DIETARY INTAKES OF CANADIAN WOMEN AGE 18 TO 34 YEARS IN THE 1990s

A Thesis Submitted to the
College of Graduate Studies and Research
in Partial Fulfillment of the Requirements
for the Degree of Master of Science
in the
Department of Nutrition and Dietetics
of the
College of Pharmacy and Nutrition
University of Saskatchewan
Saskatoon

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ABSTRACT

Nutrition monitoring is important for determining nutrient intakes of a population but trend evaluation requires greater than two points. This thesis provides national mean nutrient intake estimates of Canadians aged 18 to 74 based on published 1990s provincial nutrition surveys that fall between the Nutrition Canada Survey (1970/72) and Canadian Community Health Survey (2004). The focus of this thesis was on four key nutrients (calcium, iron, folate, and vitamin C) reported by childbearing age women. Objectives included examining data for temporal or geographic patterns; reviewing for similarities to 1970/72; and assessing intake adequacy using Dietary Reference Intakes (DRIs).

Estimates were derived from 24-hour recall data reported by 16,915 adults of nine provinces, excluding Manitoba. Provincial group mean nutrient intakes were population-weighted using the Canadian census appropriate to the data collection years and totaled in proportion to provincial population size. The eight adult age and gender groups were then called the Province-derived Nutrition Survey (PNS). A temporal folate trend was noted as 1998 folate fortification doubled intake for the female population. In terms of geography, calcium intake appeared higher in British Columbia compared to Newfoundland. Nutrient intake declined with age except for some micronutrients associated with fruit/vegetables. Nutrient density indicated that the quality of women's diets improved with age. Nutrients which appeared inadequate for childbearing age women included fibre, potassium, magnesium, folate, iron, and calcium. Micronutrients that were below AI or RDA values suggest plant-based food intake was inadequate. Nutrient density showed that diet quality had improved since Nutrition Canada however, increased efforts are required to improve dietary intake further.

This thesis provides Canada's most recent comprehensive national nutrient intakes and a point with which to observe change. Intake in the 1990s compared to the previous Nutrition Canada Survey (NCS) showed that many nutrients had increased but education efforts did not appear to have resulted in optimum intake. Fortification and food consumption habits influenced which foods were the primary micronutrient sources, e.g., fortification with folic acid. While calcium and folate intake was higher in the 1990s compared to the NCS, these increases did not bring young women to their desired intake.

Overall iron intake did not notably increase from 1970/72 but the primary food source of dietary iron had changed. When the 2004 Canadian Community Health Survey cycle 2.2 (nutrition) is published, it could be compared to the Province-derived Nutrition Survey to confirm whether these patterns are trends.

ACKNOWLEDGEMENTS

The author wishes to thank Dr. Susan J. Whiting for her guidance as a supervisor. The support and assistance throughout my academic journey was invaluable. Advice on skill development and planning for the future was also very much appreciated. Thank you to my advisory committee members, Dr. Gordon Zello, Dr. Joan Bobyn, and Dr. Evelyn Peters for their direction, feedback, and enthusiasm.

Thank you to the Canadian Rural Economy Research Lab (C-RERL) from the Department of Agricultural Economics at the University of Saskatchewan for their work to complete the population-weighting of the data for this study. Their time and effort was greatly appreciated.

Thank you to all faculty and staff in the College of Pharmacy and Nutrition and to my fellow graduate students who provided motivation and lent an ear during my studies.

Thank you to my parents and siblings. You support me in all of my decisions and help me to consider the options. Despite the 'road less traveled' option I often take, you show strength and provide a great deal of support and encouragement.

This project benefited immensely from the hard work put forth by the research teams involved in the provincial nutrition surveys conducted during the 1990s. The author wishes to acknowledge and applaud your efforts. The author also wishes to acknowledge funding support from The Centrum Foundation and the University of Saskatchewan Scholarships.

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LIST OF ABREVIATIONS

AI	Adequate Intake
BBCA	Bureau of Biostatistics and Computer Applications
CANSIM	Canadian Socio-Economic Information Management System
CCHS	Canadian Community Health Survey, cycle 2.2 (Nutrition)
CFG	Canada's Food Guide
CFGHE	Canada's Food Guide to Healthy Eating
CNF	Canadian Nutrient File
CSFII	Continuing Survey of Food Intake of Individuals
DFE	Dietary Folate Equivalents
DRI	Dietary Reference Intakes
EAR	Estimated Average Requirement
FHC	Food Habits of Canadians
IMA	Interim Marketing Authorization
MFP	Meat, Fish, and Poultry
NC	Nutrition Canada
NCS	Nutrition Canada Survey
NFCS	National Food Consumption Survey
NHANES	National Health and Nutrition Examination Survey
PNS	Province-derived Nutrition Survey
RAE	Retinol Activity Equivalents
RDA	Recommended Dietary Allowance
RE	Retinol Equivalents
UL	Tolerable Upper Level Intake
USDA	United States Department of Agriculture

1.0 INTRODUCTION

The purpose of this study was to estimate and present the nutrient intake data of adult Canadians in the 1990s by summarizing published data from provincial nutrition surveys that have reported results. In this study the estimated national value was called the province-derived nutrition survey (PNS).

Nutrition is a major contributor to health. Adequate nutrient intake is important for the prevention and treatment of many diseases. The importance of nutrition to good health continues to be more widely accepted and much of the current work in nutrition focuses on the associations between nutrition and health as a whole and not just nutrient deficiency (Health and Welfare Canada, 1990; Lee & Nieman, 2003; Thompson, Manore, & Sheeshka, 2005). Surveys that assess nutritional status provide valuable information for the direction of priorities, policies, and programs that affect the overall health of a country's population (Department of National Health and Welfare, 1973; Hendricks, 1993; Lee & Nieman, 2003). Reliable food and nutrient intake data from these types of surveys is vital to the implementation of any action plan on nutrition and to ultimately improve Canadians' nutritional health (National Institute of Nutrition, 1997). The need to monitor nutritional status is increasingly important because of the number of changes in Canada's food supply and in the habits and lifestyle of its population over the years.

Regular monitoring was viewed as fundamental in 1964 (Department of National Health and Welfare, 1973; Sabry, Campbell, Campbell, & Forbes, 1974) and continues to be considered essential (Hendricks, 1993; McAmmond, 2000; Lee & Nieman, 2003). In 1964 the Canadian Council on Nutrition reported it was extremely important to be able to assess nutritional health (Department of National Health and Welfare, 1973). To this end, Nutrition Canada (NC) and the Nutrition Canada Survey (NCS) evolved. The researchers involved in NC intended the survey to be a beginning. The NCS was the first monitoring point for the assessment of the significance of nutrition in the lives of Canadians.

The NCS was a comprehensive look at nutritional status and was to be the basis of planning efforts to encourage people to improve their nutrition where needed and to continuously monitor nutrition changes in Canada (Department of National Health and Welfare, 1973). The 1970/72 NCS is considered out of date but it was designed to be a scientific base. This base allowed for monitoring change and it provided a starting point for understanding the nutritional status of Canadians.

Regular nutrition monitoring may help evaluate successes or failures of past or currant nutrition programs and policies. In 1997, the National Institute of Nutrition reported that the importance of nutrition to health was very well recognized but Canada needed a good 'yardstick' to measure success or failure in tackling nutrition issues. Periodic monitoring is necessary for the development of effective health and nutrition programs (Lee & Nieman, 2003) and awareness of what Canadians are eating is a must so that a framework to improve the Canadian diet might be established (Johnson-Down, Ritter, Jacobs Starkey, & Gray-Donald, 2006). NC and the NCS are an important legacy and research continues to support the need for current nutrient intake information. As changes in nutritional status and food supply occur, it is advantageous to have many national level monitoring points for assessing trends in intake. To help provide these points, the most logical place to start was to gather the available nutrition information. Hendricks (1993) and the National Institute of Nutrition (1997) previously suggested utilizing existing data would be an appropriate place to start.

The provincial nutrition surveys conducted between 1990 and 1999 (Balram, Villalon, McCaie-Burke, Ericson, & Boyne, 2005; Bertrand, 1995; Forster-Coull, Milne, & Barr, 2004; Gabos, Hansen, Field, & Raine, n.d.; MacLean, 1993; Mendelson, Tarasuk, Chappell, Brown, & Anderson, 2003; Roebothan, 2003; Stephen, & Reeder, 2001; Taylor, Van Til, & MacLellan, 2002) were provincial initiatives supported by Health Canada. The provincial nutrition surveys were not comprehensive assessments of nutritional status but they provided available nutrient intake information and may build upon the scientific base provided by the NCS. Aggregating data from individual reports into a national picture may be challenging and inter-provincial comparisons between all ten provinces have yet to be completed. Given the overall favorable response rates and relatively large sample sizes from each of the provincial nutrition surveys, a reasonable

representation of nutrient intake from the 1990s Canadian adult population might be achieved. An estimated national values derived from the data reported by the provincial nutrition surveys would provide a national monitoring point that lies in time between the 1970/72 NCS and the Canadian Community Health Survey conducted in 2004.

The 2004 version of the Canadian Community Health Survey (CCHS) cycle 2.2 was a national nutrition survey and publications of results from the dietary assessment component are expected (Statistics Canada, 2005). In July 2005, two reports on obesity rates from measured heights and weights were issued; Statistics Canada reports further publications of nutrient intake results would likely be issued in 2007 (Gravel, 2006).

