THE UNIVERSITY OF MANITOBA

AN EVALUATION OF THE ABILITY OF FOOD GUIDES TO RECOMMEND A DIETARY INTAKE WHICH WILL MEET THE 1975 CANADIAN DIETARY STANDARD RECOMMENDATION FOR IRON

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by

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A dissertation submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

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Twenty-four hour dietary intakes were collected from a non-random sample of 2,925 volunteers participating in ReNu, a recreation-nutrition project. These individuals were classified into the ten physiological groups outlined in the 1975 Canadian Dietary Standard for iron. The individuals' dietary intake was given a score in each of the four Food Groups of the ReNu Food Guide. Then the milligrams of iron contained in each dietary intake were calculated. A regression equation was developed using the four Food Group scores as the independent x variables, and the milligrams of iron contained in the diet as the dependent y variable. The average milligrams of iron contained in a diet including the recommended number of servings of foods in each of the four Food Groups was predicted, using the regression equation, for each of the ten physiological groups. These calculations were performed to determine if a diet including the food consumption recommendations of the Food Guide would subsequently contain an average iron level which meets the recommendations of the 1975 Canadian Dietary Standard. The predictions indicated that only the diets of adult men and adult women over 50 years of age including the recommended foods would supply an average iron level which meets the 1975 Canadian Dietary Standard. The diets of the other physiological groups were predicted to contain an average iron level below the 1975 Canadian Dietary Standard. The physiological groups that were predicted to be

least able to meet their iron recommendations were adult women under 50 years of age, and adolescents, especially female. If these groups are unable to meet their iron requirements by following Food Guide recommendations, then perhaps other means need to be investigated to increase their dietary status.

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INTRODUCTION

The aim of nutrition education is to teach the principles of a well balanced diet. A well balanced diet could be defined as one which contains the needed amounts of the essential nutrients. It includes the kinds and amounts of foods which supply the needed quantity of the essential nutrients. A food guide consists of foods with similar nutrient content placed into groups, and then recommendations are made concerning the number of servings of foods from each of the groups that should be consumed by an individual in order that the required amount of the essential nutrients is provided. The foods included in food guides are labelled as protective foods, since they make the largest contribution of essential nutrients to the diet. Food guides have been developed to promote a pattern of food consumption which will ensure an adequate intake of nutrients and conform to existing patterns of food use (McClinton et al., 1971). A food guide will also ensure uniformity in the advice given to the public on the selection of foods (McClinton et al., 1971).

How useful have food guides been in meeting these objectives? It is recognized that the amounts of foods recommended by the guide will not meet the caloric needs of an individual (Stare and McWilliams, 1973). The primary concern of this thesis is whether the food guide fulfills its major objective of promoting a pattern of food consumption which will ensure an adequate intake of nutrients. Can an individual following the recommendations of a food guide be guaranteed that he will receive all the essential nutrients? This thesis examines this question by looking

at one nutrient, iron, in particular.

An inadequate iron intake is one of the most common dietary deficiencies found in the world population. This dietary iron deficiency is not limited to the underdeveloped areas of the world, but is very prevalent in North America. Nutrition Canada (1973), this country's first national nutrition survey, reported the presence of a widespread iron deficiency among both men and women. The survey results specific to Manitoba were similar to the national sample (Nutrition Canada, 1975). The dietary data for Manitoba indicated that women and adolescents had only marginal intakes of iron with a median intake in the range of 10 to 15 milligrams, and only men had adequate iron intakes well in excess of the recommended 10 milligrams (Nutrition Canada, 1975).

A deficit of iron in the diet is not a recent problem. The results of four Canadian Dietary Surveys conducted in 1939-40 reported the existence of extensive dietary deficiencies (Young, 1949). The men surveyed had adequate levels of iron intake, but one-half of the women and one-third of the children had iron intakes below 70% of the 1939 Canadian Dietary Standard (Young, 1949).

The primary cause of this widespread dietary deficiency was thought to be a lack of nutrition knowledge (McHenry, 1939_a; McHenry 1939_b; Pett, 1942_a). People did not seem to be able to select the kinds and quantity of foods that would provide them with the needed amounts of the essential nutrients. Therefore, an educational tool, in the form of a food guide, was developed to serve as a guide to the public in their food selection.

The present widespread incidence of iron deficiency would indicate that either the public has not been consuming the foods recommended by the food guide, or else the recommendations of the food guide are inadequate, as far as iron is concerned. The latter has been suggested as the more likely by Stare and McWilliams (1973). They state in their text that the consumption of food according to the Basic Four[1] will provide adequate amounts of nutrients with the exception of iron and energy.

Canada's Food Guide is the food guide of this nation. It consists of five food groups, and the recommended number of servings are presented in Figure 1. If Canada's Food Guide fulfills its objective of recommending a pattern of food consumption that will ensure an adequate intake of nutrients, then individuals consuming the recommended number of servings of foods in each of the Food Groups should also be receiving the milligrams of iron recommended by the Canadian Dietary Standard. The nutrient recommendations in the Canadian Dietary Standard cover the needs of the majority of the population, therefore consuming a level of iron recommended by the Canadian Dietary Standard will make a dietary deficiency very unlikely.

A calculation of the iron content of a menu based on Canada's Food Guide recommendations should answer this question. Table 1 presents a menu for one day that includes the recommended number of servings from each of the Food Groups. The iron content of this menu is calculated to be nine milligrams. This intake is insufficient to meet the

1 The Basic Four is the food guide of United States containing four food groups.

FIGURE 1

CANADA'S FOOD GUIDE RECOMMENDATIONS

C A N A D A ' S F O O D G U I D E

These Foods Are Good To Eat.
Eat Them Everyday For Health.
Have Three Meals Each Day.

MILK	Children (up to about 11 years)	2½ cups (20 fl.oz.)
	Adolescents	4 cups (32 fl.oz.)
	Adults	1½ cups (12 fl.oz.)
	Expectant & Nursing Mothers	4 cups (32 fl.oz.)
FRUIT	Two servings of fruit or juice including a satisfactory source of Vitamin C such as oranges, tomatoes, vitamized apple juice.	
VEGETABLES	One serving of potatoes Two servings of other vegtables, preferably yellow or green and often raw.	
BREAD and CEREALS	Bread (with butter or fortified margarine) One serving of whole grain cereal.	
MEAT and FISH	One serving of meat, fish or poultry. Eat liver occasionally. Eggs, cheese, dried beans or peas, may be used in place of meat. In addition, eggs and cheese each at least three times a week.	
VITAMIN D	400 International Units, for all growing persons and expectant and nursing mothers.	

APPROVED BY THE CANADIAN COUNCIL ON NUTRITION, 1961

NUTRITION DIVISION, DEPT. NATIONAL HEALTH & WELFARE, CANADA

iron recommendations of the 1975 Canadian Dietary Standard for all physiological groups except women over 50 years of age.

If liver was included in the menu presented in Table 1 , the iron content of the diet would be increased from nine milligrams to fifteen milligrams. This level would,according to the 1975 Canadian Dietary Standard, meet the needs of all physiological groups.

Of course, the menu presented in Table 1 can be criticized because it represents a very basic food intake which does not include either additional servings of the recommended foods, or non-recommended foods, such as cakes and cookies. It would most certainly not meet the caloric needs of an individual. Including sufficient foods in the diet to increase the caloric intake would increase the iron intake, as well. Therefore, instead of looking at the iron content of menus written according to Canada's Food Guide, it would be more appropriate to examine the iron content of diets consumed by a sample of people. Examining the types of foods eaten and the iron content would indicate whether the consumption of a diet including the recommendations of Canada's Food Guide would supply enough iron to meet the recommendations of the 1975 Canadian Dietary Standard.

One sample, although non-random, of individuals for which this type of dietary information was available was the sample of individuals participating in Operation ReNu. Operation ReNu is a recreation-nutrition program sponsored by the Manitoba Department of Health and Social Development. ReNu evaluated the physical fitness levels and dietary status of Manitobans during the summers of 1973, 1974, 1975 and 1976. This thesis utilizes the dietary data collected by the ReNu teams in the summer months of June, July and August in the years 1974 and 1975.

