiamine.

The test most frequently used in surveys in evaluating thiamine nutrition has been the determination of the excretion of the vitamin in the urine for a one-hour period during fasting, or for several hours following the administration of oral or parenteral test doses of the vitamin(48). The excretion of thiamine has been shown to fall rapidly when the intake of this vitamin is lowered(53). At an intake of about 0.07 mg. per day, Mickelson found the thiamine excretion to approach zero(45).

Mickelson, Castor and Keys(45) have shown by statistical methods that the excretion of thiamine is highly characteristic of the individual, as well as the intake, and that variability in data becomes more marked as thiamine intake increases. There is considerable disagreement in the literature in regard to the quantitative output of thiamine on low intakes and concerning the levels of excretion which may be considered indicative of normalcy and deficiency(48).

Cox *et al*.(14) studied the relationship between daily blood levels of thiamine with urinary excretion and found no significant relationship. Blood levels do not seem to reflect changes in the dietary intake of thiamine as sensitively as does the urinary excretion.

2) Riboflavin.

Methods for the determination of riboflavin which are applicable to surveys include estimation of the quantity in the blood(serum and erythrocytes), and measurement of the urinary excretion for one hour during fasting, and for several hours after the oral or parenteral administration of a test dose of riboflavin(48). In general, the amount of riboflavin excreted in the urine parallels the dietary intake until high levels are reached, then the quantitative excretion is increased but the percentage of the intake excreted is little affected(4).

Hou and Dju(48) found the 24-hour riboflavin excretion lower in patients with glossitis, cheilosis, and eye signs of riboflavin deficiency than in normal persons. They also found that the amount of riboflavin excreted was usually proportional to the volume of urine and paralleled thiamine excretion.

3) Niacin.

Since niacin is excreted in the urine in various forms such as N' methylnicotinamide, niacinamide, nicotinic acid, nicotinuric acid and in the form of a pyridine compound, numerous chemical tests for its appraisal have been presented(74). There seems to be little change in the urinary excretion of freely hydrolyzable derivatives of niacin with variations in the diet and only a slight decrease occurs in pellagra(55).

Findings should be interpreted with caution in evaluating niacin nutrition. There are marked individual differences in the percentage of various metabolites of niacin which are excreted. This may be due in part to the methylating ability of the organism. At present, the determination of N' methylnicotinamide in the urine during fasting and after the administration of a test dose of niacinamide is a worthwhile procedure in the assessment of nutritional status(48).

e) Ascorbic acid.

Tests used in the evaluation of vitamin C status include the determination of ascorbic acid levels in the plasma, whole blood, white cell and platelet layer, and the estimation of urinary excretion during fasting and in a 24-hour period(74). The level of ascorbic acid during fasting generally corresponds with the dietary intake of this vitamin(24). However, temporary fluctuations of ascorbic acid in the plasma are frequent and there is a wide range of values at any given level of intake(32).

Levels ranging from 0.3 to 0.7 mg. per 100 ml. blood have been suggested as the lower limit of normal for vitamin C(48). Several investigators are of the opinion that levels as low as 0.1 to 0.5 mg. per cent are not indicative of a deficiency but merely reflect a low recent dietary intake, or suggest that the body is not saturated with vitamin C. Unsaturation may be compatible with normal health.

In the majority of studies, little or no correlation has been demonstrated between the amount of ascorbic acid in the plasma, or the degree of saturation of the tissues, and changes in the gums ascribed to a deficiency of ascorbic acid(38). If the mean plasma level in a population is low, it appears likely that intake has been poor for long periods of time and that bodily stores have been depleted. Plasma levels of less than 0.3 mg. per cent are regarded as suggestive of a chemical deficiency and levels below 0.6 mg. per cent are indicative of an intake that is less than desirable.

Ascorbic acid in the white cell-platelet layer of centrifuged blood is more significant and levels below 0.1 mg. per 100 ml. have a close correlation with the presence of scurvy(32). In summary, plasma levels mirror more closely the diet; white cell levels, the tissue stores(48).

f) Calcium and vitamin D.

Only two procedures have been used in nutrition surveys for the appraisal of calcium and vitamin D levels. They are; the determination of the level of calcium in the blood and the measurement of alkaline phosphatase in the serum(74).

Alkaline serum phosphatase is elevated early in rickets and parallels the activity of the disease in the healing process. Other causes of an increase in phosphatase activity are uncommon at the age when rickets is prevalent, and are easily detected. The value of including phosphatase determinations in surveys other than those involving infants and young children remains to be determined.

The normal concentration of calcium in the blood ranges from 9 to 11 mg. per cent in adults and from 10 to 11 mg. per cent in children. If serum calcium falls to low levels, the clinical syndrome of tetany or osteomalacia occurs(48).

3. Clinical examination and diagnosis.

It is difficult to measure the physical condition against the adequacy of food intake. Since there is no such thing as a single pathognomic sign of nutritional adequacy, the interpretation of clinical findings in a given individual requires careful differential diagnosis. The diagnosis should be based on a complete case history, physical examination, anthropometric analysis and laboratory findings. In a number of cases, a therapeutic trial is necessary to confirm or obviate clinical judgments.

Joliffe(31) has summarized these views as follows:

> "In connection with signs of malnutrition, it is necessary to emphasize four important points. The first is that, with but few exceptions, the signs are non-specific and may be produced by trauma other than malnutrition. No single sign of malnutrition is necessarily diagnostic; each must be evaluated in light of the history, and other signs and symptoms. Other possible causes must be ruled out. Interpretation of these findings requires all the diagnostic acumen and clinical judgment required in other branches of internal medicine."

The physician who faces the problem of diagnosing a condition from an assorted collection of symptoms ressembling a nutritional deficiency must consider, and have a knowledge of, at least eleven possible classes of etiology(20). These are: congenital and hereditary; deficiency of oxygen and nutrients; parasites; trauma, including the effects of the environment; physical irritants; chemical poisons; tumors; degenerations; endocrine and metabolic; and unknown.

Since a good diagnostician of nutritional deficiencies must make good use of case histories, anthropometric analysis and therapeutic trials, these topics will be discussed separately.

a) Medical case histories.

Although the process of taking a case history is time-consuming, it is often the patient's account of symptoms which confirms a diagnosis of deficiency disease. Questions in a history should be designed to discover abnormalities of growth, malfunction of the gastro-intestinal system, disturbed psyche, and ocular or visual imperfections. The physician should also make an effort to determine if physiological or pathological stresses are present in the group or individual under study, and to gauge the extent to which these stresses may complicate malnutrition.

b) Therapeutic trials.

One accepted method of confirming clinical diagnosis of nutritional disturbances or diseases, is to observe the effect of therapy on the patient or group studied. If a patient with a probable deficiency improves under treatment with the nutrient in question, that patient probably had a true nutritional deficiency(48).

Diagnostic therapeutic trials may be applied to small or large populations. The group studied must be divided into two numerically equivalent sections with numbers equally distributed with regard to age, sex, body build, activity, dietary intake and clinical findings. Both groups must remain in the same environment and consume the same diet. One group is then given the vitamin or vitamins suspected of being generally deficient in the diets. The second group is given a placebo which resembles the therapeutic agent as closely as possible in appearance and taste. Comparisons of the two groups are made at the end of the experimental period. When vitamins are used for therapeutic diagnostic purposes, it is customary to give them each day in amounts which are five times the recommended daily allowances of the National Research Council(74).

c) Anthropometric analysis.

Meredith and Stuart(44) believe that seven measurements should be made in physical examinations for nutrition surveys. These are body weight, standing height, chest circumference, hip width, leg girth and two subcutaneous tissue measurements - below the scapula and immediately above the ileum crest. These figures provide the basis for a fair appraisal of the degree of leanness or fatness in an individual.

Brozek(5) states that height and weight are the two basic measurements of importance in nutrition surveys but, if time and resources permit, measurements should be taken of the skinfold at the back of the upper arm and the width of the pelvic girdle (measured as the bicristal diameter and serving as a measure of width of the skeletal framework). These four variables have primary significance in anthropometric analyses. They may be supplemented with the following figures of secondary importance; measures of the thickness of subcutaneous fat on the trunk (subscapular skinfold), muscular development of the upper arm (circumference of the approximate diameter calculated from the circumference and corrected for subcutaneous fat), and bony width of the shoulders (biacromial diameter).

The fact is readily appreciated that body weight, even when evaluated with reference to the size of the skeleton, is an inadequate measure of fatness. The same gross weight in different individuals is comprised of different mixtures of the basic components, namely, bone mineral, fat, intracellular fluid and 'cells'(34). For this reason, several methods have been devised for a more realistic estimation of body fat. These methods are(6):

(1) Biochemical analysis of the whole body for fat,

total water, protein and total ash.

(2) X-rays of the skeletal structure and soft tissue roentgenograms.

(3) Body density measurements.

(4) External body measurements (skinfolds, visual assessment).

The measurement of skinfold thicknesses has proven to be a practical means of estimating the amount of fat in the body(50). Keys and his associates(58) at the University of Minnesota have developed special callipers for this measurement which are carefully standardized for area and pressure. Brozek and Keys(50) have worked out an equation relating skinfold measurement to total body fat and have found such good correlation between the two that they recommend the routine taking of skinfold measurements in mass surveys.

Edwards(18) studied relative skinfold thicknesses at different sites by converting the weight of each subject to the weight corresponding to a standard height of 64 inches so that subjects of different heights could be compared by weight. The thickness of fat was found to vary from place to place according to a pattern which remained constant for weights of 110 to 180 pounds. The normal pattern showed a greater distribution of fat around the shoulders, base of neck, back, abdomen and thighs than elsewhere, and a "sparing" action of the extremities. Edwards found that after puberty the total quantity of body fat is 1.75 times as great in females of average weight than in males of average weight.

Brozek and Keys(2) state that any leanness-fatness determinations require skinfold measurements in at least three sites and the preferred positions are:

(1) Upper arm - midway on the posterior line.

(2) Below the scapula.

(3) Above the iliac crest (in the midaxilliary line).

An extensive Canadian survey was carried out during the summer of 1953 at which time, measurements were taken of height, weight and arm skinfold. A large proportion of Canada's 15,000,000 people was included in this large anthropometric study, the first extensive survey of its kind(58).

Since each method of estimating body composition has its limitations, Brozek(6) has attempted to synthesize methods for more accurate assessments. He has correlated the various degrees of endomorphic, mesomorphic and ectomorphic build from photographs with densitometric estimates of the fat content of subjects. Brozek believes this method should be improved further by correlating densitometry, skinfold measurements and soft tissue roentgenograms. This system would focus concisely on body build.

At the Army Medical Nutrition Laboratories at Denver, Colorado(6), skinfold measurements have been correlated with body densities using the following equation:

$$D = 1.08012 - 0.0007123\ S - 0.0004834\ C - 0.0005513\ A$$

D = predicted body density.
S = skinfold thickness in mm. measured at "side" (on the chest in the midaxilliary line at the level of the xyphoid process).
C = "chest" (in the juxta-nipple position).
A = "arm" (on dorsum of arm at midpoint between tip of the acromion and tip of the olecranon).

The measurement of skinfolds is relatively new in the field of anthropometric study and much work remains to be done before the skinfold measurements can be meaningly interpreted along with the older standard measurements of height, weight, and body circumference.

CHAPTER III

EXPERIMENTAL PROCEDURE

The nutrition survey was carried out during the two-week period of March 11 to 24th, 1956. Students living in the Women's Residence at the University of Manitoba were used as subjects in the study. Information on the nutritional status of each girl was obtained through a food intake record, biochemical tests and physical measurements. During the two-week survey period, records were kept of the food served in the residence dining room. The method employed in each part of the survey is outlined below.

A. SURVEY POPULATION

There were 131 girls living in residence at the time of the survey. The actual population used in the study was obtained by first asking each girl in residence to volunteer as a subject. This volunteer group was reduced in number according to the number of girls who could give blood samples on the day designated for the taking of samples. An attempt was made to include only those girls who could fulfill each part of the survey requirements.

The survey group was composed of 84 girls or 64.1% of the available residence population. Table I compares the university year and faculty representation of the survey population to that of the available residence population.