The focus of the study data presented in this thesis was to examine mean intakes of calcium, iron, folate, and vitamin C for 1990s adult Canadian women age 18 to 34 years (childbearing age). Age categories, identified concerns, and availability of data in the NCS, and the concerns suggested by recent research were the basis for examining the nutrients and population group described. The childbearing age group for adult women reported by the NCS was 20 to 39 years, and the NCS reported intakes of calcium, iron, and folate as problematic identifying them as potential public health concerns. Inadequate intake of calcium and iron were more common in women (Department of National Health and Welfare, 1973 & 1975). Recent research suggests that despite efforts to improve diets of Canadian women over the years, intake of calcium, iron, and folate remain inadequate for this particular group (Gray-Donald, Jacobs-Starkey, & Johnson-Down, 2000; Bartley, Underwood, & Deckelbaum, 2005). Although intake of vitamin C was not reported as a major concern for the adult female population in the NCS it was included because it was a nutrient from the same primary food source as folate and may be indicative of fruit and vegetable intake.

Four questions were developed to help examine the issues that were often reported in nutrition survey analyses. The issues were related to changes over time in food availability, food habits, and intake recommendations 1) Were there possible geographical differences in reported mean dietary intakes of calcium, iron, folate, and vitamin C of Canadian women in the 1990s, and were these similar to geographical differences reported in the Nutrition Canada Survey? 2) Have estimated mean population intakes of calcium, iron, folate, and vitamin C of women 18 to 34 years changed from

those reported in the Nutrition Canada Survey? 3) How might have change in the current nutrient intake recommendations, the Dietary Reference Intakes, affected assessment of calcium, iron, folate, and vitamin C of women 18 to 34 years? 4) Can differences in mean intake of calcium, iron, folate, and vitamin C for women age 18 to 34 years be potentially attributed to education or fortification initiatives?

Research Questions

Were there possible geographical differences in reported mean dietary intakes of calcium, iron, folate, and vitamin C of Canadian women in the 1990s, and were these similar to geographical differences reported in the Nutrition Canada Survey? The NCS research group determined that there were possible geographic differences in nutrient intake in 1970/72 (Department of National Health and Welfare, 1975). The NCS report described geographic differences using food groups. From the relationship between food group and nutrient a determination as to the lowest and highest consuming geographic region for calcium, iron, folate, and vitamin C might be inferred. Johnson-Down, Ritter, Jacobs Starkey, & Gray-Donald (2006) reported that health professionals needed to know which foods contributed nutrients of concern. Food groupings may vary between surveys which mean food group contributions to nutrient intakes also vary. However, addressing calcium, iron, folate, and vitamin C by specifying important food sources is still useful (Johnson-Down et al., 2006).

Have estimated mean population intakes of calcium, iron, folate, and vitamin C of women 18 to 34 years changed from those reported in the Nutrition Canada Survey? Scientific knowledge about nutrition continues to accumulate and efforts to educate the Canadian population about healthy food habits continue. Although the potential links between nutrition and prevention of disease had generated more interest than in prior decades, Frank-Spohrer (1996) suggested that acting on disease prevention was a future frontier for many people and that health and nutrition may not be priorities for younger women. Bartley, Underwood, & Deckelbaum (2005) also reported that among women of childbearing age, inadequate intake of calcium, iron, and folate were much too common. Overall, research suggests that intakes of some micronutrients may remain inadequate for this population group.

How might have changes in the current nutrient intake recommendations, the Dietary Reference Intakes, affected assessment of calcium, iron, folate, and vitamin C of women 18 to 34 years? Most reports from nutrition surveys attempt to provide estimates of the proportion of the population that have inadequate nutrient intakes. Several methods are available for professionals to evaluate dietary intakes of individuals and groups (Lee & Nieman, 2003). One tool utilized to evaluate nutrient intakes are the recommendations for nutrient intake. The Dietary Reference Intakes (DRIs) are the most recent revisions to intake recommendations and reflect nutritional adequacy criterion identified as important at the time of their review (Institute of Medicine, 2000). Although this study cannot make definitive conclusions regarding prevalence of inadequacy, inferences may be made. This current assessment tool was the reference against which national mean nutrient intakes of Canadians were measured.

Can differences in the mean intake of calcium, iron, folate, and vitamin C of women 18 to 34 years be potentially attributed to education or fortification initiatives? The education initiative used to help answer this question was Canada's Food Guide for Healthy Eating (CFGHE) (Health Canada, 2002). The CFGHE is an information source developed for the public that provides suggested daily food consumption servings. It is a nutrition education tool that translates scientific knowledge into a practical form for those who have little or no training in nutrition (Lee & Nieman, 2003). Foods are classified into groups based on similarities in nutrient content or food type. Healthy eating guidelines undergo periodic review (Figure G1 to G4) and the number of suggested daily servings and in some cases serving size has increased over time to promote the nutritional health of Canadians (Health Canada, 2002).

Canadian food fortification programs may also have an effect on the nutrient intake of the population. Fortification is an effective public health intervention which successfully improves nutritional quality in the Canadian food supply (Health Canada, 1999). Fortification may be voluntary or mandatory depending upon the food product, specific nutrient, and regulations that govern food in Canada. The Food and Drugs Act and the Food and Drug Regulations govern fortification programs in Canada (Canadian Food Inspection Agency, 2003).

Possible fortification programs that may have an effect on the data presented in this study are iron, folate, and calcium. Mandatory iron fortification of breakfast cereals occurred in 1976, optional folate fortification of flour and flour products started in 1997, and mandatory folate fortification became effective in November of 1998 (Department of Health, 1998). An Interim Marketing Authorization (IMA) letter allowed for fortification of orange juice with calcium in Canada in 1999 (Department of Health, 2006). The IMA regulation allows for the addition of a specified nutrient to a specified food product. This temporary authorization permits research for the collection of data to support regulatory amendment changes. A possible result of increased orange juice consumption to improve calcium intake might be an increase in vitamin C intake. Results gathered from questions one and two were used to help answer question four.

2.0 LITERATURE REVIEW

2.1 Dietary Assessment of the Population

2.1.1 Introduction

The variety, quantity, and quality of food and the patterns of consumption can profoundly affect health (Lee & Nieman, 2003). Scurvy was among the first diseases recognized as resulting from a lack of a specific food. In the mid-1700s a variety of test diets given to sailors found citrus fruits prevented scurvy. Scurvy was later determined to be from a deficiency of vitamin C. During the nineteenth and early twentieth century deficiency diseases posed a significant threat to human health. Changes in sanitation, healthcare, food supply, enrichment and fortification programs, and better methods of determining the nutrient content of foods have made nutrient-deficiency diseases fairly uncommon. Despite the advances of science, nutrition related disease continues (Health and Welfare Canada, 1990; Lee & Nieman, 2003).

In recent years nutrition has had a more prominent role in the relationship of health and chronic disease. Health is no longer just the absence of disease but an active state of well-being. Lee & Nieman (2003) among others reported that diet contributed in a substantial way to disease and modifying the diet might contribute to disease prevention and health promotion. Recommendations for nutrient intake have also taken into account the relationship between nutrition and chronic disease in addition to the absence of deficiency (Health and Welfare Canada, 1990; Institute of Medicine, 2000). Much of the current work in nutrition research focuses on relationships between nutrition and chronic disease (Lee & Nieman, 2003; Thompson, Manore, & Sheeshka, 2005).

Monitoring and knowing the nutritional status of an individual, population group, or that of a country is fundamental to the planning and implementation of any action on nutrition (Department of National Health and Welfare, 1973; Sabry, Campbell, Campbell, & Forbes, 1974; Hendricks, 1993; McAmmond, 2000; Lee & Nieman, 2003). A healthy

diet and a safe nutritious food supply contribute to a healthy population. A strong evidence base and an ability to measure outcomes are required to plan nutrition policies and programs that enhance population health and prevent disease. The ability to identify persons or groups at nutritional risk has made assessment of nutrition an important tool in the promotion of health and prevention of chronic disease (Lee & Nieman, 2003).

The primary method of gathering information to evaluate nutritional status is the nutrition survey which assesses data from anthropometric, biochemical, clinical, and dietary measures. These collective required components make direct determinations of nutritional status (Department of National Health and Welfare, 1973; Lee & Nieman, 2003). Nutrition surveys serve to obtain a cross-sectional picture about what people are eating. National surveys answer questions about the health of the country and its regions. If repeated, changes in patterns over time may also be assessed (Lee & Nieman, 2003).

The National Research Council (1981) stated that it was not possible to assess nutritional status from dietary intake data alone. Lee and Nieman (2003) reported that indirect inferences of nutritional status are widely made from measurement of nutrient intake from the dietary component. Dietary intake data does make it possible to provide an estimate of the prevalence of inadequacy in a population (National Research Council, 1981). Various methods for collecting dietary data are available. No single best method exists however, and measurement of diet always contains some degree of error. Despite the inevitability of error, dietary intake data have considerable value.

The methods utilized to gather information about nutrient intake include food disappearance, food accounts, diet history, duplicate food collections, food diary, food frequency questionnaire, and the 24-hour recall. Many sources are available such as the National Research Council (1981), Lee and Nieman (2003), and the Institute of Medicine (2000) that describe the details and issues of these various methods. Choice of method depends upon many factors such as research design, study objectives, target population, and available resources (money, time, personnel). Table 2.1 provides a brief summary of the data collection methods reported as strongest for quantitative assessment of nutrient adequacy by the Institute of Medicine (2000). The dietary assessment method utilized to report nutrient intake in the Canadian nutrition surveys was the 24-hour recall and this method is discussed in greater detail in the section 2.1.2.