TABLE 1

A ONE DAY MENU BASED ON CANADA'S FOOD GUIDE

	FOOD ITEMS	IRON (MG)[2]
BREAKFAST	1/2 cup rolled oats	0.7
	1/2 cup 2% milk	0.05
	1/2 cup orange juice	0.50
LUNCH	1 sandwich - 2 slices bread	1.2
	1 tbsp. margarine	-
	1-1/2oz. canned salmon	0.35
	50 gm. carrot sticks	0.4
	1/2 cup 2% milk	0.05
SUPPER	*3.6oz. roast beef	3.6
	1 boiled potato	0.6
	57 gm. lettuce	0.3
	1/2 cup broccoli	0.6
	1/2 cup yoghurt	0.05
	1/2 cup raspberries	0.68
	DAILY TOTAL	9.08

* If 3 oz. liver was substituted for the 3.6 oz. of roast beef, the DAILY TOTAL would be increased to 15.48 milligrams.

2 Iron values according to Stare and McWilliams, 1973.

Only the information on individuals 13 years of age and older is utilized. Another study by Barrett (1975) also utilized ReNu data to investigate the relationship between obesity, caloric intake, and level of physical fitness.

Twenty-four hour recalls were collected from the ReNu participants and then the foods listed in the 24-hour recall were separated into Food Groups, and the dietary intake was given a score in each of the Food Groups. The nutrient content of the 24-hour dietary intakes was calculated in order to determine the iron content. This calculation made it possible to determine if individuals attaining the desired score in each of the Food Groups would in turn receive the number of milligrams of iron recommended by the 1975 Canadian Dietary Standard.

REVIEW OF LITERATURE

The Canadian Dietary Standard makes recommendations for the amount of energy and essential nutrients required daily by the population to meet the physiological needs of practically all healthy persons (Canadian Dietary Standard, 1975). The nutrient intake recommendations of the Canadian Dietary Standard are aimed at population groups, not individuals. The Canadian Dietary Standard nutrient intake recommendations should not be used to assess the nutritional adequacy of an individual's diet, since nutrient requirements vary for each individual. However, if an individual's diet does meet the recommendations of the Standard, there is only a small likelihood that a dietary deficiency could develop.

The Canadian Dietary Standard has been used to evaluate the nutritional adequacy of diets. Comparison of dietary intakes to the Standard requires that the nutrient content of the diet be calculated. If Canada's Food Guide could be used to assess the nutritional adequacy of a diet, time consuming nutrient calculations could be omitted. It would be easier to evaluate the foods of the diet against the Food Guide, than to calculate the nutrient content and then compare these results to the Canadian Dietary Standard. Before evaluating dietary intakes with the Food Guide, one would have to know if consuming the recommended number of servings of foods from each of the food groups would supply the nutrient levels specified in the Canadian Dietary Standard.

The following review of literature outlines the history of the development of the Canadian Dietary Standard and Canada's Food Guide; and the results of other investigators when these tools have been used

for evaluating dietary iron intakes.

The nutritional adequacy of the Canadian diet became a concern in the late 30's (Editorial Board, 1941). In 1938 the Department of Pensions and National Health of Canada organized a Division of Nutrition, and a Canadian Council on Nutrition was formed (Editorial Board, 1941; McHenry, 1941). One of the primary objectives of the Canadian Council on Nutrition was to secure accurate information on the food habits of Canadians. Accordingly food consumption data was collected from urban, low income Canadian families in the cities of Halifax, Quebec, Toronto, and Edmonton (Editorial Board, 1941; McHenry, 1939_a). Information was collected on food consumption and money spent on food. There were no physical examinations nor laboratory tests.

It followed that the Canadian Council on Nutrition now needed to approve a dietary standard so the food consumption data could be evaluated for nutritional adequacy (McHenry, 1941). The Council considered the standards set forth by the Health Organization of the League of Nations, but decided that these standards were not applicable to Canadians (Canadian Council on Nutrition, 1945; McHenry, 1941). The Council decided to draw up a dietary standard of their own based on the available scientific information. This first Canadian Dietary Standard of 1939 recommended an iron intake of five milligrams daily for infants; ten milligrams for men and children, one to five years of age; and fifteen milligrams for women and children, five to eighteen years of age (McHenry, 1941; McHenry, 1939_b).

The 1939 Canadian Dietary Standard was used to evaluate the nutritional adequacy of the food consumption data of the four Canadian Dietary Surveys conducted in 1939 to 1940. The dietary intakes were judged to be inadequate if the iron level was less than 70 percent of the daily intake recommended by the 1939 Canadian Dietary Standard. Only a small percentage of the men had an inadequate iron intake, but almost half of the adult women and about a third of the adolescents and children had inadequate iron intakes (Patterson et al., 1941; Young, 1941; Hunter et al., 1941; Sylvestre et al., 1941; Young, 1949). What does comparing the dietary intakes to the Dietary Standard indicate? The people who met the nutrient recommendations of the Standard are not necessarily free from a deficiency, but they have the least likelihood of a nutrient deficiency.

The Council now wondered why dietary deficiencies should exist in a country where it was possible to secure an adequate diet from existing food sources (Editorial Board, 1941). The main factor responsible for inadequate food intakes seemed to be a lack of nutritional knowledge (McHenry, 1939_a; McHenry, 1939_b; Editorial Board, 1939; Patterson et al., 1941; Sylvestre et al., 1941; Editorial Board, 1941; Pett, 1942_a; Pett, 1942_b).

The Canadian Dietary Standard does not serve as a very useful guide to the average citizen for his nutrient intake. The dietary intake recommendations are expressed in terms of nutrients. The scientific nutrient recommendations of the Dietary Standard must be translated into a language that can be better understood by the public. Since the public is more familiar with foods than nutrients, recommendations are needed regarding what types and quantities of

foods should be consumed in order to guarantee an adequate nutrient intake. This need for food consumption guidelines led to the development of food guides.

Canada's first food guide, Canada's Food Rules[3], was originally issued in 1944 (Baxter, 1952; Canadian Council on Nutrition, 1949). Canada's Food Rules placed foods with similar nutrient content together into groups, and then recommended the number of servings of food that should be eaten daily from each of the food groups. The recommendations of Canada's Food Rules are presented in Figure 2.

Copies of Canada's Food Rules were published by the Federal Government, and sent in bulk to Provincial Health Departments for distribution to the public. The usefullness of this food guide was never evaluated. The Canadian Government gave the public 26 years, from 1944 to 1970, to learn and practice the recommendations of the food guide. Then in 1970, the Federal Government began conducting the nation's first national nutritional survey, Nutrition Canada. The aim of this study was to provide precise scientific information on the nutritional status of the Canadian population (Nutrition Canada, 1973). These results could be used to indicate if Canada's Food Guide had been useful in improving the nutrition knowledge and dietary habits of the Canadian public.

Nutritionists collected 24-hour food records from more than 19,000 Canadians of different ages, areas, and incomes (Nutrition Canada, 1973). The nutrient content of the 24-hour dietary intakes were calculated.

3 Canada's Food Rules were later revised and retitled as Canada's Food Guide.

FIGURE 2

CANADA'S FOOD RULES RECOMMENDATIONS

CANADA'S FOOD RULES

These Foods are Good to Eat.

East Them every day for Health.

Have at least Three Meals each Day.

1. MILK

   Children (up to about 12 years).....at least 1 pint
   Adolescents.....at least 1-1/2 pints
   Adults.....at least 1/2 pint

2. FRUIT

   One serving of citrus fruit or tomatoes or their juices; and one serving of other fruit

3. VEGTABLES

   At least one serving of potatoes; and
   at least two servings of other vegtables, preferably leafy, green or yellow and frequently raw.

4. CEREALS AND BREAD

   One serving of whole grain cereal; and
   at least four slices of bread (with butter or fortified margarine).

5. MEAT AND FISH

   One serving of meat, fish,poultry, or meat alternates such as dried beans, eggs and cheese.
   Use LIVER frequently. In addition:
   EGGS and CHEESE at least three times a week each.
   VITAMIN D - At least 400 International Units daily for all growing persons and expectant and nursing mothers.

Approved by the Canadian Council on Nutrition, 1950
Nutrition Division, Department of National Health and Welfare, Ottawa.

The results indicated that a deficit of iron in the diet is more common among women than men (Nutrition Canada, 1973). Approximately seventy-five percent of older adult women had less than desirable dietary intakes of iron (Nutrition Canada, 1973). Less than twenty-five percent of young and middle-aged adult men and about thirty-three percent of older adult men had dietary intakes low in iron (Nutrition Canada, 1973). Inadequate iron intakes were more prevalent among adolescent girls than boys. Seventy percent of adolescent girls and fifty percent of adolescent boys had less-than-adequate and inadequate dietary intakes.