TABLE I

A COMPARISON OF THE FACULTY REPRESENTATION AND UNIVERSITY YEAR OF GIRLS IN THE AVAILABLE RESIDENCE AND SURVEY POPULATIONS

Faculty	University Year	Available population (Number of girls)	Survey population (Number of girls)
Arts	I	2	1
	II	6	3
	III	5	5
	IV	7	2
Interior Design	I	5	5
	II	3	1
	III	1	0
	IV	1	0
Science	I	4	3
	II	7	6
	III	7	4
	IV	4	4
Home Economics	I	32	14
	II	13	13
	III	13	9
	IV	7	6
	V	1	0
Social Work	I	2	0
Nursing Education	I	2	0
Public Health	I	1	0
Plant Science	I	1	1
Architecture	II	1	1
Education	I	2	2
Fine Arts	I	1	1
Commerce	II	1	1
	III	1	1
	IV	1	1
Totals		131	84

B. FOOD INTAKE RECORDS

1. Forms.

Each girl was asked to keep a record of her food intake for seven days and supply other information of importance in a food intake report. Each record consisted of one page with questions and directions for supplying the necessary intake data, and seven lined pages for recording the actual amount of food consumed in a week. Samples of these pages are included in Appendix A.

2. Compilation of food intake data.

Each food entered on the intake sheets was analyzed for the following twelve nutrients:

Calories	Iron
Protein	Vitamin A
Fat	Thiamine
Carbohydrate	Riboflavin
Calcium	Niacin
Phosphorus	Ascorbic acid

The composition tables used for the analysis of foods were: "Food Values Recommended for Use in Canada" prepared by the Nutrition Division, Department of National Health and Welfare, Ottawa(67), and tables by Proudfit and Robinson(60) and the H.J. Heinz Company(73).

3. Analysis of the adequacy of food intakes.

A comparison of individual food intake levels was made using Canada's Recommended Allowances. These recommended levels for the survey group were(8):

$$\text{Calories} = 93(\text{Weight}_{\text{kg.}}{}^{.75}) + 500 \text{ calories for moderate activity}$$

$$\text{Protein}_{\text{gm.}} = 2.75(\text{Weight}_{\text{kg.}}{}^{.75})$$

$$\text{Fat}_{\text{gm.}} = \frac{30\% \text{ of total calories}}{9}$$

$$\text{Carbohydrate}_{\text{gm.}} = \frac{\text{total calories - calories from fat and protein}}{4}$$

Calcium = 0.01 gm. per kg. body weight

Phosphorus = 0.01 gm. per kg. body weight

Iron = 12 mg.

Vitamin $A_{(I.U.)} = 18(\text{Weight}_{\text{kg.}})$

Thiamine = 0.3 mg. per 1000 calories of diet

Riboflavin = 0.5 mg. per 1000 calories of diet

Niacin = 3.0 mg. per 1000 calories of diet

Ascorbic acid = 30 mg.

Data was treated to indicate the numbers of girls meeting their recommended nutrient levels or falling various degrees below the recommended amounts, the closeness of average nutrient intakes to average recommended nutrient levels, the extent of deficiencies in each nutrient and the differences in nutritional adequacy of the diets of girls from different faculties.

The nutrient levels of each girl were calculated separately for each of the seven days the food intake record was kept, then the averages for the seven days of meals were computed for each subject. The forms used for the calculation of daily and weekly nutrient levels are included in

Appendix A.

The food intake sheets supplied data for the analysis of food habits in the survey group by providing information on the number of meals omitted, the number of meals eaten away from residence, the number of snacks and the times they were taken, etc.

C. AVAILABLE FOOD SUPPLY

During the two-week survey period records were kept of the foods served each day in the residence dining room and the cost of each item was noted. Serving-sized portions of each food were weighed and measured in order to determine the size of portions in the dining room. When foods were found to vary considerably in weight, three different servings of them were used in order to obtain an average weight. A record for one day is presented in Appendix A.

The composition of each food served was calculated for the twelve nutrients that were used to assess the adequacy of individual food intakes(Page 33). The same tables of food composition were also employed(60,67,73). Whenever mixtures were served for which food composition figures were not available, the recipes used in preparation were obtained and analyzed to determine the nutrient levels in each serving. An example of this analysis is included in Appendix A.

The nutritional adequacy of the residence food supply was calculated by:

(1) Averaging the nutrient levels in each course served during the two-week survey period.

eg. All the fruit and fruit juices served at breakfast
All the breakfast cereals
All the protein dishes served at breakfast

The courses at dinner and supper were averaged in the same way.

(2) Drawing up a basic meal plan using Canada's Food Rules for girls of the survey group age.

(3) Fitting the averages of courses served in residence into the basic meal plan and totalling the nutrient levels.

(4) Comparing the totalled nutrient levels to the Canadian Recommended Allowances for girls of the survey group age.

D. BIOCHEMICAL TESTS

Four lab. technicians from the Provincial Laboratory in Winnipeg took blood samples from each girl on March 20th. Determinations for total protein and hemoglobin were done in Winnipeg, those for carotene and vitamins A and C were done in Ottawa using samples which had been frozen in Winnipeg and sent to Ottawa in that state.

Urine samples were collected the same day as the blood samples and sent to Ottawa to be analyzed for the presence of thiamine, riboflavin and niacin. The methods used for collecting blood and urine samples are included in Appendix A.

Normal blood and urine values were obtained from the Provincial and Federal Laboratories where analyses for the survey were done. These values are:

<u>Blood</u> (1) Hemoglobin using the oxyhemoglobin method - 14.0 gm. per 100 ml. blood.

(2) Total protein using the Biuret reaction - 6.5 to 7.5 gm. per 100 ml. serum.

(3) Ascorbic acid - 0.3 or 0.4 mg. per 100 ml. plasma indicates a low dietary intake and a lack of reserves, while 0.6 to 0.8 mg. are common values.

(4) Vitamin A - 20 to 100 mcg. per 100 ml. plasma is the normal variation but any value below 25 mcg. should be considered carefully.

(5) Carotene - 10 to 200 mcg. per 100 ml. plasma is the normal variation but any value below 40 mcg. should be considered carefully.

<u>Urine</u> Since the exact level of excretion of the B vitamins is not as much valued in our present state of knowledge as an "all or none" test, it is assumed that the body is not receiving enough thiamine, riboflavin and niacin if these vitamins are not being excreted in the urine.

The results of the blood and urine analyses were correlated with nutrient intake levels in order to discover the significance of this relationship. The biochemical results were also used to help in the general evaluation of nutritional status in the survey group.

E. PHYSICAL MEASUREMENTS

Height and weight measurements were taken of each girl along with recordings of skinfold thicknesses at three sites,-

upper right arm, ileum crest and below the scapula. Height and weight measurements were taken using a scale from the Chandler Fisher Ltd., Surgical Dealers, Winnipeg. The skinfold thicknesses were measured using a pair of callipers loaned from the Nutrition Division, Ottawa. Directions for the procedure of ascertaining skinfold thicknesses and a diagram of the callipers used are included in Appendix A, along with a sample of the form used for recording the physical data.

The height, weight and skinfold measurements were employed to discover the extent of overweight and underweight in the survey group. The weight was also required to calculate the amount of calories, protein, vitamin A, calcium and phosphorus needed by the girls studied. The three skinfold measurements were correlated with the degree of leanness and fatness as found by Canada's Height Weight Table(58) to find out which skinfold measurement was in closest agreement with the height-weight data.

A medical examination was not included as part of the nutrition survey since each girl had had a thorough examination on entry into the university. It was assumed that the results of that examination were still valid as each girl in the survey group was participating in a regular university schedule.

F. LETTERS TO VOLUNTEERS IN THE SURVEY

Each girl who volunteered to be a subject in the survey was sent a form letter which presented the findings on her nutritional status and compared them to the standards used in the survey. The letters included recommendations for improving the diets when that need was indicated. A sample of the form letter is presented in Appendix A.

CHAPTER IV

DISCUSSION OF RESULTS

A. LEVELS OF NUTRIENT INTAKE

1. Adequacy of diets.

The average recommended nutrient levels and average intake levels with their standard deviations, are shown in Table II. In addition, the Table shows the numbers of girls above their allowances, 0-15% below, 16-30% below and over 30% below their allowances.

The intake levels of protein, fat, calcium, phosphorus, thiamine, riboflavin, niacin and vitamin C appear to be quite adequate generally for this age group (16 to 23 years). The dietary levels of calories, carbohydrate, iron and vitamin A did not meet the recommended allowances as satisfactorily.

Since the Canadian Recommended Allowances are set at a nutritional floor below which it is inadvisable to go if health is to be maintained, any levels of nutrient intake below those recommended gives cause for concern. If the American Recommended Allowances had been used with their 30 to 100% factor of safety added on to the nutritional floor, many more of the girls surveyed would have appeared to have inadequate nutrient supplies.

Each of the nutrients calculated from the food intake

TABLE II

NUMBER OF GIRLS WITH NUTRIENT INTAKE LEVELS ABOVE OR BELOW

THE CANADIAN RECOMMENDED ALLOWANCES (84 girls)

Nutrients	Actual intake levels (Mean and standard deviation)	Recommended allowances (Mean and standard deviation)	Number of girls at each level of nutrient intake			
			Above allo-wance	0-15% below allo-wance	16-30% below allo-wance	Over 30% below allo-wance
Calories	2232 ± 421 cals.	2494 ± 92 cals.	24	28	23	9
Protein (gm.)	73.7 ± 14.4	59.1 ± 3.0	71	7	5	1
Fat (gm.)	97.6 ± 21.1	82.7 ± 5.1	67	10	3	4
Carbohydrate (gm.)	261.7 ± 55.2	378.1 ± 13.3	1	10	30	43
Calcium (gm.)	.982 ± .331	.605 ± .031	70	3	4	7
Phosphorus (gm.)	1.279 ± .398	.605 ± .031	83	1		
Iron (mg.)	10.56 ± 1.88	12.00	17	33	25	9
Vitamin A (I.U.)	5726 ± 2133	4299 ± 263	61	9	11	3
Thiamine (mg.)	1.03 ± .21	.75 ± .34	74	6	4	
Riboflavin (mg.)	1.71 ± .47	1.25 ± .03	67	8	3	6
Niacin (mg.)	12.2 ± 2.5	7.5 ± .3	83			1
Vitamin C (mg.)	90 ± 28	30	84			

records will be discussed separately. Reference will be made to the results of other investigators who have surveyed groups of college women. The results of these workers are included in a table in Appendix B entitled, "Average Levels of Nutrient Consumption among College Women".

a) Calories.

Approximately one-quarter of the girls had caloric intakes above the recommended level, however, the majority of the girls had caloric intake levels which were 0 to 30% below the recommended amounts. Twenty-eight girls were in the group 0 to 15% below and 23 were in the group from 16 to 30% below the allowance. Nine girls out of the 84 had diets quite inadequate in calories and it is postulated that these girls may have reduced their caloric intake purposely in order to attain or maintain a fashionably slim figure.

The average caloric intake of 2232 calories was more than 200 calories below the recommended average allowance; however, it does agree closely with the findings of other workers. Scoular and Foster(63) found the average intake of 106 college women in two studies to be 2410 and 2446 calories. Greenwood and Lonsinger(23) found an average of 2016 calories; Young(75) found an average of 2243 calories; Hoover and Coggs(29) found an average of 1940 calories.

The caloric intakes found in most studies of college women indicate a range from 1800 to 2250 calories. This range is below the calculated need when college women are classified as "Moderately active". It seems that the classification of college women would be more correct if changed to "Sedentary".

Previous surveys carried out in other population groups in Winnipeg (school children and low income families) have shown the caloric requirement to be quite adequately met(27, 56). Among women in residence, several factors influence their caloric intake which would not affect other groups as much. These factors are:

(1) Pressure of busy class schedules which leave little time for relaxed meals.

(2) Tension from course work.

(3) Need to eat meals at specified times when dining service is provided.

(4) Emphasis of this age group on attaining or maintaining the fashionably slim figure.

b) Protein.

Seventy-one of the girls surveyed received very adequate amounts of protein. Seven had intake levels 0 to 15% below the recommended amounts and six had levels 16% or more below the standard. These six definitely had an inadequate supply of protein and an increase in their consumption of this nutrient is indicated.