Table 2.1. Quantitative methods of data collection for dietary intake and nutrient adequacy assessment of a group[1]

Method	Type	Strengths	Limitations
Food record • estimated • weighed	prospective	not memory dependant detailed intake data gives data about eating habits represents usual intake (if multiple days)	requires high degree of cooperation high respondent burden possible low response rates respondent must be literate takes longer to obtain data process may cause subject to alter diet analysis expensive & labour intensive
Diet history	retrospective	assesses usual intake detects seasonal changes data on all nutrients obtained correlates with biochemical measure	lengthy interview requires highly trained interviewers difficult & expensive to code overestimates nutrient intake requires good recall ability
24-hour recall	retrospective	takes less time to administer inexpensive details on food types consumed low respondent burden probability sampling possible usual intake of group possible usual intake of individual (multiple recalls) more objective than diet history does not alter diet	one recall seldom gives usual intake relies on subject memory reporting errors occur -under report unhealthy choices -over report healthy choices data entry labour intensive

Adapted from Lee & Nieman, 2003

[1] Reported as strongest for quantitative assessment of nutrient adequacy; Institute of Medicine, 2000

2.1.2 24-hour Recalls

The 24-hour recall is the most commonly applied method to obtain dietary intake information (Lee & Nieman, 2003). For the NCS it was determined that the 24-hour recall was the most feasible. It was the simplest and most direct method for collecting data on a large group of people (Department of National Health and Welfare, 1975). It is also one of the methods reported as strongest for attaining a quantitative assessment of nutrition adequacy. Assessment requires a precise quantification of nutrient intake (Institute of Medicine, 2000). The consensus among nutrition and health researchers was that 24-hour recalls were best suited for most nutrition monitoring needs (Wright, Ervin, & Briefel, 1994).

The 24-hour recall has several strengths. It is relatively inexpensive and quick to administer. The 24-hour recall method is also considered more objective than many other methods (Lee & Nieman, 2003). It requires only short-term memory and generally well

accepted by respondents because the amount of time and effort is low. This acceptance makes possible the collection of an adequate probability sample within the population. This is important as the effectiveness of any survey method is contingent upon having a statistically adequate sampling frame (National Research Council, 1981).

The 24-hour recall has several limitations as well. The primary limitation of this method is the data is collected for a single day's diet. No matter how accurate the recall it is a poor descriptor of usual intake (Lee & Nieman, 2003). This is because of variability in the day-to-day food intake of an individual. Variability of intake may be intrasubject (within) and intersubject (between). Obtaining usual intake for individuals is particularly important if distributional analyses are the goal.

For an individual, an estimate of usual intake is possible if single day intakes are taken over long enough time periods and cover non-consecutive weekdays and weekends (National Research Council, 1981). The feasibility of doing many recalls per subject in a national survey is difficult so estimates of usual intake include a statistical adjustment to account for intrasubject variation by re-sampling a proportion of subjects (Wright, Ervin, & Briefel, 1994). Having many subjects completing a single recall addresses intersubject variation. On the other hand, if distributional analysis is not the goal and enough accurate data is collected then usual mean intake for a group is possible. If a sufficient number of recalls are collected then reasonable representation of the usual mean intake of a group(s) may be estimated (Wright, Ervin, & Briefel, 1994; Lee & Nieman, 2003).

Reporting errors are also of concern. These errors are called either under- or over-reporting. Errors might happen due to a respondent's memory, embarrassment, or need to impress. Food eaten but not reported are missing foods, while food reported but not eaten are phantom foods (Lee & Nieman, 2003). Responders are inclined to overreport healthy foods and underreport food perceived as unhealthy but underreporting is more typical. A review by Carter and Whiting (1998) reported that research indicated about 80% of adult subjects underreported what they ate and overall there is a tendency to underreport intake by an average 20 to 25% (Briefel, Sempos, McDowell, Chien, & Alaimo, 1997; Carter & Whiting, 1998; Institute of Medicine, 2000).

Underreporting food intake is a concept that started to emerge in the literature in the early 1980s (Beaton, 1994). Today, underreporting is widely recognized and recent

literature suggests that underreporting has become more prevalent and is associated with individual characteristics (Hirovonen, Männistö, Roos, & Pietinen, 1997; Black & Cole, 2001; Nielsen, Siega-Riz, & Popkin, 2002). Those groups likely to have higher rates for underreporting may include the overweight and obese, women, smokers, and the health conscious but these also differ among surveys and there is no way to separate those that happen to eat little from the underreporters. Differential effects of underreporting and the magnitude on intake estimates are difficult to determine and not well understood (Briefel, Sempos, McDowell, Chien, & Alaimo, 1997; Black & Cole, 2001).

Surveys that assess 24-hour recall data rely not only on the honesty and memory of the subjects but on the skill of the interviewer as well (Department of National Health and Welfare, 1975; Lee & Nieman, 2003). In a 24-hour recall, a trained interviewer asks the respondent to remember in detail all food and beverages consumed in the previous twenty-four hours. The skill and technique of the interviewer is essential for obtaining valid, reliable, and objective data (Department of National Health and Welfare, 1975; Institute of Medicine, 2000). To assist respondents with providing accurate information, three-dimensional food portion models and household measures are often used. Portion sizes are recorded and supplement use may also be noted. Probing to clarify information and enhance accuracy of recall also results in a substantial increase in the completeness of the recall (National Research Council, 1981).

Probing is generally accomplished by a multiple pass system. In the first pass a quick list of foods eaten in the previous day is obtained. The respondent uses any recall strategy they wish to remember the foods consumed the previous day. Wright, Ervin, & Briefel (1994) suggested that the interviewer should not interrupt the respondent in this step. The second pass gathers more detailed information. The interviewer asks questions about meal times, place, and additions such as cream in a coffee or beverage with a meal. In subsequent passes the interviewer requests additional details, inquiring about activities, brand names, and preparation methods may serve to cue a respondent and provide greater detail. After the interview, the recall is checked for omissions and mistakes. A respondent may be contacted at a later date for additional information (Lee & Nieman, 2003). Use of the multiple pass method and trained interviewers should assure the collection of accurate data and reduce reporting errors (Wright, Ervin, & Briefel, 1994; Lee & Nieman, 2003).

2.1.3 Adjusting for Usual Nutrient Intake

If the goal of a survey is distributional analysis, then assessing diets of a group requires usual nutrient intake data. When single 24-hour recall data are collected from respondents the distribution will include both intra and intersubject variability. On any given day an individual might eat more or less than usual. If the intake distributions are not adjusted for individual variability then the prevalence of inadequacy within the group will be over estimated (Institute of Medicine, 2000). Figure 2.1 illustrates this concept.

Adjusting for intrasubject variability involves collecting 24-hour recall data for two or more non-consecutive days. To try and guarantee independence between recall observations a gap of several days to no less than one week and on a different day than the initial recall is suggested (Institute of Medicine, 2000; Forster-Coull, Milne, & Barr, 2004). Collecting repeat measures from every respondent is not feasible in a large scale survey so only a subset of the sample is selected for a second recall. Provided that some individuals have two or more daily observations, an adjustment of the distribution is possible (Institute of Medicine, 2000). The result is a distribution with approximately the same median but the tails are reduced compared to the intake for one day (Figure 2.1). It is important to note that this does not produce a usual intake estimate for any particular individual. Once adjusted the distribution then only reflects intersubject variability which may be controlled using an appropriately selected and large study sample (Wright, Ervin, & Briefel, 1994; Lee & Nieman, 2003).

The subset should be randomly selected and represent the larger sample in respect to gender, age, socioeconomic variables (Wright, Ervin, & Briefel, 1994). The size of the subset depends on the purpose and goals of a survey. From recent research (Palaniappan, Cue, Payette, & Gray-Donald, 2003; Forster-Coull, Milne, & Barr, 2004; Gravel, 2006) most Canadian nutrition surveys select subsets of about 30% of the sample size. As long as data for any particular individual is collected on independent days then two recall days are sufficient for adjustment (Guenther, Kott & Carriquiry, 1997; Barr, Murphy, & Poos, 2002). Statistical methods for estimating usual intake distributions of dietary intake for a population were adapted from the National Research Council and Iowa State University recommendations (National Research Council, 1986; Wright, Ervin, & Briefel, 1994;

Guenther, Kott & Carriquiry, 1997; Institute of Medicine, 2000; Forster-Coull, Milne & Barr, 2004).

Generally the main goal of a national nutrition survey is to obtain usual intake at the population level to estimate proportions of the population having inadequate intake of the nutrients reported. Prevalence of inadequacy can point to the population groups likely to have problems or no problems consuming adequate amounts of a nutrient. Comparing adjusted nutrient intake to a reference to calculate a prevalence of inadequacy estimate is discussed in Section 2.2.