In 1939 and 1940, Canadian Dietary Surveys also reported dietary inadequacies in the nation. An educational tool in the form of Canada's Food Rules was developed to promote a pattern of eating that would supply the essential nutrients. Many years later, in 1973, dietary inadequacies were still reported in the nation (Nutrition Canada, 1973). The development of a food guide has not cured the problem. The occurrence of these dietary inadequacies leads one to believe that people either are not following the recommendations of the food guide, or people are following the guide, but the guide does not meet its objective. In other words, eating the recommended number of servings of food in each of the food groups will not guarantee that one will be receiving the level of iron recommended by the Canadian Dietary Standard.

The ability of the Food Guide to recommend a pattern of food consumption that will subsequently provide the level of nutrient consumption recommended by the Dietary Standard has been investigated in the past. In 1949, the Canadian Council on Nutrition used the recommendations of the Food Guide to write two-week menus for a sedentary man weighing 160 pounds. The average daily intake of nutrients was then

calculated. A few years later, Baxter (1952) did a similar nutrient calculation on a one-day menu for a five-year old boy weighing 40 pounds. The calculated iron intake from these menus is presented in Table 2.

The calculated daily iron intakes for the boy and for the man were 6.19 and 11.8 milligrams, respectively. When these iron intakes are compared to the 1949 Canadian Dietary Standard iron recommendation of six milligrams, both the boy and the man meet the recommendation by consuming a diet based on the food guide recommendations. However, when their daily iron intakes are compared to the 1975 Canadian Dietary Standard recommendation of ten milligrams for the man and nine milligrams for the boy, only the man is able to meet the recommendation. This comparison illustrates one problem with dietary standards. The interpretation of the quality of intakes varies with the standard chosen for comparison (Ferguson et al., 1944). For example in 1952 the boy was considered to have an adequate intake of iron but today his iron intake would be considered less-than-adequate.

The investigations of the Canadian Council on Nutrition (1949) and Baxter (1952) are important not only because they allow one to evaluate the ability of the food guide recommendations to meet, or not meet the nutrient recommendations of the Dietary Standard, but also because they point out the relative contribution each group makes toward the iron content of diet. If the food guide cannot promote a pattern of food consumption that will ensure an adequate intake of the essential nutrients, then it is interesting to learn which food group contains the foods which contribute most toward the iron content of the diet. The foods of the Meat and Alternatives Group made the largest contribution to the iron content of the diet, followed by the Vegetable

TABLE 2

FOOD GROUP CONTRIBUTION TO IRON INTAKE

Average Daily Intake for Sedentary Man (Canadian Council on Nutrition, 1949)	Iron Content (mg.)	Percentage of 1975 Canadian Dietary Standard for Iron		Iron Content (mg.)	Average Daily Intake for 5 Year Old Boy (Baxter, 1952)
MILK 1/2 pt.	0.3	3	6.7	0.6	1 pt.
FRUIT					
-citrus	0.5			.16	1/2 orange
-other	0.6			.15	1/4 cup applesauce
TOTAL	1.1	11	3.4	.31	
VEGETABLE					
-potato	1.6			0.4	1 serving
-2 other	1.2			1.28	1/4 cup beets & 1/4 cup green beans
TOTAL	2.8	28	18.7	1.68	
BREAD					
-4 slices	1.1			0.6	3 slices bread
-whole grain cereal	1.2			.08	1/2 cup rolled oats
- butter or margarine	0.1			-	butter
TOTAL	2.4	24	15.6	1.4	
MEAT					
-(liver once in 2 wk.)	4.7			1.65	2oz. ground beef
-eggs (3/wk.)	0.6			0.51	(3/wk.)
-cheese (3 times/wk.)	0.1			0.4	1/7oz. cheese (1oz./wk.)
TOTAL	5.4	54	24.4	2.2	
DAILY TOTAL	11.8	118	68.8	6.19	DAILY TOTAL

Group, and then the Bread and Cereals Group (Table 2). A small contribution is made by the Fruit Group and the Milk Group (Table 2).

Other investigators have also looked at the relative contribution different food groups make to the iron content of the diet. Kirkpatrick and Coffin (1974) recently analyzed the iron content of foods gathered in the Halifax and Vancouver area. The foods were classified into 12 different groups according to nutrient content. Their investigation revealed that meats, cereals, bread, legumes and potatoes make the largest contribution of iron to the diet. This work reemphasized the studies by Baxter (1952) and the Canadian Council on Nutrition (1949) that meat, vegetables, and bread and cereals contribute the most iron to an individual's diet, and that fruits, and milk products make a smaller contribution.

A study by Milne et al. (1963) also examined the question of whether food records scored according to Canada's Food Guide could evaluate the nutritional adequacy of the food record using the proposed 1964 Canadian Dietary Standard recommendations. They used 248, seven-day food records from adolescents with a mean age of 14.5 years. The food records were scored and placed in a diet category ranging from Excellent to Very Poor. The nutrient content of the food records was compared with the proposed 1964 Canadian Dietary Standard. Milne et al. (1963) observed that as the diet category fell, the nutrient values also fell. This observation is understandable since the nutrient content of the diet generally decreases as the quantity of protective foods in the diet decreases. Dietary surveys have shown that it is a shortage of these protective foods that results in dietary deficiencies (Editorial Board, 1941).

The records of students consuming different levels of iron were compared. Of those consuming 100% or more of the Dietary Standard recommendation, meats contributed 32%, breads 26.5%, fruits and vegetables 15%, and cereals 5% of the total iron intake (Milne et al., 1963). The remaining iron would be contributed by foods not recommended in the food guide, such as cookies and cake. Their investigations pointed out again that meat, bread, and fruits and vegetables made the greatest contribution to iron intake. Also, as the total food intake decreased, the proportions coming from the various food groups remained relatively constant (Milne et al., 1963).

Food records kept for varying lengths of time were also collected by McClinton et al. (1971). The average daily nutrient intake was calculated and compared to the 1964 Canadian Dietary Standard. Out of the 4,529 food records, only about one third (31.3%) achieved 100% of the Canadian Dietary Standard for calories and eight nutrients (protein, calcium, iron, Vitamin A, thiamine, riboflavin, Vitamin C, and niacin) and only one of these food records met Canada's Food Guide's recommendations. The meat category was usually met, but the milk category, whole grain cereal category, and other vegetable category, especially the dark green and yellow vegetables, were the common areas where people failed to meet the food guide recommendations (McClinton et al., 1971).

McClinton et al. (1971) then established baseline levels for the individual food groups - milk and milk products; meat and alternatives; fruit and vegetables; whole grain or enriched cereal, bread and pastas. These baseline levels, presented in Table 3, were based on the food group intake records of the individuals who had satisfactory nutrient intakes. However, when the nutrient content was calculated in

these baseline levels, it was found that they contained considerably less than the recommended level for iron (McClinton et al., 1971). The researchers therefore thought it necessary to raise the baseline levels in order to assure adequate intake of nutrients and incorporate realistic amounts of food. It should be noted that they used the 1964 Canadian Dietary Standard for comparison not the 1975 Canadian Dietary Standard which makes an even higher recommendation for iron intake.

When the food records of individuals with satisfactory nutrient intakes were compared with the revised level of recommended food group consumption, only 34% had consumed recommended levels in all four Food Groups (McClinton et al., 1971). Of the food records of individuals with less than the recommended nutrient intake, only 0.9% achieved the recommended levels in all four Food Groups (McClinton et al., 1971). It could also be noted that this 0.9% had satisfactory nutrient intakes for all nutrients except iron and Vitamin A, and here they were consuming more than 75% of the Standard (McClinton et al., 1971).

The calculation of the nutrient content of the revised level of suggested food group consumption revealed that the revised level provided an adequate intake of all the nutrients except iron. The iron provided for persons 10 to 19 years of age, and adult women was less than the level recommended in the Dietary Standard (McClinton et al., 1971). However, the iron provided by Canada's Food Guide was also low when the nutrient levels were calculated (McClinton et al., 1963). It seems that people do not have to follow Canada's Food Guide in order to get the essential nutrients, but all individuals who do follow the proposed guideline can be sufficiently guaranteed that they will receive

TABLE 3

COMPARISON OF CANADA'S FOOD GUIDE
RECOMMENDATIONS WITH (A) BASELINE LEVELS
AND (B) REVISED LEVELS
FOR MALES AND FEMALES AGE 20-60

Canada's Food Guide Recommended Servings		4 Food Groups	Baseline Levels Male	Female	Revised Levels Male	Female
Milk	1.5	Milk	.75	1.0	1.5	1.5
Meat & Alternates	1	Meat & Alternatives	1.5	1.5	2.0	2.0
Cheese	.4					
Eggs	1					
TOTAL	2.4					
Citrus fruit	1	Fruits & Vegetables	2.3	3.0	3.0	3.0
Other fruit	1					
Potatoes	1					
Other Vegetables	2					
TOTAL	5					
Whole Grain Cereal	1	Breads & Cereals	2.3	1.5	3.0	3.0
Bread	4					
TOTAL	5					

all the essential nutrients, with perhaps iron being the only exception for adolescents and women of child-bearing age.