The average intake level of protein was 73.7 ± 14.4 grams, an amount well over the recommended average level of

59.1 ± 3.0 grams. Most workers have found the dietary levels of protein in college women to be quite sufficient (Refer to the table in Appendix B). When Dr. L.B. Pett summarized the findings on the nutritional status of 6,057 Canadians from a collection of surveys, he reported no cases of definite or probable protein deficiency in that large sampling(57).

Rose and Wixom(62) have urged caution in stipulating what adequate and inadequate protein levels are. They have found subjects to maintain nitrogen balance on as little as 22 grams of protein a day. No girls in the present survey received under 42.5 grams per day but by the Canadian standards used in assessment, that intake level is quite low.

c) Fat.

Sixty-seven of the girls received more than 30% of their daily calories from fats. Twelve girls had intake levels 0 to 30% below the recommended amounts and four girls had intakes over 30% below.

It is recommended in Canada, that not more than 25 to 30% of the total daily calories should come from fats. Using the upper limit of this range, it was found that the survey group should have received an average of 82.7 ± 5.1 grams of fat a day; however, the average intake of the group was 97.6 ± 21.1 grams. This level of fat in the diet contributed 39.3% of the total calories consumed. Deuel(15) has estimated that 33% of the total calories in the average American diet come from fats. The present group surveyed had an average fat intake which was 6.3% higher. Considerable amounts of fried foods were served in the residence dining hall and this may partially explain the high fat intake. The high fat intake levels of the group surveyed are in accordance with the findings in other Canadian surveys(57).

The level of fat recommended as optimal still remains a matter of much dispute. Studies with rats have demonstrated that high fat diets tend to shorten the life span and increase the incidence of degenerative diseases such as arteriosclerosis(7,16). It is supposed that similar effects are experienced by human beings. It is possible that a high fat consumption in youth may not be as harmful to health as a similarly high consumption of fat in middle age.

d) Carbohydrate.

Since the recommended levels of both fat and protein are low in Canada, considerable carbohydrate must be included in the diet to bring the caloric intake up to the recommended standard. In the survey group, most of the subjects had more protein and fat than stipulated in the standards, and had less carbohydrate. Half of the girls received 30% or less of the recommended amounts.

The average of the intake levels was 261.7 $\pm$ 55.2 grams but the recommended amount was 378 $\pm$ 13.3 grams. An increased consumption of carbohydrate would have helped some of the girls reach their recommended caloric allowances.

e) Calcium.

The intake levels of calcium were quite good when one observes the contrary findings of most Canadian surveys(57). Seventy of the 84 girls received more calcium than was stated as the Canadian requirement. Seven girls received 0 to 30% less than the recommended allowances and 7 received over 30% less than the required amounts. Since college women are nearing the child-bearing period of their lives when extra strain is placed on calcium stores, any intake below the nutritional floor indicates a need for increased supplies. The seven girls receiving over 30% less than their requirements are especially in need of a larger calcium intake.

Reference to the table in Appendix B which has the average calcium intake levels of various groups of college women, shows that calcium consumption varies from 0.51 grams to 1.41 grams per day. All but one group studied had calcium intake levels above the average recommended amount of the present survey (.605 $\pm$ .031 grams).

The residence girls probably had a good calcium intake for the following reasons:

(1) Milk was offered in the residence dining room at each meal.

(2) Both chocolate and plain milk were available.

(3) Many girls would prefer to take a cold beverage than a hot one which could cool off before they were ready to drink it.

(4) There is a tendency to drink coffee and soft drinks at break periods so milk may be preferred at meal times.

(5) The majority of residence girls were from rural or urban Prairie centers. Since this whole area is based primarily on agricultural activities, the girls would have had a greater opportunity to obtain milk at their homes than would people of a similar age but not living in an agricultural area. The milk drinking habit would continue in the university age group.

f) Phosphorus.

Only one girl received less than the recommended amount of phosphorus. It has been stated that if protein and calcium intake levels are adequate, that of phosphorus will also be (12). That statement was found to be true in the present survey. Calcium and protein intake levels were generally good, and that of phosphorus was excellent. Workers who have calculated phosphorus intake levels in the diets of college women have found this nutrient is usually well supplied (See Appendix B).

Leichsenring _et_ _al_.(40) found that calcium retention is most efficient when calcium and phosphorus are almost equally supplied. Retention was considerably poorer when the phosphorus intake exceeded the calcium intake. Since the phosphorus intake level in the present survey was considerably higher than that of calcium, Leichsenring's experiment would suggest that the calcium would not be efficiently utilized in those girls with a particularly high phosphorus consumption.

g) Iron.

This nutrient was the one most inadequately supplied in the diets of the residence girls. Only 17 of the 84 girls received 12 mg. or more of iron a day. Thirty-three girls received levels 0 to 15% below the recommended amount, 25 had levels 16 to 30% below those recommended and nine girls received levels of iron which were more than 30% below the stated requirement.

Other workers have found low levels of iron intake among young women (See Appendix B). Morris and Bowers studied the diets of 100 college women at Utah State College and found the iron consumption to be only 8.86 mg. per day. Leverton and Marsh found that 69 women at the University of Nebraska had an average intake of 10.44 mg. iron per day. Greenwood and Lonsinger determined the iron intake of 203 women at Kansas State and Iowa State Colleges, and found the average to be only 10.34 mg. per day. In the present study the average iron intake was 10.56 mg. per day.

Frenchman and Johnston(19) believe a conscious effort must be made to obtain a diet with adequate iron because a seemingly nutritious diet may be low in this nutrient. It is unfortunate that many of the foods high in iron are not well liked by a large proportion of people, e.g. liver, whole grain cereals, etc. Furthermore, the iron-rich but relatively high calorie, cereal foods are often shunned by women of college age because they wish to reduce their caloric intake.

h) Vitamin A.

Three-quarters of the girls had levels of vitamin A in their diets which surpassed the recommended levels. However, nine girls had diets with 0 to 15% less vitamin A than recommended, 11 had diets with 16 to 30% less than the recommended amount and three girls received over 30% less vitamin A than they should have had. The latter group had a definite need to increase their intake levels of this vitamin.

The average recommended amount of vitamin A was 4299 ± 263 I.U. but the average intake level exceeded this by over 1000 I.U. Other studies of vitamin A intake levels in college women show higher average consumption levels than that of the present survey (See Appendix B).

In the series of surveys done in Canada from 1937 to 1942, it was found that the level of vitamin A intake in the low income group in Winnipeg was higher than that of similar groups studied in Halifax, Quebec, Toronto and Edmonton(56). Only 3% of the Winnipeg subjects received less than 70% of the Canadian standard. In the residence group of girls, 3.6% received less than 70% of the standard. Since the food habits of people in the same geographical area tend to be similar, this may explain the agreement in vitamin A intake levels between a university and outside group.

i) Thiamine, riboflavin and niacin.

Thiamine and niacin were generally very adequately supplied in the diets studied. No girls received less than 70% of the recommended thiamine standard and only one received less than 70% of the niacin standard. The average intake levels of both thiamine and niacin were well above the recommended averages for both of these nutrients.

Riboflavin was the least well supplied of the three B vitamins, but three-quarters of the group surpassed the recommended level of intake. Eight girls had intakes 0 to 15% below the standard, three girls had intakes 16 to 30% below and six girls had intake levels which were over 30% below the recommended levels. Surveys of other college groups have not shown a similarly low level of riboflavin in the dietary intakes (See Appendix B).

In surveys which have been conducted in Canada, more symptoms are found of B vitamin deficiencies than are found of any other nutrients(57). Since the present group has only 4% of the girls receiving less than 70% of the recommended allowances for the three B vitamins studied, this group is different from the majority of groups studied to date in Canada. The comparison may not be justified because girls living in residence have their meals planned and served to them by dietitians while the average Canadian has more freedom in determining what foods he will include in his diet.

j) Vitamin C.

No girl in the survey group received less than 30 mg. of ascorbic acid a day. The average intake was three times that amount. Other workers have found college women to have intakes varying from 74 to 124 mg. vitamin C daily (See Appendix B). Lamb and McPherson(37) and Chalmers *et al*.(11) found that college women living in bachelor quarters or boarding had lower intakes of vitamin C than those living in residence where citrus and other fruits were often put on the menu.

k) Possible sources of error.

Although calculations of nutrient intake levels were done as carefully as possible, errors could have arisen from several sources:

(1) The girls may have unknowingly omitted to write down some of the foods they consumed.

(2) The girls may not have given accurate measures of the foods entered in the food intake sheets although they were given personal instructions before the survey and assisted in their estimates

throughout the project.

(3) The nutrient levels of some foods were difficult to assess. Much of the food served during the survey period was fried or cooked with added fat. The only method to definitely find out the amount of fat added per serving is to weigh the food before and after the fat is added. Unfortunately this was not practicable in the present survey so values for food with added fat were found from food composition tables or by estimation.

(4) Factors which could not be controlled may have caused some error in food analyses. The food composition tables did not always give the values for cooked foods or, when cooked values were given, did not specify the method of cookery. The regional variation in the composition of food and the length of storage are also variables which could have altered nutrient values considerably from those stated in the tables.

B. EXTENT OF NUTRIENT DEFICIENCIES IN THE DIETS

The number of nutrients received in amounts below the recommended levels in the 84 diets studied have been totalled and are presented in Table III.

Only 19 girls had diets in which all the nutrient

TABLE III

THE EXTENT OF NUTRIENT DEFICIENCIES IN THE DIETS

OF THE SURVEY POPULATION

Number of nutrients below recommended levels in diets (A)	Number of diets with each number of deficiencies (B)	Total number of nutrient deficiencies (A x B)	Number of diets with deficiencies in the nutrients shown									
			Calories	Protein	Calcium	Phosphorus	Iron	Vitamin A	Thiamine	Riboflavin	Niacin	Vitamin C
0	10	0										
1	19	19	6				12			1		
2	25	50	24				25	1				
3	14	42	14	2			14	11		1		
4	3	12	3	1	3		3			2		
5	3	15	3		2		3	3	1	3		
6	4	24	4	4	3		4	2	3	4		
7	5	35	5	5	5		5	5	5	5		
8	0	0										
9	1	9	1	1	1	1	1	1	1	1	1	
Totals	84	206	60	13	14	1	67	23	10	17	1	0

intake levels were at or above the Canadian recommended allowances. This is only 12% of the survey population. Most of the diets (69%) had insufficient supplies of one or two or three nutrients. Sixteen girls (19%) had diets with four or more nutrients provided in inadequate amounts.

When only one nutrient was received in too small a quantity, that nutrient was usually iron or calories, but twice as often iron. Only one riboflavin deficiency was found among the diets with just one nutrient below the recommended level. In the diets with two nutrients received in insufficient amounts, those nutrients were calories and iron except for one diet with a deficient amount of vitamin A. When three nutrients were received in amounts below the recommended allowances, the specific nutrients were mainly calories, iron and vitamin A. Only two of the diets showed a protein deficiency and one a riboflavin deficiency. In the diets with four or more nutrient deficiencies, the nutrients generally received in inadequate amounts were calories, protein, calcium, iron, vitamin A, thiamine and riboflavin. Only one of these diets showed a deficiency of phosphorus and niacin.

Iron was the nutrient most frequently found inadequately supplied in the diets. Sixty-seven of the 84 girls showed this deficiency. Next to this nutrient, calories were found to be supplied in insufficient amounts in 60 diets. Other nutrients were not found deficient in even half as many of the diets. The other nutrients in decreasing order of the number of times they were found inadequately supplied were: vitamin A, riboflavin, calcium, protein, thiamine, phosphorus and niacin.

C. EXTENT OF NUTRITIONAL DEFICIENCIES IN THE DIETS OF GIRLS FROM DIFFERENT FACULTIES

The survey population did not include equal numbers of girls from the different faculties on campus. Half of the survey group (42 girls) was from the School of Home Economics. The other half was derived from the following faculties:

Faculty	Number of girls
Science	17
Arts	11
Interior Design	6
Commerce	3
Education	2
Plant Science	1
Architecture	1
Fine Arts	1
Total	42

The extent of nutritional deficiencies (nutrients received in amounts below the recommended levels) in the diets of girls from the different faculties is presented in Table IV.