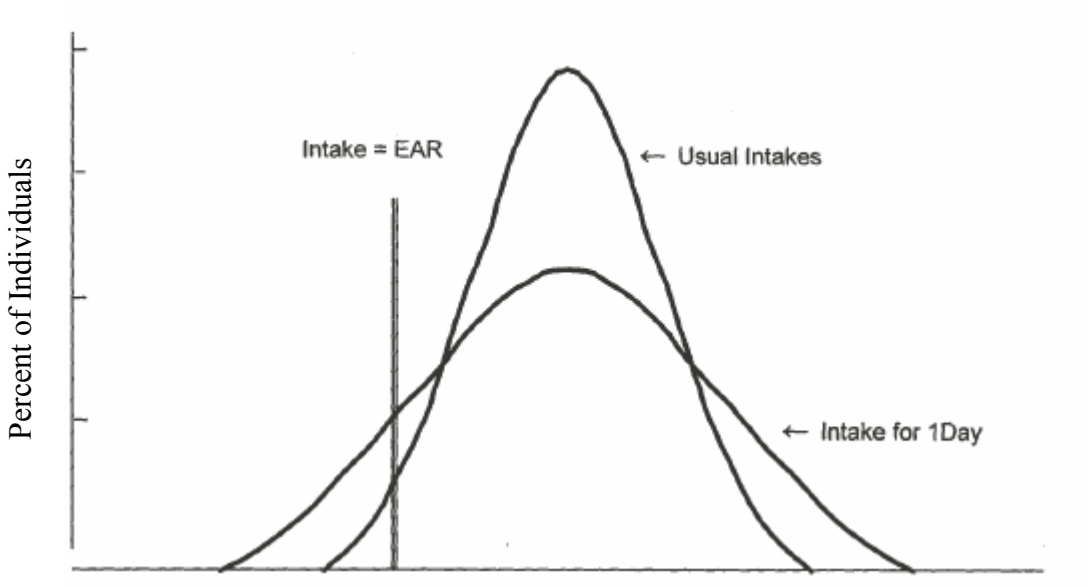

Figure 2.1. Distribution estimates of dietary intake obtained from one day unadjusted and statistically adjusted data. Redrawn from Barr, Murphy & Poos (2002). Note that the proportion of the group to the left the vertical line (EAR) would be overestimated if the one-day distribution was used instead of the usual intake distribution. EAR (Estimated Average Requirement) is the cut off point to estimate the proportion of the population with inadequate nutrient intake.

2.2 Dietary Recommendations in Canada

Dietary standards are recommendations for the quantity of energy and nutrients proposed as daily intakes for healthy individuals which serve to measure progress and set

goals for good nutrition (Institute of Medicine, 2000). Knowledge about human nutrition continues to grow so cumulative scientific and theoretical data are the basis for reviewing and determining these intake recommendations. Factors that may influence requirements such as age, sex, body weight, and physiological status are also considered. If availability of data is lacking or there is uncertainty then scientific judgment may be required to set a recommendation or there may be no recommendation (Health and Welfare Canada, 1964; Department of National Health and Welfare, 1973; Institute of Medicine, 2000). It is very important to remember that recommendations are set using the current science at the time of a review.

The Canadian recommendations of nutrient requirements were developed so the health of the majority of Canadians would be met without encouraging excess (Health and Welfare Canada, 1964). In 1938, the Canadian Council on Nutrition issued the first standard for use in Canada. This first guide was established from observed customary patterns of consumption or amounts actually ingested. Revisions to the dietary standards were published in 1942, 1950, and 1964. In 1969 a committee developed an interpretive standard used in the NCS (Section 2.4.3.). Revisions to Canadian recommendations were published again in 1975, 1983, and 1990. From 1997 through 2005 the Dietary Reference Intakes (DRIs) were adopted and published as Canadian standards as outlined below.

Table 2.2 begins with the 1964 Dietary Standard in use in Canada during the time of the NCS, includes the interpretive standard developed in 1969 specifically for NC, and follows through to the DRIs. Nutrients for this table were selected because these nutrients were reported in the NCS (Department of National Health and Welfare, 1973 & 1975) or because they demonstrated a relatively large change in value or unit of measure. Current recommendations for vitamin C for women are two and a half times 1964 values, calcium for women up to age 50 years are twice the 1964 value, and the iron value for women up to 50 years of age are almost double that of 1964. There was no dietary recommendation for folate until 1975 as there was a lack of knowledge regarding the folate content of food (Department of National Health and Welfare, 1973 & 1975). The unit used in the DRIs to measure folate is also different from that used from 1975 to 1990. Previous to 1997, units were micrograms (μg) of food folate. DRIs use Dietary Folate Equivalents (DFEs) which

include folate and folic acid (Institute of Medicine, 1998). Because one µg of food folate equals one DFE, inferences between the two measures may be made.

Canadian recommendations have evolved from 'requirement' and 'allowance' to 'reference' values. The understanding of human nutrition has also evolved and nutritional concerns have changed. Because of new knowledge, limitations in the recommendations became apparent (Lee & Nieman, 2003). Early in the development of Canadian standards it was emphasized that frequent revision was to be expected because of limitations in the data (Department of National Health and Welfare, 1960). Deficiency disease prevention was the original intent but recently the focus has become chronic degenerative diseases. There has been a growing interest in the role of diet, nutrition, disease prevention, and health (Health and Welfare Canada, 1990; Lee & Nieman, 2003; Thompson, Manore, & Sheeshka, 2005). Regardless of name and focus changes these recommendations continue to serve as a tool to maintain health in an already healthy individual (Health and Welfare Canada, 1983; Institute of Medicine, 2000).

The most recent revisions are the Dietary Reference Intakes (DRIs). The DRIs were published between 1997 and 2005 based on a collaborative effort of American and Canadian scientists. The DRIs are quantitative estimates of nutrient intake for apparently healthy people and standardized the recommendations for Canada and the United States (Institute of Medicine, 2000; Lee & Nieman, 2003). This set of current recommendations considered cumulative scientific and theoretical data, sufficiency of those data, deficiency disease, chronic disease, adverse health effects from high intake, and criterion that would determine nutritional adequacy of each nutrient (Institute of Medicine, 2000). They have specified applications and contain values for twenty-two groups of females and males of different age and physiologic condition. DRIs are a set of four reference values which are the Estimated Average Requirement (EAR), Recommended Dietary Allowance (RDA), Adequate Intake (AI), and the Tolerable Upper Intake Level (UL) (Institute of Medicine, 2000).

Table 2.2. Canadian recommendations for nutrient intake; changes in the reference value of selected nutrients over time for adults

1964 Dietary Standard	1969 Interpretive Standard "adequate"	1975 Dietary Standard	1983 Recommended Nutrient Intake	1990 Recommended Nutrient Intake	1997-2001 Dietary Reference Intake (RDA or AI)[a]
Vitamin A (RE)					**Vitamin A (RAE)**
20+ y	17+ y	19+ y F	19+ y F	19+ y F	19+ y F
750	750	800	800	800	700µg
Vitamin C (mg)					
20+ y	6+ y	19+ y	19+ y M / F	19+ y M / F	19+ y M / F
30	30	30	60 / 45	40 / 30	90 / 75
Vitamin D (µg)					
No adult	No adult	19+ y	19+ y	19-49 y / 50+ y	19-50 y / 51-70 y
recommendation	recommendation	2.5	2.5	2.5 / 5	5 / 10*
Calcium (mg)					
20+ y	22+ y	19+ y M / F	19-49 y M / F	19-49 y M / F	19-50 y / 51+ y
500	500	800 / 700	800 / 700	800 / 700	1000 / 1200 *
Thiamine (mg)					
20+ y	13+ y	19-35 y M / F	19+ y	19-24yM / 25-49yM	19+ y M / F
		36+ y M / F		19+ y F	
0.6	0.8	1.5 / 1.1	0.8	1.2 / 1.1	1.2 / 1.0
		1.4 / 1.0		0.8	
Riboflavin (mg)					
20+ y	13+ y	19-35 y M / F	19+ y	19-24 y M / F	19+ y M / F
		36+ y M / F		25-49 y M / F	
1.0	1.1	1.8 / 1.3	1.0	1.5 / 1.1	1.3 / 1.1
		1.7 / 1.2		1.4 / 1.0	
Niacin (mg)	**Niacin (NE)**				
20+ y	13+ y	19-35 y M / F	19+ y	19-24 y M / F	19+ y M / F
		36+ y M / F		25-49 y M / F	
6	13.2	20 / 14	14.4	22 / 15	16 / 14
		18 / 13		19 / 14	
Iron (mg)					
17+ y M / F	17+yM / 17-54yF	19+yM / 19-50yF	19-49 y M / F	19-49 y M / F	19+ y M / 19-50 y F
6 / 10	10 / 15	10 / 14	8 / 14	9 / 13	8 / 18
Folate (µg)					**Folate (DFE)**
No dietary value	No dietary value	19+ y	19-24 y M / F	19-24 y M / F	19+ y
			25-49 y M / F	25-49 y M / F	
		200	210 / 175	220 / 180	400µg
			220 / 175	230 / 185	

The values in this table are from Health & Welfare Canada 1964, 1983, 1990; NCS reports 1973, 1975; and the Institute of Medicine, Dietary Reference Intake reports 1997, 1998, 2000, and 2001.
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
RAE (retinol activity equivalents) 1 RAE = 1 µg retinol, 12 µg β-carotene, 24 µg α-carotene, 24 µg β-crypoxathin
DFE (dietary folate equivalents)
1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
[a] RDA (recommended dietary allowance), AI (adequate intake)
* Adequate Intake value
µg = micrograms; mg = milligrams; M = male; F = female; y = years of age

The EAR is the average daily intake level estimated to meet the needs of 50% of healthy individuals in a specified age and gender group. The term average is used but an EAR is actually an estimated median requirement. RDA is the average daily intake level which would be sufficient to meet the needs of 97% to 98% of the healthy individuals in a specified age and gender group. An RDA is calculated from an EAR and cannot be set without an EAR (Institute of Medicine, 2000). AI is a recommended average daily intake based upon observed or experimentally derived estimates of nutrient intake of apparently healthy groups of people that are assumed adequate. The AI is a group mean. AIs are set where an RDA cannot be determined because data were insufficient to set an EAR. This means that for nutrients with an AI, there is no EAR or RDA. The UL is the highest level of continuing daily intake likely to pose no risk of adverse effects to health for almost all individuals but it is not a recommended level of intake. The UL may include intake from supplements, fortification, or medications, as well as diet (Barr, Murphy, & Poos, 2002). These DRIs are used for the assessment of nutrient intakes of individuals or groups. This study examined population data for age and gender groups so Section 2.3 will focus on the evaluation of groups.