METHODOLOGY

Operation ReNu (Recreation-Nutrition) was a fitness program initiated by the Manitoba Department of Health and Social Development in the spring of 1973. The objective of the program was to motivate the public to achieve optimum physical fitness and nutrition. This was to be accomplished by developing participants' awareness of their present fitness and dietary status through physical fitness testing and dietary assessment, and then planning a program for improvement, according to the specific needs of the individual, in diet and physical fitness (ReNu, 1974).

The program was a government sponsored service for people over ten years of age in the selected communities. After registering with the team receptionist, a participant, who volunteered for the program, would first proceed to the laboratory section where a urine sample was tested by a medical technician for the presence of albumin and sugar, and a blood sample was taken in order to measure the participant's hemoglobin level. The participant then proceeded to the medical area where a medical student collected a medical history, measured the participant's percent of body fat, and conducted a brief medical examination. Passing the medical examination made the participant eligible to enter the recreation section of the clinic where a physical education student tested the individual's cardiovascular endurance, strength, flexibility, vital capacity, and power. The participant's test results were explained to him, and he was counselled as to how to improve or maintain his current fitness level.

After finding out how physically fit he was, the participant moved on to the nutrition section of the clinic. In the nutrition section, a dietary interviewer collected a 24-hour recall from the participant, filled out a food frequency questionnaire, and then counselled the individual on maintaining or improving present eating habits. To ensure standardization of data collection, the dietary interviewers, who were nutrition students, received a three-week training course at the beginning of the summer project. Even though this data was collected by different people, interviewers with similar training and background working as a team can obtain comparable data on dietary intake (Church et al., 1954).

Food Group Scores

It was impossible to calculate the nutrient content immediately following the 24-hour recall, because of the time and technology involved, therefore the participant's food intake was given a score based on the food intakes recommended by the ReNu Food Guide. The ReNu Food Guide recommends the same food intake as Canada's Food Guide, however the ReNu Food Guide uses four food groups instead of five. The four Food Groups of the ReNu Food Guide include the Milk Group, Protein Group, Bread and Cereal Group, and Fruit and Vegetable Group. The Fruit and Vegetable Group of the ReNu Food Guide unites the Fruit Group and the Vegetables Group of Canada's Food Guide because it was thought that similar nutrients were contributed by these two Food Groups. The Food Group scores recommended by the ReNu nutritionist are outlined in Table 4. A participant could obtain these desired scores by consuming a combination of the foods listed in Table 4.

TABLE 4

ReNu FOOD GUIDE RECOMMENDATIONS

SCORING	FOOD GROUPS			
	MILK GROUP	PROTEIN GROUP	BREAD & CEREAL GROUP	FRUITS & VEGETABLE GROUP
DESIRED SCORES	adult 3 points adol. 8 points child 5 points pregnancy - an extra 5 points	4 points	3 points	4 points + a Vitamin C point = 5 points
A SCORE of 1 is obtained by consuming one of:	1/2 cp. milk 3/4 oz. cheese 3/4 cp. cottage cheese 1/2 cp. cream soup 1/2 cp. milk pudding 1/2 cp. ice cream 1/2 cp. milk-shake 1/2 cp. yoghurt 1/2 cp. eggnog 2 tbsp. milk powder	1 oz. red meat 1 oz. poultry 1 oz. fish 1 oz. organ meats 1 egg 2 tbsp. peanut butter 1/3 cp. nuts 1/2 cp. dried peas or beans	1 slice whole grain or enriched bread 1/2 cp. cereal 1/2 cp. pasta 1 cp. rice 1 muffin	1 piece of fresh produce 1/2 cp. serving of fruit, vegetable or juice

It was presumed that if a participant was consuming the recommended number of servings in each of the four Food Groups then consequently he would be receiving all the nutrients his body required according to the Canadian Dietary Standard. It is the purpose of this study to check the accuracy of this presumption using only one nutrient, iron. Iron was chosen because of the findings of the Nutrition Canada Survey (1973) which reported that a shortage of iron in the diet of children and adolescents is marked and widespread, and a serious and widespread iron deficiency affects both adult men and adult women. These findings agree with the results of earlier Nutrition Surveys which also reported iron deficiency among the Canadian population (Patterson et al., 1941; Young, 1941; Hunter et al., 1941; Sylvestre et al., 1941).

Milligrams of Iron Consumed.

The nutrient content of the dietary intakes was calculated using a computer, therefore each food listed in a participant's 24-hour dietary intake was coded numerically using the food numbers in the United States Department of Agriculture Handbook No. 8 (Watt and Merrill, 1963), plus an additional list of food code numbers developed by Nutrition Canada for food items not listed in U.S.D.A. Handbook No. 8, as well as food items with nutrient levels specific to Canada (eg. packaged cereals).

The quantity of each food item consumed was estimated using the food models designed for use in the Nutrition Canada Survey (1973). A food model kit consists of a collection of glasses, bowls, spoons, cups; plaster-of-paris balls and mounds; wooden pie wedges, meat cuts, and blocks; and metal discs and squares. For each food item in his 24-hour dietary intake, the participant is presented with a set of graduated food models, and is asked to pick the size of model that best represents

the volume of that food item he consumed. Each food model has an alphabetic code which corresponds to a specific volume.

At the end of the summer the nutrient content of each 24-hour dietary intake was calculated. The numerical food codes specified what foods were eaten, and the alphabetic volume code was used to determine the number of grams of food that was eaten. Using these two sets of codes, the nutrient content of the dietary intakes could be calculated.

It should be noted that the calculation of the iron content of the diet includes the iron content of all foods listed in the 24-hour dietary intake. However, the Food Group scores only include points for the recommended or protective foods. Non-recommended foods are not included in the Food Group scores but are included in the calculated total iron content of the dietary intake.

Statistical Analysis

The sample consisted of 2,925 volunteers who were classified into the ten physiological groups designated in the 1975 Dietary Standard for iron, as outlined in Table 5. Table 5 presents the number of diets that were analyzed within each physiological group.

An SPSS[4] computer program was used to calculated a regression equation, for each physiological group, of the form:

$$y = \text{constant} + b_1(x_1) + b_2(x_2) + b_3(x_3) \pm b_4(x_4)$$

4 Statistical Package for the Social Sciences

TABLE 5

NUMBER OF 24-HOUR DIETARY INTAKES ANALYZED WITHIN EACH PHYSIOLOGICAL GROUP

PHYSIOLOGICAL GROUPS	Dietary Intakes Containing Organ Meats	Dietary Intakes Not Containing Organ Meats	Total Number
Males			
13 - 15 years	3	79	82
16 - 18 years	2	71	73
19 - 35 years	7	428	435
36 - 50 years	8	231	239
over 50 years	6	381	387
Females			
13 - 15 years	1	64	65
16 - 18 years	2	94	96
19 - 35 years	10	586	596
36 - 50 years	6	372	378
over 50 years	17	557	574
TOTAL	62	2863	2925

where:

x_1 : Milk Group Score

x_2 : Protein Group Score

x_3 : Fruit and Vegetable Group Score

x_4 : Bread and Cereal Group Score

b : estimate of average change in y per unit of increase of x

y : predicated estimate of number of milligrams of iron

The above regression equation uses the specific food group scores as the independent x variables to predict the dependent y variable, or more specifically, the average iron content of the diet. A regression equation of this form may be used to predict the average number of milligrams of iron supplied by a diet containing the recommended number of servings of foods from each of four Food Groups in the ReNu Food Guide. The regression equation could also be used to predict the average number of milligrams of iron supplied by varying levels of consumption of foods in each of the four Food Groups.

Because organ meats have a high iron content, the regression analysis was performed initially on the total sample, and then was performed omitting all 24-hour dietary intakes which included the consumption of organ meats. This extra analysis was performed in order to determine whether or not eliminating organ meats from the diet would affect the ability of the diet to meet the iron level recommended by the 1975 Canadian Dietary Standard as outlined in Table 6.