TABLE IV

THE EXTENT OF NUTRITIONAL DEFICIENCIES IN THE DIETS

OF GIRLS FROM DIFFERENT FACULTIES (84 diets)

Number of nutrients below recommended levels in the diets	Number of diets from the different faculties deficient in the number of nutrients indicated								
	Arts	Interior Design	Science	Home Economics	Plant Science	Architecture	Education	Fine Arts	Commerce
0	1		5	4					
1	1	1	2	12	1		1		1
2	3	2	5	14					1
3	2	1	2	7		1	1		
4			1	2					
5		1		1				1	
6	2			1					1
7	2	1	1	1					
8									
9			1						
Total number of girls in each faculty	11	6	17	42	1	1	2	1	3

Of the 11 diets studied from girls in Arts, only one was found to be adequate in all the nutrients calculated. Half of the group had three or more nutrient deficiencies. Four of the diets were quite poor; two were deficient in six nutrients and two were deficient in seven.

None of the diets of the girls from Interior Design were adequate in all the nutrients. Instead, the diets ranged in nutritional adequacy with one girl having a diet deficient in seven nutrients.

Five of the 17 girls from Science had diets which met the recommended allowances in all nutrients. This was the highest proportion of adequate diets found in any faculty. However, the girl with the highest number of nutrient deficiencies was also from Science.

Among the girls from Home Economics, only four out of the 42 in the survey population had diets which met the recommended allowances in all nutrients, however, 26 of the girls had diets inadequate in only one or two nutrients. There were 12 girls with diets deficient in three or more nutrients. The most inadequate diet in the girls from Home Economics had seven nutrients supplied in insufficient amounts.

The small number of girls from Plant Science, Architecture, Education, Fine Arts and Commerce had diets deficient in one to five nutrients.

Although the girls from Science had the largest proportion of adequate diets, they also had the diet most deficient in nutrients. Thirty of the Home Economics girls had diets with two or less nutrients insufficiently supplied. It appears that this faculty had the highest average level of nutrient intake.

Since the Home Economics girls receive education in Nutrition, it is supposed that they have more knowledge in the selection of adequate diets than girls from other faculties. To find out if this knowledge was put to use, a chi-square test was carried out to compare the extent of nutritional deficiencies in the diets of Home Economics girls to those in the diets of the girls from all the other faculties represented in the survey. The results of the chi-square test are presented in Table V.

The extent of deficiencies in calories and Vitamin A was highly significant for both groups but the degree of deficiency was greatest for the non-Home Economics girls. Although the extent of other deficiencies is not statistically significant, it is evident that in the nutrients where deficiencies occurred, the extent of deficiency was always greatest for the non-Home Economics group. Since the number of girls in each group was small, it is not justifiable to draw broad conclusions. However, it does seem that Home Economics girls practised the selection of more adequate diets.

TABLE V

CHI-SQUARES FOR NUTRIENT DEFICIENCIES IN HOME ECONOMICS AND NON-HOME ECONOMICS GIRLS

Nutrients	Chi-squares of each group Home Economics (42 girls)	Non-Home Economics (42 girls)
Calories	1934**	5279**
Protein	2.589	22.693
Calcium	.128	.381
Phosphorus	0[1]	0[1]
Iron	13.041	23.513
Vitamin A	1833**	3210**
Thiamine	.013	.143
Riboflavin	.411	.977
Niacin	0[1]	1.089
Ascorbic acid	0[1]	0[1]

** Significant at the 1% level

1 No girls had intakes below the recommended level

D. NUTRITIONAL ADEQUACY OF THE RESIDENCE FOOD SUPPLY

The average daily nutrient levels provided by the residence meals are presented in Table VI. Each nutrient was available in amounts large enough to surpass the needs of any subject in the survey group. If each girl had selected and consumed the proper amounts of the foods available, she would have been generously supplied with the essential nutrients.

Figures used in the calculation of nutrient levels in the residence food supply are presented in Appendix B.

E. BIOCHEMICAL EVALUATION OF NUTRITIONAL STATUS

1. Blood analysis.

The blood levels of hemoglobin, protein, vitamin A, carotene and ascorbic acid of the survey group are presented in Table VII. The age range of the girls was from 16 to 23 years. In Table VII, the number of girls at each age in the survey population is shown first, then the number of girls at the various blood levels according to their age in years.

It was not possible to have the blood of all 84 girls analyzed for each of the five components studied. Some of the girls were unable to give blood during the hours the lab technicians were working. A few of the blood sample tubes were broken in the centrifuge and a few

TABLE VI

NUTRIENT LEVELS IN THE AVAILABLE RESIDENCE FOOD SUPPLY

Nutrients	Meals			Total
	Break-fast	Dinner	Supper	
Calories	741	915	1225	2881
Protein (gm.)	21.9	35.5	41.4	98.8
Fat (gm.)	27.0	49.9	61.0	137.9
Carbohydrate (gm.)	109.6	127.6	124.7	361.9
Calcium (gm.)	.278	.363	.659	1.300
Phosphorus (gm.)	.537	.553	.667	1.757
Iron (mg.)	4.9	5.5	5.7	16.1
Vitamin A (I.U.)	1151	3155	2966	7272
Thiamine (mg.)	.36	.46	.56	1.38
Riboflavin (mg.)	.48	.67	1.03	2.18
Niacin (mg.)	5.2	6.3	6.6	18.1
Ascorbic acid (mg.)	33	41	40	114

TABLE VII

BLOOD NUTRIENT LEVELS OF RESIDENCE GIRLS ACCORDING TO AGE

Number of girls at each age in survey population (84 girls)

Age in years	Number of girls
16	1
17	15
18	15
19	22
20	15
21	7
22	5
23	4

TABLE VIIA

HEMOGLOBIN

Distribution of hemoglobin values in survey girls at ages indicated

Range of values (gm. per 100 ml. blood)	Ages 16	17	18	19	20	21	22	23	Total
13.50 and above		1		1		1		1	4
13.49 - 12.50		5	6	9	8	3	1	2	34
12.49 - 11.50		7	6	9	5	2	4		33
11.49 - 10.50	1	2	2	2	2	1			10
Total	1	15	14	21	15	7	5	3	81

TABLE VIIB

TOTAL PROTEIN

Distribution of protein values in survey girls at ages indicated

Range of values (gm. per 100 ml. serum)	Ages 16	17	18	19	20	21	22	23	Total
7.4 - 7.0		11	5	5	5	4	3	1	34
6.9 - 6.5	1	3	6	10	5	1	1		27
6.4 - 6.0			2	4	2	1		2	11
Total	1	14	13	19	12	6	4	3	72

TABLE VIIC

VITAMIN A

Range of values (mcg. per 100 c.c. blood serum)	Distribution of vitamin A values in survey girls at ages indicated — Age 16	17	18	19	20	21	22	23	Total
41.51 and above			1	1					2
41.50 - 35.51			2	3	4	2			11
35.50 - 29.51	1	7	3	7	3	2	2		25
29.50 - 23.51		2	3	8	4	1	1	2	21
23.50 - 17.51		4	3	1		1	1	1	11
17.50 and below					1				1
Total	1	13	12	20	12	6	4	3	71

TABLE VIID

CAROTENE

Range of values (mcg. per 100 c.c. blood serum)	Distribution of carotene values in survey girls at ages indicated — Age 16	17	18	19	20	21	22	23	Total
149 - 120		1		2				1	4
119 - 90		7	9	10	5	3	2	1	37
89 - 60	1	5	2	7	7	3	2	1	28
59 - 30			1	1					2
Total	1	13	12	20	12	6	4	3	71

TABLE VIIE

ASCORBIC ACID

Range of values (mg. per 100 c.c. blood serum)	Distribution of ascorbic acid values in survey girls at ages indicated — Age 16	17	18	19	20	21	22	23	Total
1.10 and above		1		2	1				4
1.09 - 0.90	1	3	2	5	3	3	1	1	19
0.89 - 0.70		2	7	7	5	1	1		23
0.69 - 0.51		6	3	5	2	2	1	1	20
0.50 and below		1		1	2			1	5
Total	1	13	12	20	13	6	3	3	71

of the blood samples were found insufficient in amount to be tested. The number of samples analyzed for each component is listed in each individual table.

In Table VIII, the average levels of hemoglobin, protein, vitamin A, carotene and ascorbic acid of the survey group are presented along with the averages which are considered normal for these constituents in this age group. The average values included in the table were those of the federal and provincial laboratories in which the blood analyses for the survey were done. The per cent of the girls studied who had blood values below those considered average is also indicated in Table VIII.

Although it is difficult to evaluate the results of blood analysis in terms of nutritional status, blood levels do help reflect the influence of dietary habits on the body state. Each of the blood components studied in the survey is discussed separately.

a) Hemoglobin.

The level of hemoglobin considered average for healthy women of college age is not agreed upon, and various investigators have recommended values varying from 12.0 to 14.0 grams per 100 ml. blood. Levels below 11.0 gm. per 100 ml. blood indicate definite anemia according to Williams _et al_. (72). Only two girls in the survey had such low readings but ten girls had below 11.49 gm. hemoglobin per 100 ml. blood.

TABLE VIII

COMPARISON OF AVERAGE BLOOD VALUES OF THE SURVEY GROUP AND RECOMMENDED LEVELS AND THE PER CENT OF GIRLS WITH BELOW AVERAGE LEVELS IN THE FIVE COMPONENTS

Components	Average levels			Number of girls		
	Survey group	Standard deviation	Recommended level	Below Recommended level	Total	Per cent below recommended
Hemoglobin (gm. per 100 ml. blood)	12.3	.7	12.8	57	81	70.4
Protein (gm. per 100 ml. serum)	6.9	.3	6.3	0	72	None
Vitamin A (mcg. per 100 ml. serum)	30	7	38	59	71	83.1
Carotene (mcg. per 100 ml. serum)	90	17	74	11	71	15.5
Ascorbic acid (mg. per 100 ml. serum)	0.77	.21	0.96	51	71	71.8

When 12.8 gm. per 100 ml. blood is taken as the recommended level, 70.4% of the girls surveyed have inadequate hemoglobin levels. Leichsenring, Donelson and Wall (39) found similarly low levels in a group of high school girls they studied. The mean range for that group was 12.08 to 12.58 gm. per 100 ml. blood. Sheets and Barrentine (64) found the mean hemoglobin value in a group of college women to be only $12.4 \pm .338$ gm. per 100 ml. blood. This value agrees very closely with that of the present study ($12.3 \pm .7$ gm.).

Since hemoglobin values vary according to several environmental factors and in relation to the red cell count, the F.A.O./W.H.O. Expert Committee on Nutrition found these readings have the most useful place in nutritional assessment when they are standardized for the time of day taken, relation to meals, exercise, etc.(2). However, this high degree of standardization was not possible in the present survey because of the busy university schedules of the girls studied. Instead, all the blood samples were taken within a four-hour period one morning. Since the girls lived in the same residence, had meals at the same hours and took similar exercise during the morning, this sampling was considered the best possible under the circumstances.

The large number of low hemoglobin levels agrees with the finding of generally inadequate iron intakes and stresses the need for increased iron supplies.

b) Protein.

The protein levels of the girls studied were all at, or above 6.3 gm. per 100 ml. blood serum. Since a protein deficiency is not indicated until the circulating blood proteins drop below 6.0 gm. per 100 ml. blood, it appears that the survey group had adequate protein intake levels.

It has been found that in protein malnutrition an accompanying diminished extra-cellular space volume may cause a protein reading to be in the normal range although the body has insufficient protein stores. It was impossible to determine whether or not this was the case in any of the subjects studied for only the total protein levels in the blood were determined.

The Committee on Nutrition set up by F.A.O. and W.H.O. urge caution in assessing blood levels for they believe these readings do not reflect the level of protein nutrition or the level of recent protein intake except under cases of extreme malnutrition. In spite of this warning, it seems reasonable to suppose the high blood protein levels of the present survey group and their protein intakes as calculated from the food records indicate adequate protein nutrition.

c) Vitamin A and carotene.

Although wide individual variations occur, a relationship has been found to exist between the amount of vitamin A and carotene in the blood and clinical evidences of a vitamin A deficiency. It is especially difficult to evaluate low blood levels of this vitamin for they may indicate a vitamin A deficiency, decreased reserve stores or some disease which affects vitamin A metabolism.