2.3 Dietary Assessment of Groups

Assessing a group(s) nutrient adequacy requires accurate intake data, an adjusted distribution, the appropriate DRI reference, and appropriate interpretation of those results (Institute of Medicine, 2000). Assessment should compare the distribution of individual group members' usual intake with the distribution of the nutrient requirement. Typically the percentage of the group whose usual intake is less than the EAR is estimated, which provides prevalence of inadequacy estimates. The proportion of the group likely to be at some risk for adverse health effects can be estimated from usual intake above the UL. If the intake distribution is not properly adjusted, the inappropriate reference is used, or the interpretation is faulty then estimates may be incorrect (Institute of Medicine, 2000).

This is an assessment for nutrient intakes not an assessment for nutritional status. Health and nutritional status for individuals or groups must include biochemical, clinical, and anthropometric data (Institute of Medicine, 2000). Nutrient intake is compared to the reference standard to determine the size and type of population group considered to be at

risk for inadequate intake. To accomplish this, usual intake is required. As seen in Figure 2.1 this is important because it affects the distribution. If distribution is wide the number of people considered inadequate or excessive may be incorrect. Accuracy of the estimate not only depends on good quality dietary data but on consideration of the daily variation effect of an individual's actual intake (Barr, Murphy, & Poos, 2002).

The EAR is the primary reference for assessing the nutrient intakes of population groups. Nutrients with an EAR are assessed using a probability approach or the cut-point method. For these methods a few assumptions are made. The distributions for intake and requirement are independent and the shape, median (EAR), and variance of requirements must be known (Institute of Medicine, 2000). The statistical foundations and justification for these methods have been published (Institute of Medicine, 2000).

The probability approach is a statistical method that combines the distribution of requirement and the distribution of intake for the group (Institute of Medicine, 2000). A risk curve is constructed from information on the requirement of the group. This specifies the probability that a given intake is inadequate for an individual consuming that intake. For example, if intake equals the EAR then the probability of inadequacy is 50% for all nutrients whose requirement distribution is normal (Institute of Medicine, 2000). A risk value is assigned to each individual group member's usual intake and the group value is the average of those individual risks. In practice, probability approach is used when the cut-point method is not appropriate. Statistical programs are available to carry out these procedures (Institute of Medicine, 2000).

The cut-point method is a simpler version of the probability approach. It is not necessary to know the exact requirement distribution to use this method but it should be symmetrical around the EAR, i.e. normal. This is believed true for most nutrients but is known not to be true for iron (Barr, Murphy, & Poos, 2002). Basically, one counts the number of individuals reporting an intake below the EAR which is the proportion of the group with inadequate intakes (Institute of Medicine, 2000). The cut-point method is not used for iron in menstruating women because it underestimates prevalence of inadequacy as requirement is not symmetrical for this group (Institute of Medicine, 2000).

For nutrients without an EAR there is an AI but prevalence of inadequacy cannot be determined from an AI (Institute of Medicine, 2000). The AI is based on mean intakes

of apparently health groups of people and as such is experimental. This means there was not enough evidence to set the distribution of requirement for these nutrients. Individuals with intake below the AI cannot be interpreted as inadequate but may identify population intakes of the nutrient as a potential concern (Forster-Coull, Milne, & Barr, 2004). When mean or median nutrient intake of the group equals or exceeds the AI, it is likely that the prevalence of inadequacy is low (Institute of Medicine, 2000; Barr, Murphy, Poos, 2002).

In the DRIs, the RDA is not designed to be a cut-point measure. The RDA is an intake level exceeding the needs of almost all individuals when requirement has a normal distribution (Institute of Medicine, 2000). In the past, studies often compared group mean intake to the RDA concluding that if mean intake equaled or was above the RDA then the group diets were adequate. This is misleading because even when mean intakes equal the RDA, some in the group may have usual intake less than the EAR (Institute of Medicine, 2000; Barr, Murphy, & Poos, 2002). Mean and median intake estimations do not include measures of variation, as a result prevalence of inadequacy cannot be determined. A low probability of inadequacy may be implied however, when the mean nutrient intake of the group exceeds the RDA (Institute of Medicine, 2000).

The last reference value used in the assessment of group diets is the UL. As intake increases above the UL, the possibility of an adverse health effect increases. At this time the magnitude of that risk is unknown so UL values are a cut-off for safe intake (Institute of Medicine, 2000). The same technique is applied here as for the EAR cut-point method; the proportion of the group with intake above the UL is counted. To assess the proportion of the population with usual nutrient intake above the UL, consumption information from all sources of food, supplements, fortification, and medications are required for nutrients such as vitamin C, calcium, and iron. The UL for folate is based on the intake of fortified foods and supplements and the UL for other nutrients is based on intake information from supplements, fortification, or medications (Barr, Murphy, & Poos, 2002). It is unlikely that micronutrient ULs will be exceeded from consumption of food alone.

It is more appropriate to compare the prevalence of inadequacy estimates for two or more groups than mean or median intake (Institute of Medicine, 2000) but recently the nutrient density method is gaining favor because it emphasizes nutritional quality of diet. Nutrient density is the ratio of a nutrient to total dietary energy for a specified kilocalorie

(kcal) amount. Quantity per 1000 kcal of energy is most often expressed (Lee & Nieman, 2003). Expressing intake in this manner helps control for confounding variables such as energy (National Research Council, 1981) because the ratio is independent of the amount of energy consumed by the group. This allows for direct comparison of intakes when two or more groups are assessed, especially if diets are very low in or very different in energy (Lee & Nieman, 2003). Energy is the most appropriate common denominator to compare diets and the evaluation is simple and quick (Drewnowski, 2005). As a diet quality index, nutrient density may be compared to a nutrient standard. The general concept is that if the quantity of nutrient per 1000 kcal is great enough, then one's nutrient needs would be met if energy needs are met (Lee & Nieman, 2003). Theoretical and quantitative applications for nutrient density for public health have been published (Backstrand, 2003; Institute of Medicine, 2003).

2.4 Nutrition Survey Review

Diet is a major contributor to nutritional status and population health. Periodic monitoring is necessary for the development of effective health and nutrition programs and policies. Assessing trends in dietary intake is essential to understanding the role of diet and nutrient intake in public health (Briefel & Johnson, 2004). National nutrition surveys are a primary source of dietary information and ongoing nutrition surveillance and monitoring is important (National Institute of Nutrition, 1997; McAmmond, 2000; Lee & Nieman, 2003).

National data describing dietary intakes in Canada are limited. Canada does not have a systematic surveillance system in place that monitors its population's nutritional status and longitudinal data are nearly non-existent (National Institute of Nutrition, 1997; McAmmond, 2000). In contrast, the United States has an extensive nutrition monitoring system. Results collected through that American system have been used to justify many changes in government policy and spending that are related to food, nutrition, and health promotion (Lee & Nieman, 2003). American national nutrition surveillance programs are considered to be well worth the expense and to contribute greatly to the policy, programs, and outcomes affecting the overall health of Americans (McAmmond, 2000).

National surveys assessing nutritional status provide valuable information for the direction of nutrition policies and programs that affect the overall health of a country's population (Department of National Health and Welfare, 1973; Hendricks, 1993; Briefel & Johnson, 2004). Nutrition data are also utilized to develop dietary guidelines and other reference tools used by health professionals for public education (Institute of Medicine, 2000; Lee & Nieman, 2003). The commonly referenced Canadian national nutrition data in much of the nutrition research were from 1970/72 so American survey data have been a surrogate information source for Canadian eating habits (Institute of Medicine, 2000).

Because American data have been used, a review of nutrition surveys in Canada and the United States containing a dietary intake segment was compiled. Table 2.3 is an overview of the completed or continuing nutrition monitoring practiced through surveys in each country. These surveys attempt to collect, analyze, and interpret food and nutrient intake information (McAmmond, 2000; Lee & Nieman, 2003). American surveys are also used to identify probable temporal trends in the food and nutrient intake of the population (Nielsen, Siega-Riz, & Popkin, 2002; Briefel & Johnson, 2004). NHANES data helped to develop, evaluate, and revise such tools as the infant and child growth charts, fortification regulations, and an American cholesterol education program (Lee & Nieman, 2003). NCS data led to mandatory food fortification expansion for Canada (Nathoo, Holmes, & Ostry, 2005). The DRI reports included CSFII, NHANES, and selected provincial survey data to show usual mean intakes and percentiles, reference heights and weights, and as evidence to support recommendations (Institute of Medicine, 1998; 2000; 2001).

Only the NCS and NHANES are nutritional status surveys because they included clinical and medical parameters. Although most nutrition surveys are not status surveys, they provide important dietary information. Nutrient intake measurement from the dietary component of the survey is a widely used surrogate for nutritional status (Lee & Nieman, 2003). Canadians may be similar to Americans in population and health issues but are not identical, especially regarding food fortification (Institute of Medicine, 2003). There is a need for Canada to have a systematic national nutrition monitoring program to determine trends in Canadian nutrient intake (Hendricks, 1993; McAmmond, 2000).