TABLE 6

RECOMMENDATIONS OF THE 1975

CANADIAN DIETARY STANDARD FOR IRON INTAKE

AGE	Milligrams of Iron	
	MALE	FEMALE
13 - 15 years old	13	14
16 - 18 years old	14	14
19 - 35 years old	10	14
36 - 50 years old	10	14
over 50 years old	10	9

RESULTS AND DISCUSSION

The average number of milligrams of iron supplied by diets including the recommended number of servings of foods in each of the four Food Groups was predicted using a regression equation. These calculations were performed to determine if a diet including the food consumption recommendations of the Food Guide would subsequently contain an average iron level which met the recommendations of the 1975 Canadian Dietary Standard. A diet following the recommendations of the ReNu Food Guide would have a Milk Group score of three points for adults and eight points for adolescents; and Protein Group, Fruit and Vegetable Group, and Bread and Cereal Group scores of four, five, and three points, respectively, for all age groups (Table 4). These Food Group scores correspond to the independent x variables.

The sample regression coefficients, b's, used in the prediction equation are outlined in Table 7. The sample regression coefficient represents the slope of the sample regression equation. It estimates the average change in the y variable (milligrams of iron) per unit change in the x variable (food group score) (Snedecor and Cochran, 1973). By multiplying each of the four Food Group scores by its corresponding regression coefficient, then totalling the four values, and adding a constant value, one can calculate the prediction of the y variable. The prediction of the average milligrams of iron supplied by the recommended diet was calculated separately for all ten physiological groups, and the results are presented in Table 8.

The predictions of the average iron levels using the regression equation indicate that only the diets of adult men and adult women over

TABLE 7

REGRESSION COEFFICIENTS AND CONSTANTS USED TO PREDICT THE MILLIGRAMS OF IRON SUPPLIED TO THE TEN PHYSIOLOGICAL GROUPS BY A DIET FOLLOWING THE RECOMMENDATIONS OF THE RENU FOOD GUIDE

PHYSIOLOGICAL GROUPS	Regression Equation Constant	Food Groups (independent x variables) Milk Group (x_1)	Protein Group (x_2)	Fruit & Vegetable Group (x_3)	Bread & Cereal Group (x_4)
Males					
13 - 15 years	2.08961	0.24215	0.70342	0.52820	0.75649
16 - 18 years	8.24840	-0.01101	0.34362	0.66370	0.90285
19 - 35 years	5.39136	0.05469	0.48981	0.26413	0.73056
36 - 50 years	5.65541	0.07455	0.54236	0.57634	0.47486
over 50 years	2.60386	0.21780	0.60572	0.72715	0.64903
Females					
13 - 15 years	1.99705	0.16607	0.81674	0.21461	0.85314
16 - 18 years	2.23999	0.14927	0.17204	0.85345	0.59345
19 - 35 years	2.99444	0.11816	0.56808	0.47627	0.65201
36 - 50 years	3.05670	0.18775	0.52927	0.62979	0.52685
over 50 years	2.40715	0.23811	0.45830	0.80396	0.57417

TABLE 8

PREDICTION OF AVERAGE DAILY IRON CONTENT FOR DIETS CONTAINING THE RECOMMENDED NUMBER OF SERVINGS OF FOOD FROM EACH OF THE FOUR FOOD GROUPS

Physiological Groups	1975 Canadian Dietary Standard Daily Iron Intake Recommendation	Average Predicted Iron Level (total sample of 2925 individuals)	Average Predicted Iron Level (2863 individuals not consuming organ meats
	MG.	MG.	MG.
Males			
13 - 15 years	13	11.8	11.5
16 - 18 years	14	12.6	12.3
19 - 35 years	10	11.0	11.0
36 - 50 years	10	12.4	11.9
over 50 years	10	11.3	11.0
Females			
13 - 15 years	14	10.2	10.2
16 - 18 years	14	10.2	10.2
19 - 35 years	14	10.0	10.0
36 - 50 years	14	10.5	10.5
over 50 years	9	10.7	10.6

50 years of age containing the recommended foods will supply an average iron level which meets the 1975 Canadian Dietary Standard. For example, the predicted average iron value for adult men in the age group 19 to 35 years is eleven milligrams of iron when the recommended number of serving of foods from each of the four Food Groups is consumed. Stating that the average iron content of the diet is predicted to be eleven milligrams means on the average that 50% of the men in this age group consuming the recommended foods will receive more than eleven milligrams of iron and 50% will receive less than eleven milligrams of iron. The 1975 Canadian Dietary Standard recommends a daily iron intake of ten milligrams for men of this age group. Therefore it is estimated that over 50% of adult men aged 19 to 35 years would be able to meet the iron intake recommended by the 1975 Canadian Dietary Standard by consuming the recommended number of serving of foods in each of the four Food Groups.

The predicted average iron intake for adolescents and adult women under 50 years of age consuming the recommended number of servings of foods in the four Food Groups is calculated to be below the level recommended by the 1975 Canadian Dietary Standard. For example, Table 8 predicts an average iron intake of approximately ten milligrams for women consuming a diet including the recommended number of servings of food from each of the four Food Groups. This statement means that on the average 50% of women consuming the recommended number of servings will receive more than ten milligrams of iron, and 50% of these women will receive less than ten milligrams.

The 1975 Canadian Dietary Standard recommends a daily iron intake of fourteen milligrams for adult and adolescent females. Therefore,

a high percentage of women and adolescent girls are unable to meet their recommended daily intake of iron by consuming the number of servings of foods recommended in the Food Guide. On the average more than 50% of adolescent boys are also unable to meet their daily iron requirement by consuming the recommended number of servings of food in each of the four Food Groups.

Because of the high iron content of organ meats, such as liver, kidney and heart, it was thought worthwhile to predict the average milligrams of iron in the 24-hour dietary intakes which did not contain organ meats, to determine whether these dietary intakes would be able to meet the 1975 Canadian Dietary Standard recommendations for daily iron intake. In the sample of 2,925 diets which were analyzed, 2,863 of the diets did not contain organ meats. The results of the regression analysis performed on the ten physiological groups in this sample, excluding organ meats from the diet are presented in Table 8. The number of milligrams of iron predicted using the regression equation for this sample excluding organ meats from the diet are very similar to the predictions for the total sample. It was predicted that adult men and adult women over 50 years of age including the recommended number of servings in each of the four Food Groups would have an average iron content that exceeded the 1975 Canadian Dietary Standard recommendation for daily iron intake. However, on the average, over 50% of adolescent boys and an even higher percentage of adolescent girls and women under 50 years of age could not meet their daily iron recommendation by consuming the recommended number of servings of food in each of the four Food Groups. The reason

that the predicted iron levels are very similar for the sample excluding organ meats from the diet and for the total sample could be due to the fact that only 62 individuals in the total sample included organ meats in their diet.

A sample regression line for this data is illustrated in Figure 3. It points out the relationship between the dependent y variable (milligrams of iron) and independent x variable (Bread and Cereal Group score). To test the goodness of fit of the regression equation, analysis of variance tables were calculated. These A.O.V. tables are presented in Table A of the Appendix. All of the F values are significant at both the 1% ($p \leq 0.001$). This means the hypothesis that the standardized regression coefficient (beta), which represents the slope of the regression equation, does equal zero is rejected. In other words, the y variable is dependent upon the x variable. More specifically, the milligrams of iron contained in a diet is dependent upon the amount of the protective foods consumed.

Scattergrams were produced to illustrate the relationship between the y variable and one of the x variables within each physiological group. The milligrams of iron consumed (vertical axis) was plotted against one of the Food Group scores. An example of one such scattergram is presented in Figure 4. The upper two quadrants contain the individuals of that physiological group who did consume the number of milligrams of iron recommended by the 1975 Canadian Dietary Standard. The number of individuals who met or surpassed the iron consumption recommended by the 1975 Canadian Dietary Standard was counted within each physiological group, and the percentages are presented in Table 9.