In the survey group 83.1% of the girls had vitamin A blood levels below the recommended average and 15.5% had carotene blood levels below the recommended average. Castor(9) has stated that the concentration of vitamin A in the serum is a characteristic of the individual rather than a reflection of the vitamin A intake. He recommends that serum carotene be used as a measure of vitamin A status. In the present survey over five times as many girls had adequate carotene blood levels as had adequate vitamin A blood levels. If carotene is used to judge the state of vitamin A nutrition in the body and it is assumed the girls were in normal health, it would seem that at least 15.5% of the girls would profit from increased vitamin A supplies. This agrees with the findings from the food intake records kept by the girls.

Patients with clinical signs of vitamin A deficiency have blood levels which average 6 I.U. for vitamin A and 24 mcg. for carotene per 100 ml. blood serum. No girls in the survey population had levels that low.

d) Ascorbic acid.

Most investigators have found that ascorbic acid serum levels show frequent temporary fluctuations and show a wide range of values at any given level of intake(32).

Of the girls studied, 71.8% had serum levels below the recommended average of 0.96 mg. per 100 ml. blood serum. However, even levels below 0.1 to 0.3 mg.% are not necessarily indicative of a deficiency state but may merely reflect a low recent dietary intake(48). Since undersaturation of the tissues with ascorbic acid has been found compatible with health, it does not seem justifiable to conclude that 71.8% of the present survey group need greater amounts of vitamin C. It is surprising that the blood ascorbic acid levels are generally low because all the girls received high levels of vitamin C (average of 90 mg. daily).

2. Correlation of blood and dietary nutrient levels.

Since vitamin A and protein intake levels are calculated using body weight, these values were different for most of the girls studied. For correlation purposes, the amounts that actual intakes were above or below the recommended intake levels were correlated with blood levels. Iron and vitamin C levels were constant values for all the girls in the survey. The actual intake levels of these nutrients were correlated with hemoglobin and ascorbic acid blood levels. The correlation coefficients found for these relationships were as follows:

Relationships studied	Correlation coefficients
Protein in blood and diet	- .291
Hemoglobin in blood and iron in diet	+ .012
Vitamin A in blood and diet	+ .008
Carotene in blood and vitamin A in diet	+ .054
Ascorbic acid in blood and diet	+ .115

Poor correlation was found between any of the relationships studied. This may be partly the result of time lags before blood levels reflect the level of dietary intake. On the other hand, it may emphasize the statement frequently made that many factors influence nutrient levels in the blood besides the adequacy of nutrient supplies.

3. Urinalysis.

The presence of thiamine, riboflavin and niacin in the urine indicates an adequate supply of these B vitamins in the body. Table IX indicates the number of girls in the survey who did not have these vitamins present in the urine and shows whether the dietary intake was adequate or inadequate.

TABLE IX

NUMBER OF GIRLS WITH NO EXCRETION OF B VITAMINS IN THE URINE AND THE ADEQUACY OF THEIR DIETS

Vitamin	Number of girls with no excretion of vitamin indicated	Dietary intake	
		Adequate	Inadequate
Thiamine	12	9	3
Riboflavin	19	15	4
Niacin	11	11	0

Only three of the girls with inadequate thiamine excretion and four with inadequate riboflavin excretion received insufficient amounts of these vitamins in their diets. The others received adequate dietary supplies. It is possible that the latter group was comprised of girls who require greater than average amounts of these vitamins to maintain normal levels in their bodies.

The urine samples were sent to Ottawa for analysis and may have had the vitamin levels slightly affected on route although the samples were sent by air as quickly as possible.

F. ANTHROPOMETRIC ASSESSMENT

1. Overweight and underweight.

When the height, weight and age data of the survey population were evaluated according to Canada's Table of Average Weights for Women(58), 30 girls were found to be 10 or more pounds below the average weight and 16 girls were found to be 10 or more pounds above the average weights. The extent of underweight appeared to be greater than that of overweight. Less than half the girls were within the normal weight range.

In order to determine whether the caloric intakes of the girls were in keeping with their degree of overweight or underweight, a correlation was made between the amounts caloric intakes deviated from recommended allowances and the amounts weights deviated from the averages stated for each subject's height and age. There was almost no correlation between these two sets of figures ($r = -.105$). Although a greater amount of correlation may have been expected, one must remember that the subjects' build was not taken into consideration in determining the correct weight and factors such as basal metabolic rates were not calculated.

2. Skinfold thickness measurements.

The amount that the weight of each girl deviated from the recommended weight was correlated with each of the three skinfolds in turn to determine which skinfold thickness measurement was most closely related to the degree of overweight or underweight. The correlations were as follows:

Ileum	+ .412
Arm	+ .599
Scapula	+ .623

Although all three correlations are statistically significant at the 1% level, the skinfold taken just under the scapula came closest to corresponding with the degree of overweight or underweight. Brozek(6) has found all three skinfold measurements to correlate well with the degree of leanness or fatness.

Ohlson *et al.*(51) took skinfold measurements at the same positions as those used in the present survey and, in addition, measured the skinfold thickness of the thigh just above the knee. These skinfold measurements were plotted against the per cent deviations from correct weight. The findings of Ohlson and her coworkers agree with the average correlation found for the three skinfold measurements and weight deviations of the present study.

It would be interesting to plot skinfold measurements and weight deviations against the amount calorie consumption varies from recommended levels. This correlation was contemplated but it was decided that the caloric deviation was not too well an established figure. The proposed correlation would require the exact energy requirement of each subject to be known so the intake deviation from this figure would represent an over or under consumption of calories which could be reflected in overweight or underweight.

3. Comparison of survey group and average Canadian measurements.

The average weights, heights and arm skinfold measurements for the age groups in the residence population have been compared to those found when the whole Canadian population was sampled in 1953(59). The results are presented in Table X.

The girls in the survey group were taller and heavier and had larger arm skinfold average measurements in each age group than those found to be average for Canada. Although this may seem to conflict with the previously made statement that there was a larger amount of underweight than overweight among the residence girls, it must be kept in mind that the survey group was a small sampling compared to the nation-wide sampling that was done to determine the average Canadian figures. The extreme cases at the tall, overweight end of the distribution curve in the comparatively small residence population may have distorted the average figures.

TABLE X

COMPARISON OF AVERAGE CANADIAN HEIGHT, WEIGHT AND ARM SKINFOLD MEASUREMENTS TO THOSE OF THE RESIDENCE GIRLS SURVEYED

C = Canadian measurement
R = measurement of residence girls

Ages in years	Average height in inches		Average weight in pounds		Average arm skinfold in millimetres		Average weight/ height	
	C	R	C	R	C	R	C	R
16 - 17	62.5	64.4	120.0	126.5	13.3	18.2	1.92	1.96
18 - 19	62.6	65.9	124.0	131.9	13.6	18.0	1.98	2.00
20 - 24	62.8	65.2	124.0	129.0	12.4	14.3	1.96	1.99

G. FOOD HABITS

A study of food preferences and eating patterns was made using the food intake records kept by the residence girls. The 80 records in which seven complete days of meals and snacks were recorded were used in this study.

1. Meal patterns.

Each girl had a possible total of 21 meals for the 7-day study period. In the 80 food intake records there was a total of 1680 meals. These meals were taken as follows:

1328 meals or 79.0% eaten in the residence dining hall

173 meals or 10.3% eaten away from the residence dining hall

179 meals or 10.7% omitted altogether

Since room and board payments were made in advance in two installments during the university year, it would be more economical for the girls to take the meals in residence that they had already paid for than to purchase meals away from residence.

The 179 meals which were omitted altogether were divided as follows:

167 or 93.3% were breakfasts

5 or 2.8% were dinners

7 or 3.9% were suppers

Of the 80 girls studied, 60 omitted breakfast an average of 2.78 times during the week while 20 did not miss any breakfasts. Nygreen(49) found that 42% of the girls were usually absent from breakfast at the dining hall at the University of Washington, Seattle. Young(80) studied the food habits of freshmen at Oregon State College. She stated that 15% missed breakfast one or more times a week and 9% missed it every day. The findings of the present study are between those of Nygreen and Young.

2. Snacks.

a) Breakfast patterns and mid-morning snacks.

The 60 girls who omitted one or more breakfasts during the week had a total of 79 mid-morning snacks. This was an average of 1.32 per person. Snacks were generally taken on the mornings that breakfasts were missed. The 20 girls who did not omit any breakfasts had only eight mid-morning snacks during the week. This was an average of only 0.4 snacks per person. Although the group that consistently had breakfast was only one-third the size of the other group, the figures indicate that those who skipped breakfasts averaged about three times as many mid-morning snacks as those who did not.

b) Number of snacks.

During the survey week the 80 girls studied took a total of 724 snacks at the times indicated on the following page.

Time of snack	Number of snacks	Per cent of total snacks
Between breakfast and dinner	87	12.0
Between dinner and supper	237	32.7
After supper	400	55.3
Total	724	100.0

Over half of the total snacks were taken in the evening hours after supper. Since the evening meal was lighter than that served at dinner and there was a large period of time between supper and bedtime, it is not surprising that considerable snacking was done then. Furthermore, many girls received food parcels which they had time to share with their friends during the evening. It was also possible to meet socially and enjoy a variety of refreshments in the cafeteria which was open six nights a week in the basement of the residence.

One-third of the total snacking was done in the afternoon and one eighth in the morning. The longer period of time between dinner and supper than between breakfast and dinner may partly explain this difference in figures.

c) Nutritive value of snacks.

The average levels of protein, fat, carbohydrate and calories provided in the snacks are presented in Table XI. The girls derived an average of 16% of their

TABLE XI

NUTRITIVE LEVELS OF SNACKS AND THEIR CONTRIBUTION TO DAILY INTAKE LEVELS

Nutrients	Level in snacks Average and standard deviation	Total daily intake Average and standard deviation	Per cent of intake supplied by snacks %
Protein (gm.)	7.5 ± 4.0	73.7 ± 14.4	10.2
Fat (gm.)	13.7 ± 6.1	97.6 ± 21.1	14.0
Carbohydrate (gm.)	51.6 ± 23.1	261.7 ± 55.2	19.3
Calories	358 ± 153	2232 ± 421	16.0

caloric intake from snacks. Even with this amount of snacking, 60 girls in the total survey population did not meet their recommended caloric allowances. As stated before, this may not be indicative of a need for greater caloric consumption at meals or in the form of snacks but may indicate a need to change the classification of college women to "Sedentary".

The foods chosen for snacks contributed almost twice as much carbohydrate as protein to the diet and considerably more fat than protein. The specific foods taken as snacks are discussed under food preferences.

3. Food preferences.

Since all the girls obtained their meals in the same dining hall, the amount of choice was limited; however, the foods in which preferences could be shown have been studied separately.

At breakfast there was a choice between cooked and dry cereals. Dry cereal was preferred to cooked cereal with 51% of the girls taking dry cereal an average of 2.4 times a week and 37% of the girls taking cooked cereal an average of 2.6 times a week. Thirty-nine per cent of the girls did not take either dry or cooked cereal at breakfast. Eggs, bacon or some other meat was served at breakfast each day. Twenty-three per cent of the girls never took this high protein food but 77% took it an average of 2.6 times a week.

There was a choice between whole wheat and white bread at each meal. If the total survey population were divided into five parts, it would be found that two parts would prefer white bread, one part would prefer brown or whole wheat, and two parts would not show any preference.

At dinner there were several possible food combinations. The dietitians planned that the noon meal should be the large hot meal of the day for residence students. However, the girls in the survey population took this full hot meal an average of only 3.6 times a week. Main course foods taken instead included luncheon dishes, salads and sandwiches.

The analysis of nutrient intake levels for the group revealed that iron was the nutrient most consistently supplied in inadequate amounts. The food preferences of the girls showed they did not often select high iron foods when they had the choice. Breakfast cereals were not taken by a large proportion of the group; when they were, cold cereals were preferred to the more iron-rich hot cereals. The protein food at breakfast was taken by only a small percentage of the girls and was not taken by them consistently. Any substitute for the main hot meal at dinner lowered the nutrient levels in the daily intake for only the main hot dish provided an ample serving of meat, potatoes and vegetables. The iron intake of the group could no doubt be raised considerably through education in a more adequate selection of foods from the available supply.