Table 2.3. Canadian and American nutrition surveys and data collection year(s)

Canada[1]	**United States**[2]	
NCS	NHANES (I, II, III)	NFCS
1970-1972	1971-1975	1977-1978
	1976-1980	1987-1988
Provincial Nutrition Surveys[3]	1988-1994	
1990-1999		CSFII
		1985-1986
FHC	NHANES[4]	1989-1991
1997-1998	1999-2000	1994-1996
	2001-2002	1997-1998
CCHS	2003-2004	
2004	2005-2006	

[1] McAmmond (2000), Statistics Canada (2005)
[2] Lee & Nieman (2003)
[3] Nutrition surveys conducted individually by ten Canadian provinces, excluding the Territories
[4] Continuous survey, conducted in two-year collection cycles
NCS = Nutrition Canada Survey
FHC = Food Habits of Canadians
CCHS = Canadian Community Health Survey cycle 2.2 (nutrition)
NHANES = National Health and Nutrition Examination Survey
NFCS = National Food Consumption Survey
CSFII = Continuing Survey of Food Intake of Individuals

The 1970/72 NCS was the first study of nutritional status conducted in Canada and of an entire industrialized nation (Department of National Health and Welfare, 1973; Enloe, 1974). Designed to be a beginning, the objective was to provide a body of precise scientific information about the Canadian population's nutritional status (Department of National Health and Welfare, 1973). NCS researchers felt that the information would be useful in identifying areas where research could improve the knowledge of professionals, regulatory agencies, and the public. Although intended as first of a continuous monitoring effort in Canada, another survey with this same scope has yet to be completed. Because it was first, the NCS will be discussed in detail in section 2.5.

The provincial nutrition surveys were initiatives supported by Universities and Industry under the auspices of Health Canada and Statistics Canada. During the 1990s

each province conducted an independent survey but with similar methodology. Provincial surveys were undertaken because the Canadian heart health programs identified nutrition related risk factors and gaps in the publics' dietary knowledge (MacLean, 1993; Stephen & Reeder, 2001). In addition, baseline information about dietary intakes in the provincial populations was limited and out-of-date (Roebothan, 2003; Forster-Coull, Milne, & Barr, 2004). All ten provincial surveys had common dietary intake collection tools but selected additional add on questionnaires which varied by province reflecting provincial priorities. Sections 3.1 and 3.2 discuss further details.

The Food Habits of Canadians (FHC) was a national nutrition survey conducted by researchers from McGill University during 1997/98. The primary purpose of the FHC was to monitor whether changes occurred in dietary intake since the last Canadian dietary survey in 1970/72 (Gray-Donald, Jacobs-Starkey, & Johnson-Down, 2000; Pasut, 2001). The FHC selected their study sample by regions and although a very important work the FHC had limitations with response rate and sample size.

The 2004 Canadian Community Health Survey (CCHS) Cycle 2.2 nutrition is the most recent dietary survey completed. This version of the survey came about because the previous national level survey completed under the auspices of the Canadian government was from 1970/72 and having current Canadian food and nutrient data were considered a priority (Garriguet, 2006). Obesity, general health, and preliminary food group data were available but national and provincial nutrient intake pattern reports are expected in 2007 (Gravel, 2006).

Table 2.4 compared some components of the Canadian nutrition surveys that were completed in the years between 1970 and 2004. This also helps demonstrate the rationale for utilizing the provincial nutrition surveys to estimate a 1990s national level monitoring point. All studies used established valid survey protocols and procedures and had similar exclusion criteria for the general population. Common exclusions included those living in institutions, serving in the military or on a base, remote geographic locations, Aboriginals living on a reserve, pregnant or lactating women, and Territories (Department of National Health and Welfare, 1973, 1975; Gray-Donald, Jacobs-Starkey, & Johnson-Down, 2000; Fitzgerald, Maclean, & Veugelers, 2002; Gravel, 2006). Each survey collected data from differing age ranges and this thesis only considered adult ages.

Information in Table 2.4 also shows that all Canadian nutrition surveys reported the same dietary collection method, the 24-hour recall. Most collected information about supplement use although not all published reports. Each reported group mean intake data from the assessment of food intake only. All but the NCS statistically adjusted for intra-subject variability. The extent of possible bias cannot be determined but values of group mean intake are not necessarily biased (Wright, Ervin, & Briefel, 1994).

Survey non-response occurs when selected subjects cannot be contacted, refuse to participate, or are unable to answer. People who choose to participate in a survey may be more interested in nutrition and other healthy behaviors than those who do not and if the response rate is low, results may present a favorable picture (Sabry, Campbell, Campbell, & Forbes, 1974; Forster-Coull, Milne, & Barr, 2004). The method of analyzing and effect of non-response may differ among surveys. If the nutritional characteristics of responders and non-responders are similar, then bias in nutrient intake estimates are likely small and difficult to detect (Balram, Villalon, McCaie-Burke, Ericson, & Boyne, 2005). Effects of non-response and its magnitude are difficult to assess, cannot be eliminated by weighting, and there is no acceptable or unacceptable non-response level (Roebothan, 2003; Forster-Coull, Milne, & Barr, 2004).

The NCS and CCHS are considered reliable national level surveys with published response rates of 46% and 77% respectively (Department of National health and Welfare, 1973; Gravel, 2006). The CCHS reported it is representative for the Canadian population, whereas Sabry, Campbell, Campbell, and Forbes (1974) stated history must decide if the NCS was. The total number of adults studied throughout the provincial surveys is similar to that reported nationally by the CCHS and the national sample size reported in the FHC is about the same as one provincial survey. Collectively, the provincial nutrition surveys would provide a reasonable estimate of nutrient intakes in the Canadian adult population given their overall favorable response rates and relatively large sample sizes.

Table 2.4. Components of nutrition surveys conducted in Canada

Survey (Year)	Interview	Dietary Assessment Method	Physical Measures	Questionnaire[c]	Examinations	Age Range (adult)	Studied Subjects (adult)	Response Rate (%)[i]
NCS (1970/72)	In-person	24-hr recall[a] FFQ[b]	Direct	Yes	Dental Clinical Biochemical	20-65+	7,036[e]	46
Provincial Nutrition Surveys (1990-99)	In-person	24-hr recall FFQ[b]	Direct	Yes	None	18-74[d]	1,187-2,212[f]	29-80[j]
FHC (1997/98)	In person	24-hr recall	Self report	Yes	None	18-65	1,544[g]	30
CCHS (2004)	Telephone In-person	24-hr recall	Direct Self report	Yes	None	19-71+	20,197[h]	77

Data from the NCS 1973 report, provincial nutrition surveys conducted 1990-99, Gray-Donald et.al. (2000), and Statistics Canada 2005
NCS: Nutrition Canada Survey; FHC: Food Habits of Canadians; CCHS: Canadian Community Health Survey cycle 2.2 (nutrition)
[a] Repeat recalls were not completed to adjust for intrasubject variability to estimate usual intake
[b] Data collected not reported
[c] Questionnaires might include sociodemographic, non-response, nutrition knowledge, attitudes, health, physical activity, food security, and supplement use.
[d] Required age range for ten provinces, British Columbia also included a 75-84 year age group (Table 3.2)
[e] Subject age and sample size of full survey 0-65+ years = 12,795
[f] Range of reported studied subjects for nine provinces (Table 3.2). Total for nine provinces = 16,915 does not include Manitoba as data was unavailable
[g] Also collected separate data from 178 adolescents 13-17 years
[h] Subject age and sample size for full survey 0-71+ years = 35,107
[i] Rates presented are % reported for total survey response
[j] Range of response rates reported by nine provincial nutrition surveys. Does not include Manitoba as data was unavailable
FFQ = Food Frequency Questionnaire

2.5 Nutrition Canada Survey

2.5.1 Introduction to the Nutrition Canada Survey

In 1964 the Canadian Council on Nutrition recommended a proposal for a comprehensive nutrition survey of Canada. The council reported that it was extremely important to be able to assess nutritional health. That proposal was called *Nutrition Canada* and was the first such initiative undertaken in Canada (Department of National Health and Welfare, 1973). The Nutrition Canada Survey (NCS) gained approval in 1969 after the Food and Drug Directorate completed a feasibility study for such an enormous undertaking. The NCS is unique because although completed for the government it was conducted independent of their influence. The NCS was completed between September 1970 and December 1972 with results presented to parliament in November 1973. The NCS is historically important because it was the first national nutritional health survey in Canada (Sabry, Campbell, Campbell, & Forbes, 1974; Enloe, 1974).

Data and a description of results, recommendations, and priorities were tabled from the information collected by the NCS and published in two main reports. The two reports are titled Nutrition Canada, Nutrition: A National Priority (1973) and Nutrition Canada, Food Consumption Patterns Report (1975). The first report presented details on the survey methodology, national median intake data, and estimated the proportion of the population at nutritional risk. The second report tabled national and regional mean intake data and made comments on the nutritional adequacy of group diets. That second report also commented on differences in food intake between the regions. During 1974, twelve additional volumes were published that addressed specific details on diet and prevalence of nutritional abnormalities in each province, among Aboriginals (Indians) on reserves, and Inuit (Eskimos) in settlements (Sabry, Campbell, Campbell, & Forbes, 1974). This thesis focused on information provided by the two main reports of national assessment.

2.5.2 Methodology of the Nutrition Canada Survey

The NCS was a comprehensive survey of nutritional status. The survey included demographic and general questionnaires, and a dietary assessment component as well as anthropometric, medical, dental, and biochemical parameters. All of these components

are required to make direct determinations of nutritional status (Department of National Health and Welfare, 1973; Institute of Medicine, 2000). Experts developed the valid and practical procedures used for the assessment of nutritional status of Canadians. The Food and Drug Directorate, Statistics Canada, and several Canadian Universities provided this input. A team of professionals implemented the protocols across the country (Department of National Health and Welfare, 1973). Three key committees completed data processing and analysis: Data Processing, Data Interpretation, and Report Preparation.

The NCS was designed to provide estimates of nutritional characteristics for three populations groups. The main group comprised of residents from the ten provinces. This group is the one to which all further reference to the NCS apply in this thesis. Group two included provincial and territorial Aboriginals (Indians) living on reserve or crown lands. The third group consisted of Inuit (Eskimos) living in Eskimo Point, Pelly Bay, Frobisher Bay, and Coppermine. Also surveyed for each group were women in their third trimester of pregnancy. Because local health units referred these women they were not probability samples (Department of National Health and Welfare, 1973). NCS researchers developed three separate sample designs to address issues related to the population groups. Specifics about survey design and respondents for each sample strata were published in the report (Department of National Health and Welfare, 1973).