FIGURE 3

PLOT OF REGRESSION PREDICTION FOR THE AVERAGE MILLIGRAMS OF IRON CONTAINED IN THE BREAD AND CEREAL FOOD GROUP FOR MALES (16-18 YEARS)

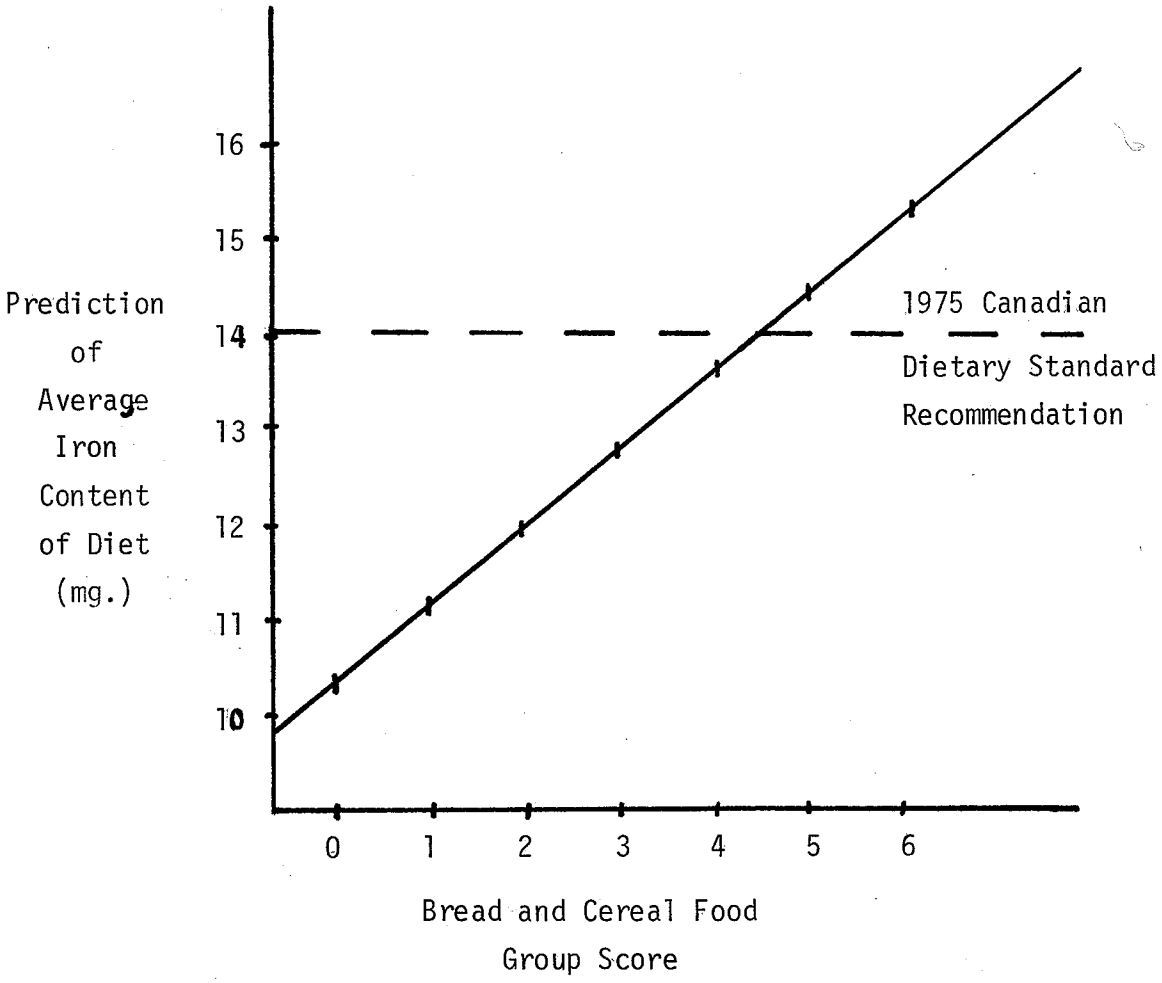

FIGURE 4
SCATTERGRAM OF PROTEIN FOOD GROUP SCORE AGAINST MILLIGRAMS
OF IRON CONSUMED BY MALES (13-15 YEARS)

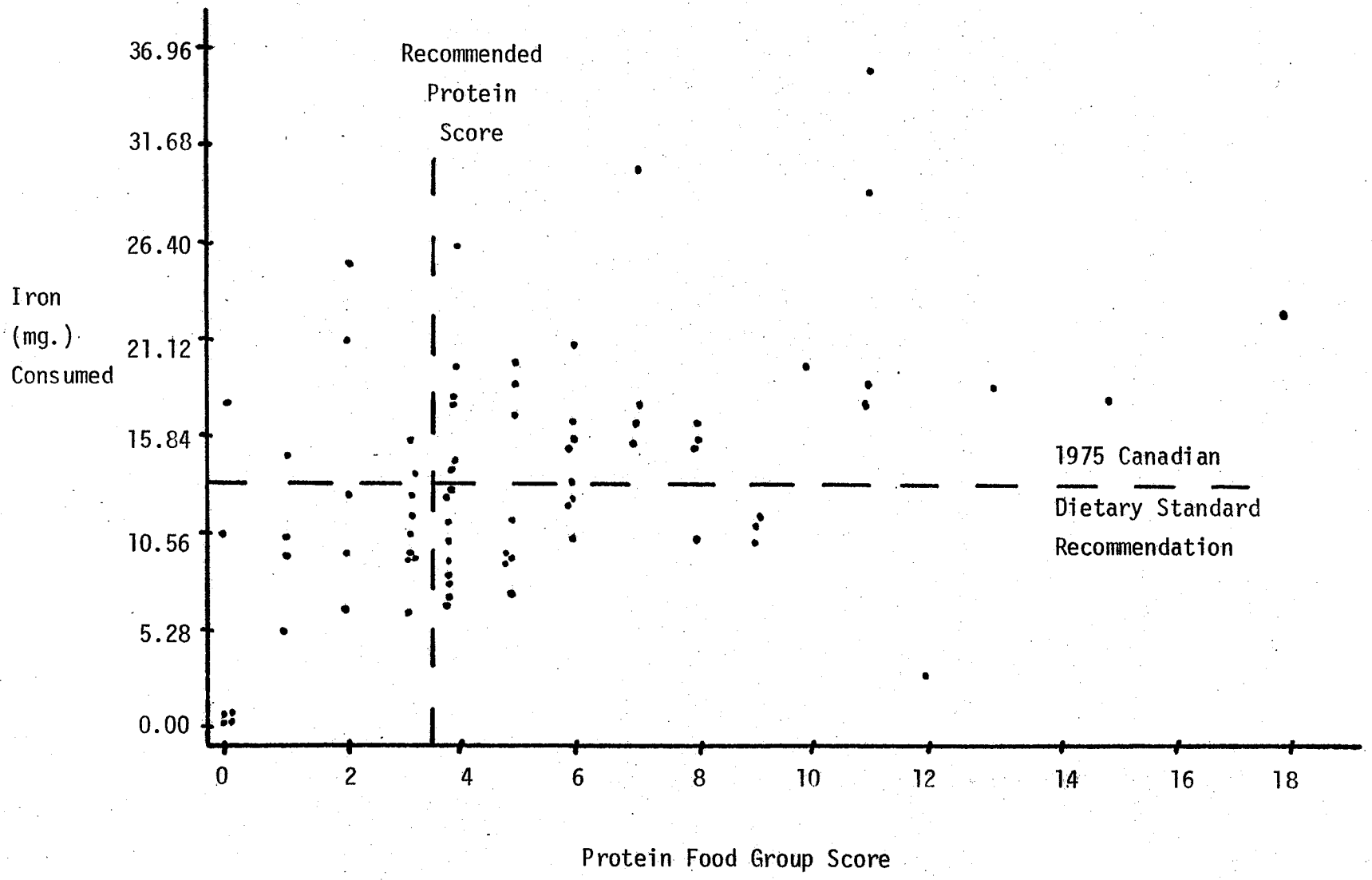

TABLE 9

PERCENTAGE OF INDIVIDUALS IN ReNu SAMPLE IN EACH PHYSIOLOGICAL GROUP CONSUMING THE MILLIGRAMS OF IRON RECOMMENDED BY THE 1975 CANADIAN DIETARY STANDARD

PHYSIOLOGICAL GROUP	PERCENTAGE
Males	
13 - 15 years	46
16 - 18 years	60
19 - 35 years	73
36 - 50 years	76
over 50 years	61
Females	
13 - 15 years	18
16 - 18 years	16
19 - 35 years	20
36 - 50 years	16
over 50 years	49

It is interesting to compare the adequacy of iron intakes based on the ReNu sample with results of another nutrition survey. Nutrition Canada, a national nutrition survey, also collected 24-hour dietary intakes, and also calculated the nutrient content of these dietary intakes (Nutrition Canada, 1973). Nutrition Canada evaluated the nutritional adequacy of the dietary intakes using the 1968 Canadian Dietary Standard. The 1975 Canadian Dietary Standard recommends a higher daily iron intake than the 1968 Standard. A comparison of the 1968 and 1975 Canadian Dietary Standards is presented in Table 10.

Nutrition Canada developed interpretive standard based on the 1968 Canadian Dietary Standard to classify nutrient intakes into three categories designated as inadequate, less-than-adequate, and adequate (Nutrition Canada, 1973). The interpretive standard used for iron intakes is presented in Table 11. Examining Table 10 and Table 11, one can see that the level of dietary intake of iron classified as adequate most closely corresponds to the iron recommendations of the 1975 Canadian Dietary Standard. The percentage of dietary intakes classified as adequate for iron are presented in Table 12.