Beverages were taken at meal times and as snacks. The milk consumption was surprisingly high. The girls received an average of 13.4 ounces of milk a day. Reynolds et al.(61) found an average milk consumption of eight ounces a day among 360 Wisconsin students. Chocolate milk was taken by 15 of the residence girls with an average daily intake of 4.4 ounces. On the whole, seventeen times as much plain homogenized milk as chocolate milk was used. No skimmed milk was served in the dining hall. It would be interesting to see if the milk consumption would increase if skimmed milk were included since there appeared to be several "calorie-conscious" girls in the survey population. Coffee was consumed by 73 girls and tea by only 34. Very small amounts of either beverage were taken. Coffee drinking averaged only 1.2 cups a day and tea only 0.6 cups a day. The low consumption of tea and coffee and the high consumption of milk may be surprising. However, it is well to remember that all the beverages were available at each meal and milk does not cool off on a tray like coffee and tea do. It is possible the milk consumption might not be as high if these same girls ate their meals at home.

All the foods taken as snacks by the 80 girls during the 7-day study period are presented below.

Foods taken as snacks	Amount in 7-day period
Cake, cookies, tarts, pie	248 servings
Bread, rolls, quickbreads	202 servings
Fruit, fresh and juice	196 servings
Soft drinks	131 bottles
Doughnuts	82 single
Ice cream	57 servings
Hot chocolate	55 cups
Meat - plain or in sandwiches	48 servings
Chocolate patties and bars	37 single
Candy	34 servings
Cheese	16 servings
Popcorn	14 boxes
Milkshakes	12 milkshakes
Hot dogs	11 single
Peanut butter	11 servings
Hamburgers	7 single
French fries	7 servings
Honey	5 servings
Soup	4 servings
Cheesecake	3 servings
Buttermilk	2 cups
Fish and chips	1 serving
Ravioli	1 serving
Chinese food	1 serving

Starch foods from the bread and cake families led the list of snack foods. These items were taken often because they were relatively inexpensive to purchase and were often sent to the girls in food parcels. It was possible to keep cookies, tarts, quickbreads, etc. in the residence rooms without fear of rapid spoilage.

There was a high consumption of fresh fruits and fruit juices. Apples and oranges could be purchased at coffee shops on the campus or could have been received in food parcels. Two of the girls bought cans of frozen concentrated orange juice and kept these on hand.

Soft drinks were taken for snacks at an average of over 1 1/2 bottles per person per week. Two girls had nine bottles a week. Doughnuts averaged one a week per person. The consumption of chocolate bars and candy was not high. Half of the girls did not have any of either one during the survey week. It appeared that sandwich fillings were kept by the girls in their rooms. These fillings included honey, peanut butter, meat spreads and cheese.

The amount of snacking is bound to be considerable among residence students for social meetings center in the coffee shops or in residence rooms where food parcels have been received. It is also to be expected that some of the girls will use eating instead of non-food satisfactions to deal with the tensions they experience away from home.

H. LIMITATIONS IN SURVEY

It is difficult to calculate the level of nutrients supplied in a diet from the food intake record kept by a subject. In addition to the errors that each person may make in recording all the foods eaten and in estimating the measures they were taken in, further errors may arise if foods assessed are not exactly the same as those listed in food composition tables or if mixtures are taken which are difficult to analyze.

The usefulness of blood and urine analyses and physical measurements, including skinfolds, in evaluating nutritional status is not definitely known. Much work remains to be done in this field before survey results are homogeneously assessed by different workers.

It was not possible to give each girl a medical examination as part of the survey. Instead, it was assumed that the results of the medical examination given on entry into the university were still valid. It would have been better if medical examinations were included as part of the survey. Findings may have given information to interpret some of the low nutrient levels in the blood and may have singled out symptoms of low nutrient intake levels.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

1. Intake levels were generally satisfactory in protein, fat, calcium, phosphorus, thiamine, riboflavin and niacin. No diet was low in ascorbic acid.
2. Iron ranked first and calories second in the nutrients most inadequately supplied. The other nutrients in decreasing order of the extent they were found deficient in the diets were: vitamin A, riboflavin, calcium, protein, thiamine, phosphorus and niacin.
3. It would seem more correct to classify university girls as "Sedentary" rather than "Moderately active".
4. Home Economics girls appeared to have more nutritionally adequate diets than girls from the other faculties represented in the survey.
5. Blood levels of hemoglobin, vitamin A and ascorbic acid were below average in 70% or more of the girls. The level of carotene was low in 15% of the girls and the level of protein was not below average in any girl.
6. Thirteen to 23% of the girls had low body stores of thiamine, riboflavin or niacin as shown by no excretion of these vitamins in the urine.

7. Anthropometric measurements revealed that less than half the girls were within the normal weight range and that more girls were underweight than overweight. The skinfold measurement taken just under the scapula correlated most closely with the degree of overweight or underweight.
8. Ten per cent of the total meals were skipped and the meal most frequently omitted was breakfast. A large number of snacks were taken, particularly in the evenings. Food preferences indicated a need for greater knowledge in the selection of an adequate dietary.

B. RECOMMENDATIONS

1. Improvement in the nutritional status of the survey group.

Since an adequate food supply was available, it appeared that the level of nutrient intake would need to be raised by:

a) Allowing less choice in the selection of foods.
b) Launching a program to educate the students in the selection of a more adequate dietary.
c) Carrying out a detailed survey to determine the food preferences of the group served.

If the first method listed were adopted, the foods which would be served less frequently would be dry cereals, white bread and main course substitutes for the hot meal at dinner. It may have been wiser to serve the large meal at supper when there was not the choice of less nutritious main course foods such as luncheon dishes, salads and sandwiches.

Most students are not interested in Nutrition as a subject but they are interested in what good nutrition will do for them. It is the latter angle that should be stressed in any education program. Posters with nutrition information could be placed in the dining room or similar information could be stamped on the paper tray covers. Since the residence students hold regular meetings, it would not be difficult to organize discussion or lecture groups to give information on nutrition and to stress the importance of an adequate diet.

A survey to determine food preferences would accomplish two goals at once. It would give the dietitians knowledge of the foods students would like to see served and it would make the students more conscious of the importance of the foods they select. This consciousness would create a psychological readiness for any information conveyed on posters or tray covers or through meetings.

2. Need for similar studies.

It would be interesting to learn what the nutritional status is of university women at other Canadian university residences. Further information on meal patterns and food preferences would help in the food servicing and education of university groups.

Studies comparing the nutritional adequacy of diets of girls living in different types of accommodation outside the university to that of girls living in residence would also be informative. It is possible that the nutritional status of residence groups is superior to that of other students because the residence food supply is planned and served by a dietary staff. Quite often there is not the same freedom of choice in foods at a residence as there is away from it.

Studies of other population groups in Winnipeg and its surrounding area may reveal patterns of nutrient intake which are characteristic of this geographical area and its racial and religious groups.

3. Accessory study.

When people are asked to keep records of their food intake, there is the possibility that they may not be honest in writing down their actual intake or that they may have difficulty in estimating the size of servings accurately. For example, do overweight people fail to write down all the food they eat and do they under estimate the size of their servings? Do underweight people have the opposite tendencies? This problem could be studied by pairing overweight and underweight people and having them estimate the amounts of food they think the other person eats and the amounts of food they think they eat themselves. A third person could weigh the servings given and the foods left on the plates. This may prove that the present method of having people write down their own food intake gives considerable error if those persons are above or below the average weight range.

CHAPTER VI

SUMMARY

A nutrition survey was carried out with 84 girls from the Women's Residence at the University of Manitoba in the spring of 1956. The purpose of the survey was to assess the nutritional status of this group by means of 7-day food intake records kept by the girls, urine and blood analyses and measurements of height, weight, age and skinfold thicknesses. The nutritional adequacy of the available residence food supply was also calculated.

Nutrient levels in the foods entered on the food intake sheets and in the residence food supply were calculated by using food composition tables. Evaluation of the nutritional adequacy of the diets and food supply was made on the basis of Canada's recommended allowances for this age group of 16 to 23 years. Meal patterns, food preferences and the extent of snacking were also studied from the individually-kept food intake records.

The Federal and Provincial Laboratories cooperated in the work to determine the levels of hemoglobin, protein, vitamin A, carotene and ascorbic acid in the blood and to test for the presence of thiamine, riboflavin and niacin in the urine. These nutrient levels were correlated with those in the food intake.

Measurements were taken of height, weight, age and skinfold thicknesses at three sites, the upper arm, under the scapula and above the ileum crest. These figures were used to determine the extent of underweight and overweight and the correlation with skinfold measurements. Canada's Table of Average Weights for Women was used in this evaluation.

The analysis of nutrient intake levels revealed that the girls generally received adequate supplies of protein, fat, calcium, phosphorus, thiamine, riboflavin, niacin and ascorbic acid. Iron was the nutrient most poorly supplied in the diets. Sixty-seven of the 84 girls received less than 12 mg. of iron a day. Calories ranked second in the nutrients most inadequately supplied. Three-quarters of the girls did not meet their recommended allowances in calories. No other nutrients were supplied in even half such insufficient amounts in the diets. The other nutrients in decreasing order of the number of times they were found poorly supplied were: vitamin A, riboflavin, calcium, protein, thiamine, phosphorus and niacin. No diet had less than the recommended amount of ascorbic acid.

The food supplied in the residence dining hall contained each of the nutrients studied at levels well above the requirements of any girl in the survey population. Each girl could have met her recommended allowances in each nutrient if she had used better judgment in selecting foods.

The low intake levels of calories and iron require special consideration. Although the average caloric intake was generally below the recommended allowance, the figures found in this group agree well with those found for similar groups of college women by other workers. It is suggested that college women would be more correctly classified as "Sedentary" rather than "Moderately active". The low iron intake may be partly explained by the preference shown for low-iron foods when a choice could be made.

When the nutritional adequacy of the diets of the girls from different faculties was compared, it was found that the Home Economics girls seemed to have more satisfactory intake levels in each nutrient studied.

Blood analyses showed that 70% or more of the girls had below average levels of hemoglobin, vitamin A and ascorbic acid. Only 15% had below average readings in carotene and no girls had low protein readings. It is difficult to account for the large number of low readings. Although iron was poorly supplied in the diets, vitamin A was in better supply and the intake of ascorbic acid was excellent. Since no significant correlation was found between blood and dietary nutrient levels, it is assumed that other factors influence blood levels beside the nutritional adequacy of the diet.

Thirteen to 23% of the girls had insufficient body levels of thiamine, riboflavin or niacin as evidenced by no excretion of these vitamins in the urine. Since this was usually found in the presence of an adequate dietary supply, it is suggested that these girls may require greater than average intake levels of the three B vitamins in order to maintain average body levels.

Physical measurements showed that less than half the girls were within the normal weight range. Although 36% of the group appeared to be underweight, it must be remembered that the Canadian average figures do not take the width of the frame into account. The skinfold measurement taken under the scapula was superior to those taken at the arm or above the ileum crest in correlating with degrees of overweight or underweight.

The study of meal patterns revealed that 10% of the meals were skipped altogether and the meal most frequently omitted was breakfast. The girls who skipped breakfasts took three times as many mid-morning snacks as those who did not. Over half of the total snacks were taken in the evening. The snacks provided two times as much carbohydrate as protein and also considerably more fat than protein. Foods from the bread and cake families and fruit were most frequently taken as snacks.

There was a surprisingly high consumption of milk and a low intake of coffee and tea. When there was a choice, the girls seemed to prefer the foods which were not as high in iron, e.g. white bread was preferred to whole wheat bread, dry cereal was preferred to cooked cereal, and the main hot meal was taken only half the time during the week.

In view of the adequacy of the food supply, the nutritional levels of the diets could be raised by allowing less freedom in the choice of foods or by educating the girls in the selection of a more nutritionally adequate diet.

It is hoped that the results of this survey will help those who are responsible for the food service in university dining halls and those who are carrying out studies with similar groups of girls. The findings on meal patterns and food preferences should aid programs for the re-education of food habits where that need is indicated.