A stratified, three-stage, probability sample design was implemented. Canadian census information from 1961 and 1966 were used to obtain a sample by population type (rural, urban, and metropolitan), region, income, and season. Households were randomly selected then individuals randomly selected from within those households. Respondents included age and gender groups from 0 to 65+ years. Approximately 13,000 people were surveyed in the main group (7,000 adults 19 years plus) with a reported response rate of 46% (Department of National Health and Welfare, 1973).

Trained survey team professionals administered the survey and completed the questionnaires for the subjects during in person interviews. The professionals included dietitians, dentists, nurses, lab technicians, hygienists, and support staff. Data collection covered two seasons corresponding with winter and summer. It was expected that season would influence food habits. An advance team conducted home visits first and collected socio-demographic, food buying, and food preparation information and then scheduled an

appointment for a clinic visit about a week later. Clinics took place at a local school or church hall (Monday to Friday) where the interviews took place. In two hours the dietary interview, anthropometric measures, medical, and dental exam were done and blood and urine samples collected (Department of National Health and Welfare, 1973).

The NCS dietary interview comprised of a single 24-hour recall which included vitamin and mineral supplements and a food frequency questionnaire (FFQ). Supplement use was included in the initial assessment report but not in the mean intake re-assessment. Interviewers utilized the multiple pass method and three dimensional food portion models to increase intake accuracy. The FFQ contained a list of seventy-eight foods designed to gather information on possible food additive consumption. The FFQ could not be used to assess nutrient intake or food consumption patterns because the number of foods was so limited (Department of National Health and Welfare, 1975).

Food composition tables of the United States Department of Agriculture (USDA) were the basis of the nutrient composition database used in the NCS. Updates included uniquely Canadian foods or foods affected by Canadian regulations. Foods not available in the USDA included convenience foods, wild game, and enriched foods. Folate values were added to the database for the 1975 re-assessment. Because limited data about food folate composition was available some assumptions were drawn. The amount of folate in cooked vegetables was taken to be 50% of the raw value for example. Also, if data were lacking, published values or additional analyses completed by Health Protection Branch Research Laboratories were used (Department of Health and Welfare, 1975). There was a quality assurance system to minimize data handling errors. Specialized staff reviewed all forms before the information was sent to data entry and NC monitored each phase of the data processing operation so the quality of collected data was maintained (Department of National Health and Welfare, 1973).

2.5.3 Evaluation and Reporting of Nutrition Canada Survey Data

The NCS presented group data from single 24-hour recalls and as a result the data contained a wide distribution that does not occur when intake data are adjusted. The first document reported median nutrient intakes from food and supplements and estimated the percentage of individuals considered at nutritional risk based on the interpretive standard

(Department of National Health and Welfare, 1973). However, because the NCS did not statistically adjust for intrasubject variability inadequacy may be overestimated. Percent of the population considered inadequate was measured against the interpretive standard.

The Committee on Standards and Data Interpretation developed this interpretive standard in 1969. The standard was set based on the available scientific knowledge and contained specific criteria defined to assess inadequate intake. It included classification levels for inadequate, less-than-adequate, and adequate nutrient determinations. Cut-off points corresponded to below the desirable nutrient intake, above minimum requirement but below desirable, and provides desirable margin of safety respectively (Department of National Health and Welfare, 1973). The adequate cut off was similar to the 1964 dietary standard in use at the time (Table 2.2).

The 1975 NCS report re-assessed the dietary intake data collected from 1970/72 and reported it as national group mean and regional group mean intakes. The 1975 report assessed intake from food alone and did not include the use of supplements (Department of National Health and Welfare, 1975). This report did not attempt to classify individuals at risk or estimate proportions of the population with an inadequate intake. This report calculated the arithmetic mean for each reported nutrient intake value. Although the mean is less stable than the median and it is influenced by extremes in the distribution, it can be added and more can be done statistically. For example, mean intake of calcium is the sum of the means for milk, cheese, and other dairy products whereas median values might not be the sum of all medians (Department of National Health and Welfare, 1975).

2.5.4 Reported Nutrition Canada Survey Results

The NCS found no consistent influence on nutritional status or dietary intake from season, income, or population type, therefore the Canadian food distribution system was deemed effective (Department of Health and Welfare, 1973). There appeared to be equal access to food however, the researchers acknowledged that this finding did not exclude the possibility that low income adversely affected diet. Even though season was expected to influence food habits and thereby nutrient intake, this expectation was not supported by the assessment. Dietary intake data showed that even if consumption of some foods decreased in a particular season there was a concurrent increase in another food. For

example, vegetable intake decreased in the winter but fruit intake increased. Nutrients associated with vegetable and fruit consumption did not appear influenced by summer or winter (Department of National Health and Welfare, 1973; 1975). Seasonal food usage patterns do occur but when food intakes are converted to nutrient intakes, true seasonal effects are hard to find (Beaton, 1994).

The incidence of overweight and obesity was a concern. More than half the adult Canadian population was overweight. For some age/gender categories the incidence was considered extreme (Department of National Health and Welfare, 1973). The NCS used the Ponderal Index ($^{\text{height (in)}}/_{\text{cubic root weight (lbs)}}$) which was the precursor to the Body Mass Index ($^{\text{weight (kg)}}/_{\text{height (m}^2\text{)}}$). Depending on stature the Ponderal Index may classify subjects as overweight where the Body Mass Index classifies normal. Caloric intake itself could not account for apparent weight problems and researchers cited lack of physical activity suggesting obesity was largely a self-inflicted problem (Department of National Health and Welfare, 1973). Nutrients of greatest concern were iron, calcium, thiamin, and folate and generally for these nutrients inadequacy was more prevalent in women.

For adults age 20 to 39 years, men ate approximately 1300 more kcals and had higher intakes for all nutrients than the women. Although men consumed more grams of fat and protein than women, the distribution of energy for these two macronutrients was similar. Based on mean nutrient intake from the 1975 NCS report, iron intake for females in this age group was below the recommendation. Reported mean intakes of calcium and thiamin in females were assessed 'borderline' because the mean values barely exceeded recommendations. Mean folate intake for males and females in this group was below the recommended intake value. Group mean intakes for other reported nutrients were above the recommended values for adults in this age group (Department of National Health and Welfare, 1975). The percentage of women age 20 to 39 years at nutritional risk from poor calcium, iron, and vitamin C intakes were 42%, 76%, and 21% respectively (Department of National Health and Welfare, 1973).

For adults aged 40 to 64 years, men ate more energy (945 kcal) than women and had higher mean nutrient intakes for all but vitamin C. Again the distribution of fat and protein was similar between the genders even though men consumed more grams of fat and protein. Mean nutrient intake results in the 1975 NCS report showed calcium intake

fell below recommendations and iron intake was described as 'borderline' in females. For both males and females reported mean intake of thiamin and folate fell below and mean intake for other nutrients exceeded recommendations. The percentage of women 40 to 64 years of age reported at nutritional risk for calcium, iron, and vitamin C were 44%, 67%, and 17% respectively (Department of National Health and Welfare, 1973).

For the eldest age group (65+ years), men consumed more energy (526 kcal) than women. Except for vitamin C, men also had higher nutrient intakes. There was the same pattern of fat and protein intake for this age group as was seen in the other age categories. Both genders reported mean intake values below recommendations for calcium, thiamin, and folate and above recommendations for the other assessed nutrients (Department of National Health and Welfare, 1975). The proportion of women 65 years and older listed at nutritional risk for calcium, iron, and vitamin C were 48%, 56%, and 13% respectively (Department of National Health and Welfare, 1973).

Table 2.5 presents the NCS reported national mean nutrient intake data assessed from the consumption of food only. The mean nutrient intake values reported in NC were energy, macronutrients (protein, carbohydrate, fat), fibre, and eight micronutrients. Mean nutrient intake data were taken from the adult population of ten provinces from the 1975 NCS publication. The numbers of reported respondents for each age and gender category are included. Nutrient intake data for children and adolescents reported in the 1975 report were not included here (Department of National Health and Welfare, 1975). The NCS did not report the mean percentage of distribution for energy from protein, carbohydrate, and fat from their raw data so approximate estimates were calculated from mean values listed in Table 2.5 and presented in Table 2.6. Formulas used to calculate distribution are based on the Atwater factors using the following formulas. % protein = grams protein x 4 / energy x 100; % carbohydrate = grams carbohydrate x 4 / energy x 100; and % fat = grams fat x 9 / energy x 100.