The results in Table 12 indicate that adult men are the physiological group most likely to meet their iron recommendation. Only about half of adolescent boys meet their iron recommendation. Females seem to have the most difficulty meeting their daily recommended iron intake. The percentage of females attaining their recommended daily iron intake increases with age. Only about one- quarter of adolescent girls were able to meet their iron recommendation, while about half of women over 65 years were able to meet their iron recommendation. These findings parallel the results of the ReNu sample.

TABLE 10

COMPARISON OF 1968 AND 1975 CANADIAN DIETARY STANDARD RECOMMENDATIONS FOR DAILY IRON INTAKE

Physiological Group	1968 Recommendations (mg.)	1975 Recommendations (mg.)
Males		
13 - 15 years	12	13
16 - 17 years	12	14
18 - 19 years	6	14
adult	6	10
Females		
13 - 15 years	12	14
16 - 17 years	12	14
18 - 19 years	10	14
adult	10	14
over 50 years	10	9

TABLE 11

THE INTERPRETIVE STANDARD DEVELOPED BY NUTRITION CANADA FOR IRON INTAKES

Physiological Group	Classification of Iron Intakes (mg./day)		
	Inadequate	Less-than-adequate	Adequate
Male & Females 9 - 16 years	Below 10	10 - 15	Above 15
Males 17 years & older	Below 6	6 - 10	Above 10
Females 17 - 54 years	Below 10	10 - 15	Above 15
Females 55 years & older	Below 6	6 - 10	Above 10

(Nutrition Canada, 1973)

TABLE 12

PERCENT OF DIETS IN NUTRITION CANADA SURVEY CLASSIFIED AS HAVING AN ADEQUATE[5] IRON LEVEL

Nutrition Canada Physiological Group	% of Diets Classified to Contain Adequate Iron Levels
Males	
10 - 19 years	53.6
20 - 39 years	84.7
40 - 64 years	81.7
≥ 65 years	65.1
Females	
10 - 19 years	21.8
20 - 39 years	23.9
40 - 64 years	33.2
≥ 65 years	44.1

5 Nutrition Canada (1973) presents the percentage of dietary intakes classified as inadequate and less-than-adequate. The % of diets classified as having adequate iron intakes is calculated by subtracting the % inadequate + % less-than-adequate from 100%.

The Nutrition Canada results referring specifically to Manitoba, published in 1975, revealed essentially similar findings regarding iron intakes.

The previous discussion has pointed out that it is difficult for some physiological groups, such as adolescents and women under 50 years of age, to obtain the recommended level of iron even by consuming the recommended number of servings of foods from the Food Groups. These results would seem to indicate that the Food Guide is not fulfilling its main objective. Following the recommendations of the Food Guide does not guarantee that all physiological groups will receive the recommended iron level.

It would now seem worthwhile to look more specifically at the individual food groups rather than looking generally at the guide as a whole. The standardized regression coefficients, beta's, indicate the relative contribution of each Food Group towards predicting the average iron level of the diet, or in other words, the dependent y variable. Standardized regression coefficients were calculated for each of the four Food Groups in all 10 physiological groups, and are presented in Table 13.

Table 13 points out that the Bread and Cereal Group and the Protein Group scores make the largest contribution towards predicting the iron level in the diets of males. The Bread and Cereal Group score makes the largest contribution towards predicting the iron content of the diet for adolescent boys and young adult males between the ages of 19 to 35 years, followed by the Protein Group score. In the diets of older adult men, over 35 years of age, the Protein Group score makes the largest contribution towards predicting the iron content of the diet,

TABLE 13

THE STANDARDIZED REGRESSION COEFFICIENTS OF THE FOUR FOOD GROUPS RANKED IN ORDER OF THEIR IMPORTANCE IN PREDICTING THE IRON CONTENT OF THE DIET (ie. DEPENDENT y VARIABLE)

Physiological Groups	Largest ← Ranked Importance To Prediction → Smallest			
Males 13 - 15 yrs.	Bread & Cereal 0.43444	Protein 0.38885	Fruit & Vegetable 0.17952	Milk 0.14209
16 - 18 yrs.	Bread & Cereal 0.42317	Protein 0.24124	Fruit & Vegetable 0.01893	Milk -0.01172
19 - 35 yrs.	Bread & Cereal 0.36519	Protein 0.35546	Fruit & Vegetable 0.11053	Milk 0.03994
36 - 50 yrs.	Protein 0.37644	Bread & Cereal 0.24649	Fruit & Vegetable 0.19889	Milk 0.03651
over 50 yrs.	Protein 0.35488	Bread & Cereal 0.28730	Fruit & Vegetable 0.24151	Milk 0.09322
Females 13 - 15 yrs.	Protein 0.59892	Bread & Cereal 0.30227	Milk 0.11177	Fruit & Vegetable 0.07128
16 - 18 yrs.	Fruit & Vegetable 0.37301	Bread & Cereal 0.33654	Protein 0.15901	Milk 0.14417
19 - 35 yrs.	Protein 0.37504	Bread & Cereal 0.28699	Fruit & Vegetable 0.22624	Milk 0.06743
36 - 50 yrs.	Protein 0.28882	Fruit & Vegetable 0.26473	Bread & Cereal 0.26159	Milk 0.08969
over 50 yrs.	Fruit & Vegetable 0.30498	Protein 0.22444	Bread & Cereal 0.21316	Milk 0.08342

followed by the Bread and Cereal Group score. The Fruit and Vegetable Group score makes the third largest contribution towards predicting the iron content of the diets of males in general, and the Milk Group score makes the smallest contribution towards predicting the iron content of the diets of males.

In the diet of females, it is the Protein Group and the Fruit and Vegetable Group scores that make the largest contribution towards predicting the iron content of the diet. The Protein Group score is the predictor of the iron level in the diets of young adolescent girls, 13 to 15 years of age; and adult women, 19 to 50 years of age. It is in the diets of older adolescent girls, 16 to 18 years of age; and older adult women, over 50 years of age, where the Fruit and Vegetable Group score is the best predictor of the iron level. The Bread and Cereal Group score is the second best predictor of the iron content of the diets of adolescent girls and young adult women, 19 to 35 years of age. The Fruit and Vegetable Group score is the second best predictor of the iron content of the diets of middle age adult women, 36 to 50 years of age. The Protein Group score is the second best predictor of the iron content of the diets of adult women over 50 years of age. The Bread and Cereal Group score makes the third largest contribution towards predicting the iron content of the diet for middle age and older adult women, 36 to 50 years of age. The third best predictor of the iron content of the diet is made by the Fruit and Vegetable Group score in the case of young adult women, 19 to 35 years of age; the Protein Group score in the case of older adolescent girls, 16 to 18 years of age; and the Milk Group score in the case of younger adolescent girls, 13 to 15 years of age. In all age groups except young adolescent girls, the Milk

Group score makes the smallest contribution towards predicting the iron content of the diet. Generally, the Bread and Cereal and Protein Group scores make the largest contribution towards predicting the iron level of the diet, but in females the Fruit and Vegetable Group score increases in importance. These general trends could be useful for nutrition counsellors. If an individual has a high Bread and Cereal and Protein Group score, then he is most likely to have a high iron level in his diet.

One reason for the change in the relative importance of a food group score from one physiological group to another may be due to changes in consumption of specific foods within that food group. If one group consumes a quantity of dried fruits and dark green vegetables, or other produce with a relatively high iron content, while another group chooses apples, oranges, corn and carrots, or other products with relatively low iron content then each group could receive the same score in the Fruit and Vegetable Group but in the former case the Fruit and Vegetable Group score would make a larger contribution towards predicting the iron content of the diet. When McClinton et al. (1971) compared food intakes of individuals with the recommendations of food guides, they found from the recommendation that what the majority of people did not meet was the inclusion of dark green and yellow vegetables in their diets. Dark green vegetables are noted for their relatively high iron content. Law et al. (1972) reported that the vegetables least liked by teenagers include lima beans, spinach, and turnip greens. Harrison et al. (1976) reported that broccoli, and spinach lead the list of vegetables found in school food service garbage.

These vegetables reported in the above articles are all good vegetable sources of iron.

In spite of the fact that some foods contain more iron than others, each of the four Food Groups includes foods that contain some iron, therefore each food group will make some contribution to an individual's iron intake. McClinton et al. (1971) have stated that no one food group by itself can provide enough of any one nutrient to meet an individual's total daily requirement.