APPENDIX A

FORMS AND DATA RELATED TO THE EXPERIMENTAL PROCEDURE

FOOD INTAKE RECORD

Room No. ______ Survey No. ____

Name : ________________________

Date : ________________________

Faculty : __________ Year ______

Instructions:

1. Please keep a record of all the food you eat at meals and between meals for seven days.

2. Describe each food and state the amount as accurately as possible.

Example:

Food	Description	Amount
Milk	Chocolate	1 glass (8 oz.)
Egg	Fried	1 egg
Sandwich: Bread	White	2 slices
Butter		2 teaspoons
Peanut butter		2 tablespoons
Roast beef	Lean	1 slice (4" x 3" x 1/4")

3. Name all food accompaniments, describe them and state amounts. This includes gravies, sauces, the sugar and/or cream used on puddings, in beverages, on cereals, etc.

Example:

Food	Description	Amount
Puffed wheat		3/4 cup
Sugar	White	2 teaspoons
Milk	Whole	1/2 cup
Ice cream	Vanilla	1/2 cup
Sauce	Butterscotch	3 tablespoons

4. State whether each meal was eaten in residence or elsewhere by circling R for residence and O for outside residence.

5. If you do not eat a meal anywhere, write the word "nothing".

6. Try to record your intake as soon as possible after eating.

7. If you need any help in keeping the record or have any questions to ask about the survey, come to see me, Lin Miller, in Room 417. If I am not in, leave your name on the sheet posted on the door and I will call on you.

Question:

Did you have a cold or any other infection during the time you kept the food intake record? Yes ___ No ___
Describe:

Sample of the Sheets used to record the Actual Food Intake
(7 sheets for each record)

Day: ____________________ Date: _____________

MEAL	FOOD	DESCRIPTION	AMOUNT
Breakfast			
R O	Space for record		
Dinner			
R O	Space for record		
Supper			
R O	Space for record		
Snacks			
Time	Space for record		

Please write the time of day you had each snack to the left of the snack.

Form used for the Calculation of Daily Nutrient

Levels from the Food Intake Records

Day: ____________________

Name: ____________________ Survey No. ________

Food	Amount	Calories	Protein gm.	Fat gm.	Carbohydrate gm.	Calcium gm.	Phosphorus gm.	Iron mg.	Vitamin A	Thiamine mg.	Riboflavin mg.	Niacin mg.	Vitamin C mg.
Totals													

Form used to calculate Average Daily Nutrient Intakes

Name: ______________________ Survey No. ______

Day	Calories	Protein gm.	Fat gm.	Carbohydrate gm.	Calcium gm.	Phosphorus gm.	Iron mg.	Vitamin A I.U.	Thiamine mg.	Riboflavin mg.	Niacin mg.	Vitamin C mg.
1												
2												
3												
4												
5												
6												
7												
Totals												
Averages												

Sample of the Record kept of the Residence Food Supply

Day: ______________ Date: ______________

Meal	Menu	Measure	Weight (gm.) I	II	III	Av.	Cost $
B	Grapefruit, fresh	1/2 gpft.	212	264	208	228	.07
	Sugar on fruit	1 1/2 t.				30	

Record of Residence Food Supply (continued)

Meal	Menu	Measure	Weight(gm.) I	II	III	Av.	Cost $
B	Puffed rice	1 cup				20	.15
	Brex	2/3 cup				160	.15
	Sugar on cereal	1 1/2 t.				30	
	Poached eggs	1 egg	46	44	44	45	.10
	Toast, white and brown	1 slice				30	.03
	Butter	1 pat				7	.02
	Jam	1 T.	25	25	24	25	.02
	Tea - cup						.05
	pot						.10
	Coffee	1 cup					.07
	Cream for beverage	3 tbsp.				36	
	Sugar for beverage	2 t.				40	
	Milk	10 oz.					.06
D	Juice - blended	4 oz.				100	.07
	tomato	4 oz.				84	.07
	Vegetable soup	3/4 cup					.05
	Mixed grill - sausage	1 med.	16	19	15	17	
	liver	1 pce.	56	50	60	55	
	bacon	1 strip	24	26	20	23	.40
	French fries	2/3 cup	80	83	74	79	.10
	Harvard beets	1/2 cup	76	74	80	77	.06
	Macaroni and cheese	1 cup	290	302	315	302	.18
	Blueberry muffins	1 muff.	57	62	63	61	.07
	Butter	1 pat				7	.02
	Salad bowl -						
	cottage cheese	3 T.	42	48	36	42	
	pineapple jello	1/2 cup				128	
	salad dressing	1 T.				15	
	lettuce bed	1/2 cup				30	.20
	Egg side salad -						
	hard cooked egg	1 egg				50	
	celery heart	1 hrt.				60	
	salad dressing	1 T.				15	
	lettuce bed	1/2 cup				30	.15
	Small waldorf salad -						
	apples					50	
	celery					40	
	walnuts					8	
	salad dressing	1 T.				15	.10
	Sandwiches -						
	egg						
	sliced ham						
	roast beef						
	salmon						.15

Record of Residence Food Supply (continued)

Meal	Menu	Measure	Weight (gm.) I	II	III	Av.	Cost $
D	Salad plate -						
	potato salad					47	
	salad dressing	1 T.				15	
	Cottage cheese					78	
	carrots					10	
	asparagus tips					16	
	cucumber wedge					28	
	black olives					3	
	raisin bread					15	
	celery heart					60	
	lettuce bed					35	.30
	Apple pie	1/8 pie				110	.10
	Blueberry pie	1/8 pie				112	.10
	Apple cheese crisp	1/2 cup				108	.07
	Jello	1/2 cup					.07
	Fruit cup-	1/2 cup					.07
	banana					25	
	grapefruit					25	
	apple					34	
	grapes					38	
	Ice cream	1/3 cup				70	.05
	Tea - cup						.05
	pot						.10
	Coffee	1 cup					.07
	Milk	10 oz.					.06
S	Soup (from dinner)						.05
	Shepherd's pie -						
	minced beef and pork					80	
	mashed potatoes					100	.27
	Mustard relish					30	
	Boiled carrots	1/3 cup	76	76	84	79	.06
	Salad - radishes					10	
	green onions					5	
	cabbage					35	
	French drsg.	1 T.				15	.06
	Canned pears	1/2 pr. & jce.	76	81	80	79	.07
	Sugar cookies	2			40		.05
	Tea - cup						.05
	pot						.10
	Coffee	1 cup					.07
	Milk	10 oz.					.06

Calculation of Nutrient Levels from a Recipe

Recipe: Squash Buns

Servings: 160

Foods	Measure	Cals.	Pro. gm.	Fat gm.	CHO gm.	Ca. gm.	P. gm.	Fe mg.	Vit. A I.U.	Vit. B_1 mg.	Vit. B_2 mg.	Vit. B_3 mg.	Vit. C mg.
Milk	48 oz.	918	49.8	49.8	69.6	1.668	1.314	1.2	2280	.54	2.40	1.2	12
Fat	12 oz.	1002		343.2									
Sugar	12 oz.	1311			338.4								
Pumpkin	1 1/2 lb.	125	4.1	.8	26.6	.102	.102	2.7	1770	.35	.62	5.4	116
Flour	8 3/5 lb.	13700	467.8	46.4	2770.1	.662	3.982	31.0		3.10	1.20	31.0	
Eggs	4 eggs	288	22.8	20.4	1.2	.096	.376	4.8	2040	.16	.52		
Totals		17414	544.4	460.6	3205.9	2.528	5.774	39.7	6090	4.15	4.74	37.6	128
Per serving		109	3.5	2.9	20.4	.016	.037	.3	39	.02	.03	.2	1

Directions for taking Blood Specimens

1. Cleanse finger with alcohol and puncture with a No. 11 scalpel blade or any preferred method.

2. Three quarters fill 2 four inch lengths of polyethylene tubing by touching horizontally to the drop of blood on the finger. The tubing will fill by capillary action. Glass capillary tubes may be used and sealed with plicene cement. Plastic tubing may be held rigid by fastening to a wooden applicator stick with cellulose tape.

3. The ends of the tubing are heat-sealed by pinching with forceps warmed in an alcohol lamp or candle flame. An identifying label is attached with adhesive tape.

4. Allow the blood to coagulate.

5. Centrifuge until the blood is well separated.

6. Pinch the plastic tubing with warm forceps just above the junction of the red cell layer and the serum. This seals the serum in its own plastic container, preventing contamination.

7. If ascorbic acid (Vitamin C) is to be analyzed, freeze solid on dry ice. For other tests freezing is not necessary. Dry ice may be obtained from branch offices of the Liquid Carbonic Corp. and some dairies and universities.

8. Send or deliver to your Provincial Laboratory with completed request form, unless they have authorized direct shipment. Ship in returnable thermos flasks, half filled with dry ice by "air cargo collect" to Dr. L.B. Pett, Room 719 Jackson Bldg., Dept. of National Health and Welfare, Ottawa, Ontario. Samples from officers of the Indian and Eskimo Health Services are shipped directly to Ottawa, not through Provincial Laboratories and must also contain Request forms.

<u>Note</u>: If venous blood is used, a sample of the clear serum may be drawn directly into the polyethylene tubing and sealed off in a similar manner to above.

Directions for taking Urine Specimens

At 7 a.m. or one hour before breakfast void and discard the morning specimen; then drink a large glass of water. At 8 a.m. or one hour later, collect a specimen of urine. Put at least 10 c.c. in a clean brown bottle and stopper tightly. No freezing or preservative is needed. Ship as described above.

Form used for Physical Record

Room No. ________ Survey No. ____

Name: ______________________________________

Home Address: ____

____

Age _______ Height _______ Weight ______ Correct weight ___

Skinfold Measurements: Upper arm ________________

Ileum crest ________________

Below scapula ________________

Directions for taking Skinfold Measurement

Using 1953 Minnesota Skin Calliper

Prepared Feb., 1953.
By Nutrition Division, D.N.H. & W.

1. The back of the upper arm, midway between the shoulder and elbow, is the preferred site. With person standing and arm bare, you stand behind them.

2. Relax the muscles and bend the elbow slightly.

3. Pinch and lift up a fold of skin plus adherent tissue, the fold running the long way of the arm. Choose a spot well to the back.

4. Hold the callipers in the right hand. Make sure the toggle shift is straight out from the shaft.

5. Open calliper jaws wide, and choose a site about 1 cm. away from the finger-thumb pressure.

6. Close the callipers until the pointer moves to the mark (constant pressure).

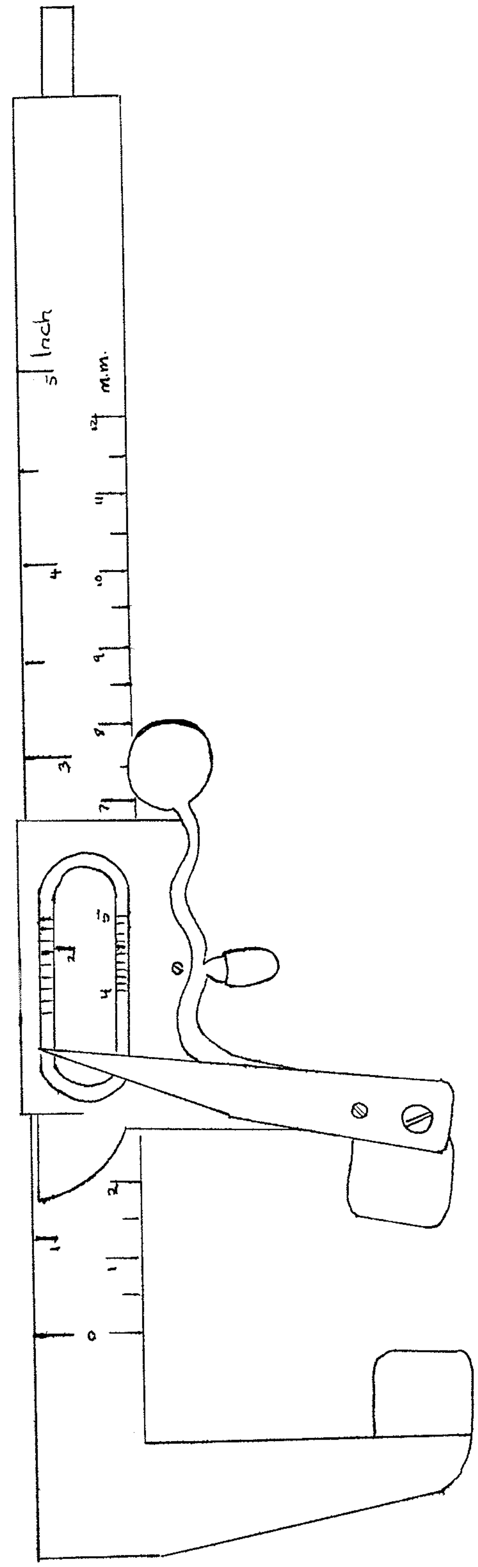
7. Read the lower scale (millimeters) to the nearest millimeter.