Food Group scores can be used to predict an average iron level in the diet. Therefore, it would seem that the type of foods recommended by the food guide must make a major contribution of iron to the diet. If the Food Guide is recommending the right types of foods, and some individuals who consume these foods still cannot meet their daily iron requirement according to the 1975 Canadian Dietary Standard, then perhaps the food guide is not recommending the correct quantity of the protective foods.

Milne et al. (1963) found that iron intake had the highest correlation, 0.951, with caloric intake. If an individual eats more, he is then going to increase his intake of iron. People would be quite willing to eat more, especially if they were told it was beneficial, but in order to maintain caloric equilibium their increased caloric intake would have to be accompanied by an increased caloric output, and it definitely would not be an easy job to motivate people to become more active.

However, one cannot make a general recommendation that people should eat more food. The recommendation must be qualified to give

guidelines regarding the type of foods of which one should increase his consumption. Sandin et al. (1939) found that the degree of nutritional adequacy of the diet is directly associated with the proportion of calories derived from protective foods. The more protective foods one includes in the diet, the higher the nutrient content. This finding would suggest that people should not only be told to eat more food, but also to eat more of the protective foods. This suggestion raises several questions. How much more of these foods would people have to eat? Should they increase their consumption of one food group, or all food groups?

Predictions of the average iron content of diets were made using increasing numbers for the different food group scores in the regression equations. Table 14 illustrates the results when three of the four recommended food group scores are kept at the recommended levels,(Table 4), while the recommended score of the fourth food group is increased to a level where the prediction of the average iron content will meet the 1975 Canadian Dietary Standard. Keeping the other three food group scores constant, it is pointed out in Table 14 that a score of twenty-seven is required in the Protein Group before an average iron content is predicted that meets the Canadian Dietary Standard recommendations for all physiological groups. In order to obtain a score of twenty-seven in the Protein Group, one would have to consume twenty-seven ounces of meat; or perhaps, ten ounces of meat plus seven eggs plus twenty tablespoons of peanut butter.

The same predictions can be made for the other Food Groups by keeping three food group scores at the recommended level and

TABLE 14

SCORE REQUIRED IN ONE FOOD GROUP, WHEN OTHER THREE GROUP SCORES ARE KEPT CONSTANT, IN ORDER FOR REGRESSION EQUATION TO PREDICT AN AVERAGE IRON CONTENT IN THE DIET THAT MEETS THE RECOMMENDATIONS OF THE 1975 CANADIAN DIETARY STANDARD

Physiological Group	Food Group Score		
	Protein	Bread & Cereal	Fruit & Vegetable
Males			
13 - 15 years	6	5	8
16 - 18 years	9	5	27
19 - 35 years	4	3	5
36 - 50 years	4	3	5
over 50 years	4	3	5
Females			
13 - 15 years	9	8	23
16 - 18 years	27	10	10
19 - 35 years	8	10	14
36 - 50 years	11	10	11
over 50 years	4	3	5

increasing the fourth to a level where the average iron prediction will meet the 1975 Canadian Dietary. Under these conditions a score of ten would be required in the Bread and Cereal Group. This score of ten could be obtained by consuming ten slices of bread; or perhaps, two cups of macaroni plus a cup of cereal plus four slices of bread.

A score of twenty-seven would be required in the Fruit and Vegetable Group before the average iron content of the diet is predicted to exceed the Canadian Dietary Standard for all physiological groups. In order to obtain a score of twenty-seven, one would have to consume, for example, twenty-eight ounces of juice plus five pieces of fruit plus five cups of vegetables plus two and a half cups of berries.

All of these increased recommendations seem unrealistic, especially the increased recommendations of the Protein Group and the Fruit and Vegetable Group. It would seem more reasonable to increase one's consumption of foods a little from each of the food groups rather than a large increase in the foods from one food group. Furthermore it would be more reasonable to increase consumption of the foods from the Bread and Cereal Group more than from another food group since an extra serving in this group will only provide an average of 68 calories (Canadian Diabetic Association, 1970) while an extra serving of foods from the Protein Group would provide an average of 73 calories. In addition, an extra serving of foods from the Bread and Cereal Group does not have the accompanied fat intake, especially saturated fat, that is associated with an extra serving of foods from the Protein Group. Foods in the Bread and Cereal Group are also generally less expensive than foods in the Protein Group. Another point to consider is that foods in the Bread and Cereal Group do not have a seasonal availability such as some foods in the Fruit and Vegetable Group do.

SUMMARY AND RECOMMENDATIONS

A 24-hour dietary intake was collected from a non-random sample of 2,925 individuals participating in the ReNu (recreation-nutrition) program, and these diets were subsequently given a score in each of four Food Groups. A regression equation was calculated for each of the ten physiological groups in the 1975 Canadian Dietary Standard for iron (Table 6). These regression equations were used to predict the average milligrams of iron (dependent y variable) contained in a diet that included the kinds and amounts of foods recommended by the ReNu Food Guide (Table 8).

The predictions indicate that only the diets of adult men and adult women over 50 years of age will contain an average iron content that meets the 1975 Canadian Dietary Standard. The diets of the other physiological groups are predicted to contain an average iron content below the 1975 Canadian Dietary Standard, when the diet includes the kind and quantity of foods recommended by the ReNu Food Guide. The physiological groups that are predicted to be least able to meet their iron recommendations are adult women under 50 years of age, and adolescents, especially female.

Increasing the amounts of foods eaten will subsequently increase the iron content of the diet, but can also lead to an obesity problem. This situation would be especially true for females whose iron recommendation is higher than for males, and therefore would have to consume a lot of additional food. It is very difficult for females to obtain the required amount of iron from the food they eat. Increasing their food intake would not be a desirable situation since the caloric

requirements of females are lower than for males.

Perhaps one solution would be for nutrition educators, to put more emphasis on promoting the iron-rich foods within the Food Groups. If people began substituting broccoli, tomatoes, peas, strawberries, dried fruit, and other produce with a high iron content, for produce with a low iron content, such as corn, pears, apples, and cabbage, then their iron intake would increase even though they were still following the recommendations of the Food Guide.

The findings of this thesis, and other research work, indicate that the Bread and Cereal Group score makes one of the largest contributions towards predicting the average iron content of the diet. The fact that the Canadian Government requires that flour be enriched with iron to a minimum level of 13 milligrams per pound, would account for the important contribution of the foods of the Bread and Cereal Group towards the iron content of the diet (Elwood et al., 1968). Perhaps the government should increase its enrichment program, and either add more iron to flour, or else begin enriching or fortifying other foods with iron. But this solution also brings new problems to light. What form of iron should be used? Will the iron added be well enough absorbed to improve the nutritional status as well as the dietary status? To what foods should the iron be added? What level should be added? What will be the effect on the segments of the population already receiving an adequate supply of iron? This latter question has been the cause of some controversy when proposing an increase in the iron enrichment level of flour (Crosby et al.,1972).

Perhaps, if an increased level of enrichment is unnecessary for some physiological groups, then a better solution would be to prescribe iron supplements to the groups, such as adult women under 50 years of age and adolescents, who are at risk of being iron deficient. Again, there is

the problem of the method of distribution, and the form of iron in the supplement.

Regardless of the method used to increase the iron content in peoples' diets, the results of this investigation indicates that there is a need for action.

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APPENDIX

TABLE A

ANALYSIS OF VARIANCE FOR REGRESSION EQUATIONS OF THE TEN PHYSIOLOGICAL GROUPS

Physiological Groups / A.O.V.	Males (Years)					Females (Years)				
	13-15	16-18	19-35	36-50	> 50	13-15	16-18	19-35	36-50	> 50
DEGREES OF FREEDOM										
Regression	4	4	4	4	4	4	4	4	4	4
Deviation	77	68	430	234	382	60	91	591	373	569
SUM OF SQUARES										
Regression	2810.03	1434.81	7862.27	3347.69	5627.86	938.46	886.11	5362.02	2800.90	3638.92
Deviation	2488.12	3002.13	14742.69	7146.58	10152.16	1337.85	1222.16	9646.41	6894.44	12531.14
MEAN SQUARE										
Regression	702.51	358.70	1965.57	836.92	1406.97	234.61	221.53	1340.51	700.22	909.73
Deviation	32.31	44.15	34.29	30.54	26.58	22.30	13.43	16.32	18.48	22.02
F Value*	21.74	8.12	57.32	27.40	52.94	10.52	16.49	82.13	37.88	41.31

* $P(F > F \text{ value}) < 0.001$ for all physiological groups