8. Holding the callipers in the same position (approximately) open and close them three times, reading each result.

Do this quickly. Use only the median number; for example, the number 25 in each of the following series: 25, 35, 23; 35, 23, 25; 25, 25, 35. Open the callipers wide and remove from the arm.

9. Subtract 20 mm. from the median measurement and record.

Diagram of the Callipers used for Skinfold Measurements.



Sample of the Letter sent to Each

Volunteer in the Survey

Dear Volunteer:

Here is the picture of your nutritional status as found through the nutrition survey you participated in.

		Yours	Recommended
Height		________	____________
Weight		________	____________
Skinfolds:	Upper arm	________	____________
	Scapula	________	____________
	Ileum crest	________	____________

Conclusions:

Nutrient Levels

Nutrient	Daily Intake	Recommended Level	Difference	Lab Tests	Recommended Level
Calories					
Protein					
Fat					
Carbohydrate					
Calcium					
Phosphorus					
Iron					
Vitamin A					
Thiamine					
Riboflavin					
Niacin					
Vitamin C					

Letter (continued)

Conclusions:

I wish to thank you sincerely for taking part in the survey. Your willingness to help me and the interest you displayed throughout it have been greatly appreciated. If you have any questions you would like to ask concerning the survey, I will be pleased to answer them. Either write to me at the Dietary Dept., University Hospital, Saskatoon or contact me at the School of Home Economics this fall.

Thanks again.

Yours sincerely,

Lin Miller

Recommendations (if any) are on back of sheet.

APPENDIX B

Average Levels of Nutrient Consumption among College Women (From a review by Greenwood and Lonsinger(22,23) unless otherwise stated)

Author	Year	Subjects No.	Subjects Age years	Nutrients Cals.	Nutrients Pro. gm.	Nutrients Ca. gm.	Nutrients Fe. mg.	Nutrients P gm.	Method of study	No. of days	Place of study
Coons & Schiefelbrusch	1932	18	College	1990	56.0	0.93		1.19	Weighed, analyzed	4-7	Oklahoma
Hetler	1932	85	19-37	1700	55.0				Food records calculated	3-7	Univ. of Ill.
Goddard et al. (Period 1)	1934	89	17-25	3699	57.5	0.51	13.0	1.34	Inventory calculated	8	Univ. Calif.
Goddard et al. (Period 2)	1934	89	17-25	2501	75.0	0.75	13.0	1.15	Inventory calculated	8	Univ. Calif.
Wheeler & Mallory	1935	28	College	2397	70.0	0.92	11.8	1.32	Inventory calculated		Vassar Coll.
Morris & Bowers	1939	100	College	1805	60.7	0.72	8.8	1.10	Food records calculated	7	Utah State Coll.
Leverton & Marsh	1942	69	16-27		59.2	0.84	10.4	1.30	Weighed, analyzed	7	Univ. of Nebraska
McKay et al.	1942	124	College		63.1	0.94		1.18	Weighed, analyzed	7-10	Univ. of Nebraska
Greenwood & Lonsinger	1942	203	College	2016	64.6	0.83	10.3	1.18	Food records calculated	7	Kansas State & Iowa State Coll.

Average Levels of Nutrient Consumption among College Women (continued)

Author & Place	Year	Subjects		Nutrients				Method of study	No. of days	Vit. A I.U.	Vit. B_1 mg.	Vit. B_2 mg.	Vit. B_3 mg.	Vit. C mg.
		No.	Age yrs.	Cals.	Pro. gm.	Ca gm.	Fe mg.							
McMillan & Leverton (Univ. of Nebraska)(43)	1943	8	Coll.	1728	60.0	0.94		Inventory calculated	7		1.30	1.80	11.3	74
Barker(3)(McGill Univ.)	1945	100	Coll.	3272	123.6	1.19	18.68	Foods available at residence		7005	1.71	3.98		94
Young(75) (Cornell Univ.)	1946	18	Coll.	2243	76.3	1.14	13.62	Food record calculations	7	9866	1.23	2.30		110
Scoular & Foster (63) (Texas State Teachers' Coll.)	1946	106	15-25	2428	96.5	1.41	20.00		14	8064	2.70	2.70		110
Hoover & Coggs(29) (Tuskegee Coll.)	1948	50	Coll.	1940	75.0	0.79	11.65	Food record calculations	4	10423	1.07	1.39		124
Present study (Univ. of Man.)	1956	84	16-23	2232	73.7	0.98	10.56	Food record calculations	7	5726	1.03	1.71	12.2	90

Nutrient Levels in the Residence Food Supply

Foods served	Nutrients											
	Cals.	Pro. gm.	Fat gm.	CHO gm.	Ca gm.	P gm.	Fe mg.	Vit. A I.U.	Vit. B_1 mg.	Vit. B_2 mg.	Vit. B_3 mg.	Vit. C mg.
<u>Breakfast</u>												
Fruit	46	.6	.2	11.8	.018	.018	.4	166	.04	.03	.3	30
Cereal	116	3.6	.7	25.0	.013	.120	1.3		.09	.03	1.9	
- sugar	32			8.3								
- milk	76	4.1	4.1	5.8	.139	.109	.1	190	.04	.20	.1	1
Meat or eggs	111	5.8	9.2	.5	.019	.085	1.1	335	.07	.08	.4	
Bread (2 slices)	144	5.6	1.6	29.4	.030	.158	1.4		.10	.06	2.0	
Butter	54	.5	6.1	.5	.002	.001		250				
Jam	70	.1	.1	17.8	.002	.002	.1					1
Hot beverage												
- cream	60	1.6	5.0	2.2	.055	.044	.5	210	.02	.08	.5	1
- sugar	32			8.3								
Totals	741	21.9	27.0	109.6	.278	.537	4.9	1151	.36	.48	5.2	33
<u>Dinners</u>												
1. Soup	111	4.9	4.3	15.3	.072	.081	.7	180	.05	.09	.7	4
Main hot plate	513	24.9	27.8	37.5	.074	.309	4.0	4043	.39	.39	5.9	23
Bread (1 slice)	72	2.8	.8	14.4	.015	.079	.7		.05	.03	1.0	
Hot bread	147	4.0	4.1	23.4	.050	.063	.6	10	.06	.07	.6	
Butter	54	.5	6.1	.5	.002	.001		250				
Dessert	210	3.3	8.1	29.7	.059	.056	.7	347	.04	.09	.3	4
Hot beverage												
- cream	60	1.6	5.0	2.2	.055	.044	.5	210	.02	.08	.5	
- sugar	32			8.3								
Totals	1199	42.0	56.2	131.3	.327	.633	7.2	5040	.61	.75	9.0	32

Nutrient Levels in the Residence Food Supply (continued)

	Foods served	Cals.	Pro. gm.	Fat gm.	CHO gm.	Ca gm.	P gm.	Fe mg.	Vit. A I.U.	Vit. B_1 mg.	Vit. B_2 mg.	Vit. B_3 mg.	Vit. C mg.
2.	Juice	36	.5	.1	9.1	.008	.012	.3	275	.04	.02	.3	23
	Large salad plate	308	15.2	10.9	40.4	.105	.208	1.2	1281	.18	.27	3.1	41
	Hot bread	147	4.0	4.1	23.4	.050	.063	.6	10	.06	.07	.6	
	Butter	54	.5	6.1	.5	.002	.001		250				
	Dessert	210	3.3	8.1	29.7	.059	.056	.7	347	.04	.09	.3	3
	Tea - cream and sugar	92	1.6	5.0	10.5	.055	.044	.5	210	.02	.08	.5	1
	Totals	847	25.1	34.3	113.6	.279	.384	3.3	2373	.34	.53	4.8	69
3.	Soup	111	4.9	4.3	15.0	.072	.081	.7	180	.05	.09	.7	4
	2 sandwiches	628	26.4	30.8	65.8	.170	.376	3.2	902	.32	.32	5.6	2
	Egg salad	114	7.6	7.7	5.4	.045	.117	1.5	1350	.08	.25		7
	Dessert	210	3.3	8.1	29.7	.059	.056	.7	347	.04	.09	.3	4
	Tea - cream and sugar	92	1.6	5.0	10.5	.055	.044	.5	210	.02	.08	.5	1
	Totals	1155	43.8	55.9	126.4	.401	.674	6.6	2989	.51	.83	7.1	18
4.	Juice	36	.5	.1	9.1	.008	.012	.3	275	.04	.02	.3	23
	1 sandwich	314	13.2	15.4	32.9	.085	.188	1.6	451	.16	.16	2.8	1
	Salad bowl	139	9.9	2.7	22.1	.065	.110	.7	358	.06	.20	.2	5
	Hot bread	147	4.0	4.1	23.4	.050	.063	.6	10	.06	.07	.6	
	Butter	54	.5	6.1	.5	.002	.001		250				
	Dessert	210	3.3	8.1	29.7	.059	.056	.7	347	.04	.09	.3	4
	Tea - cream and sugar	92	1.6	5.0	10.5	.055	.044	.5	210	.02	.08	.5	1
	Totals	992	33.0	41.5	128.2	.324	.474	4.4	1901	.38	.62	4.7	34

Nutrient Levels in the Residence Food Supply (continued)

Foods served	Cals.	Pro. gm.	Fat gm.	CHO gm.	Ca gm.	P gm.	Fe mg.	Vit. A I.U.	Vit. B_1 mg.	Vit. B_2 mg.	Vit. B_3 mg.	Vit. C mg.
5. Soup	111	4.9	4.3	15.0	.072	.081	.7	180	.05	.09	.7	4
2 sandwiches	628	26.4	30.8	65.8	.170	.376	3.2	902	.32	.32	5.6	2
Small salad	85	2.1	5.1	9.8	.053	.054	.8	1203	.08	.09	.4	23
Hot bread	147	4.0	4.1	23.4	.050	.063	.6	10	.06	.07	.6	
Butter	54	.5	6.1	.5	.002	.001		250				
Dessert	210	3.3	8.1	29.7	.059	.056	.7	347	.04	.09	.3	4
Tea - cream and sugar	92	1.6	5.0	10.5	.055	.044	.5	210	.02	.08	.5	1
Totals	1327	42.8	63.5	154.7	.461	.675	6.5	3102	.57	.74	8.1	34
6. Juice	36	.5	.1	9.1	.008	.012	.3	275	.04	.02	.3	23
Luncheon dish	346	14.0	19.7	28.1	.161	.249	2.0	1231	.10	.22	2.2	6
Hot bread	147	4.0	4.1	23.4	.050	.063	.6	10	.06	.07	.6	
Butter	54	.5	6.1	.5	.002	.001		250				
Small side salad	85	2.1	5.1	9.8	.053	.054	.8	1203	.08	.09	.4	23
Dessert	210	3.3	8.1	29.7	.059	.056	.7	347	.04	.09	.3	4
Tea - cream and sugar	92	1.6	5.0	10.5	.055	.044	.5	210	.02	.08	.5	1
Totals	970	26.0	48.2	111.1	.388	.479	4.9	3526	.34	.57	4.3	57
<u>Supper</u>												
Soup	111	4.9	4.3	15.0	.072	.081	.7	180	.05	.09	.7	4
Main hot dish	540	19.3	32.2	37.5	.148	.208	3.8	1739	.32	.32	4.8	27
Bread (1 slice)	82	2.6	1.0	15.5	.024	.028	.2		.02	.03	.3	
Butter	54	.5	6.1	.5	.002	.001		250				
Dessert	247	3.7	7.0	41.7	.065	.075	.7	322	.06	.09	.5	6
Milk (10 oz.)	191	10.4	10.4	14.5	.348	.274	.3	475	.11	.50	.3	3
Totals	1225	41.4	61.0	124.7	.659	.667	5.7	2966	.56	1.03	6.6	40

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