Table 2.5. Reported national mean nutrient intake from food of the Canadian adult population by age and gender from the 1970/72 Nutrition Canada Survey[1]

	Males			Females		
	20-39	**40-64**	**65+**	**20-39**	**40-64**	**65+**
	n = 999	n = 1222	n = 881	n = 1347	n = 1500	n = 818
Energy, kcal	3370	2670	2060	2000	1730	1530
Protein, g	119	94	72	72	63	54
Carbohydrate, g	351	286	235	227	197	187
Fat, g	154	118	89	89	75	63
Fibre, g	4.61	4.16	3.86	3.20	3.37	3.30
Calcium, mg	1080	883	709	709	613	619
Iron, mg	18.0	16.0	13.0	12.0	11.0	10.0
Vitamin A, RE	1550	1330	1110	1290	1030	1010
Thiamine, mg	1.57	1.32	1.08	1.02	0.90	0.85
Niacin, NE	48.0	37.0	28.0	28.0	25.0	21.0
Riboflavin, mg	2.59	2.09	1.77	1.70	1.49	1.47
Folate, μg	221	183	151	146	148	130
Vitamin C, mg	118	101	85	89	106	87

[1]Data taken from the 1975 NCS report; excluding pregnant women, reserves and crown lands, institutions, military camps, and North West Territories.
Number of reported NCS respondents: n
Rounded to no more than 3 significant digits
kcal = kilocalorie; g = grams; mg = milligrams; μg = micrograms
RE (retinol equivalents) = 1μg retinol = 6μg β-carotene (10 IU) = 3.33 IU other pre-formed vitamin A
IU = international units
NE (niacin equivalents) = 1mg niacin = 60mg tryptophan

Table 2.6. Estimated distribution (%) of mean energy intake from protein, carbohydrate, and fat of the Canadian adult population by age and gender from the 1970/72 Nutrition Canada Survey

	Males			Females		
	20-39	**40-64**	**65+**	**20-39**	**40-64**	**65+**
	n = 999	n = 1222	n = 881	n = 1347	n = 1500	n = 818
Protein	14.1	14.1	14.0	14.4	14.6	14.1
Carbohydrate	41.6	42.8	45.7	45.4	45.7	48.9
Fat	41.1	39.8	39.0	40.0	39.1	37.1

Derived from data in the 1975 NCS report presented in Table 2.5
n = number of reported NCS respondents

From the relationship between a food and nutrient an inference about geographic differences for a nutrient may be made. Generally, foods are grouped according to their contributions to a nutrient. Dairy products mainly provided calcium and riboflavin; MFP provided iron, niacin, and vitamin A; vegetables and fruit provided vitamin C, folate, and fibre; and cereals provided fibre, iron, and thiamin (Department of National Health and Welfare, 1975). Specifying a food source to address specific nutrients is a useful tool to promote healthy eating habits (Johnson-Down, Ritter, Jacobs-Starkey, & Gray-Donald, 2006).

Differences in food group consumption were not noted for all age/gender groups but the 1975 NCS document indicated that adults in the Atlantic region had the lowest mean intake of fruit overall. ON, QC and BC had the highest vegetable and fruit intake. Of particular note were potato intakes; QC and Atlantic regions reported eating two to three times more than BC. QC adults consumed the least milk products and reported the lowest mean calcium intake overall. BC adults chose whole grain cereal products more often which appeared to correspond with higher fibre intake. Red meat consumption was lower and fish consumption higher in BC and Atlantic regions. Nuts and legumes were not a particularly important source of any nutrient because very few were consumed in 1970/72 (Department of National Health and Welfare, 1975).

Mean nutrient intake values reported by region, age, and gender are available in Appendices F (Table F1 to Table F3). Except for calcium and vitamin A, mean intake of other nutrients appeared very similar between the five regions. Vitamin A variability was attributed to liver consumption on the day preceding the interviews. Quantities of total meat consumption were similar therefore differences in vitamin A were probably due to higher proportions of liver (Department of Health and Welfare, 1975). For childbearing age women (20 to 39 years) specifically, mean intake of calcium was lowest in QC and highest in the Prairies; mean iron, folate, and vitamin C intake was highest in QC and very similar in the other four regions.

2.6 Micronutrient Needs for Women of Childbearing Age

Nutrient status of women affects not only their health but also the health of the next generation (Bartley, Underwood, & Deckelbaum, 2005). Scientists once believed a

fetus developed at the expense of the mother but we now know an inadequately nourished mother is less affected than her fetus (Shabert, 2004). A well nourished woman produces healthier children. Micronutrients have a substantial impact on a woman's health during adolescence and aging; diet quality is important for good health throughout her lifecycle. Yet, women remain vulnerable to micronutrient deficiency and large percentages do not meet their energy needs (Gray-Donald Jacobs-Starkey, & Johnson-Down, 2000). Since the consequences of poor nutrition might have such a profound impact on women and their children, those women of childbearing age will be examined in this thesis.

Vitamins are essential micronutrients. They are organic, natural components of food, required for physiologic function, not synthesized in sufficient amounts, and their absence or underutilization cause a specific deficiency syndrome (Gallagher, 2004). For the most part, vitamins are not chemically related and have different physiological roles. Vitamins are grouped based on common properties such as solubility. The human body retains water-soluble vitamins for varying periods but most are not stored in appreciable amounts. Fat-soluble vitamins may remain in the liver and fatty tissues until required but stored amounts vary. The solubility of a vitamin affects its absorption, transport, storage, and excretion in the body (Gropper, Smith, & Groff, 2005).

Minerals represent a large class of inorganic micronutrients, most of which are essential (Anderson, 2004). Minerals provide an essential medium for normal cellular activity, have osmotic properties, and are cofactors in enzyme activity. They are classed as either macro or trace but this classification does not imply importance. Macrominerals are present and needed in greater amounts in the body than trace minerals. Some minerals are readily absorbed and some require a carrier to assist in absorption. The solubility and binding capability affects absorption, transport, storage, and excretion (Gropper, Smith, & Groff, 2005).

2.6.1 Calcium

2.6.1.1 Introduction

Calcium is a macromineral and is the most abundant mineral in the body. Bones and teeth contain 99% of the body's calcium and 1% circulates in the body's intracellular

and extracellular fluids (Gropper, Smith, & Groff, 2005). It is a structural component of bone and teeth. Calcium also functions in cellular processes, nerve transmission, muscle contraction, blood pressure, blood clotting, and in various enzymes (Whitney & Rolfes, 2002; Gropper, Smith, & Groff, 2005).

Calcium is an integral component of bone which is a readily available source of the mineral should a drop in blood calcium occur. The bones gain and lose the mineral continuously whereas the structure of the teeth allows them to resist calcium withdrawal (Whitney & Rolfes, 2002). Calcium is unlike most other nutrients as the body maintains calcium blood concentration regardless of dietary intake. If dietary intake is sufficient the bones benefit and if dietary intake is insufficient the bones suffer. Blood calcium level is one of the body's highest priorities which is tightly regulated by hormones and vitamin D (Whitney & Rolfes, 2002).

Adequate calcium intake helps build a healthy skeleton in early life, maintain a healthy skeleton in adulthood, and minimize bone loss in later life. Loss of bone results from inadequate dietary calcium intake, poor calcium absorption, or excessive calcium losses. During growth, bone formation exceeds bone resorption. Bone modeling process is typically completed when height gain ceases at approximately 16 years of age for girls (Anderson, 2004). After growth cessation, bone may continue to gain density depending on dietary intake and physical activity. Dietary calcium and physical activity play a large role in supporting bone mass gains in young adult women (Anderson, 2004). Women of childbearing age may have opportunity to improve their bone density. Peak bone mass is generally achieved by 20 years of age but perhaps no earlier than 25 years and as late as 35 years (Whitney & Rolfes, 2002; Gropper, Smith, & Groff, 2005). After adult stature is achieved the skeleton may continue to accrue mass for approximately ten years (Institute of Medicine, 1997).

Many people in North America reported calcium intakes that are well below the current recommendations most notably adolescent females and young women (Forshee, Anderson, Storey, 2006; Johnson-Down, Ritter, Jacobs-Starkey, & Gray-Donald, 2006). Inadequate calcium intake in the young is of concern because of the high osteoporosis incidence in the elderly population. Bone strength depends upon bone development and maintenance during youth yet many females over the age of 12 fail to consume adequate

amounts of calcium (Gropper, Smith, & Groff, 2005). Osteoporosis manifests late in life but has origins in early life. A person may have inadequate calcium intake for years and suffer no noticeable symptoms. Blood tests are ineffective for detecting a deficiency of calcium in either bone or diet because even with a dietary deficiency blood levels remain normal as bone calcium diminishes over time (Whitney & Rolfes, 2002).

2.6.1.5 Food Sources of Calcium

Calcium is most abundant in milk and milk products. Limited data indicate dairy is the main calcium source in the Canadian diet (Johnson-Down, Ritter, Jacobs-Starkey, Gray-Donald, 2006). Skim milk, low-fat cheese, and yogurt are excellent dietary sources because they are also low in fat and calories. Regular milk, cheese, and ice cream contain high amounts of calcium but are also high in fat and energy. Although cottage cheese was thought to be a good source of calcium, it is a poor source as processing removes much of the calcium (Thompson, Manore, & Sheeshka, 2005). The best food sources of calcium on an energy basis include milk, yogurt, cheddar and swiss cheese, sardines with bones, blackstrap molasses, broccoli, green beans, and bok choy (Whitney & Rolfes, 2002).

Some cultures do not have milk in their cuisines, some vegetarians exclude milk, and some are allergic to milk protein or are lactose intolerant. For these people, foods like almonds, sesame seeds, some tofu products, and most bread may be their calcium source. Although some green leafy vegetables provide calcium some, such as spinach and swiss chard, actually provide very little available calcium as oxalates in these vegetables bind about 95% of the calcium and inhibits absorption (Whitney & Rolfes, 2002; Thompson, Manore, & Sheeshka, 2005). Recently, the Canadian Food and Drug Regulations allowed calcium fortified orange juice on the market. An Interim Marketing Authorization permit allows calcium fortified orange juice and soy beverages for sale in Canada as a substitute for those who do not consume milk (Department of Health, 2001 & 2006).

2.6.1.3 Bioavailability of Calcium

Calcium absorption is controlled by active and passive transport mechanisms. Active transport is saturable, requires energy, involves a binding protein, and regulated by vitamin D. Passive transport is non-saturable and independent of vitamin D. If intake

of calcium is high much of the absorption is passive. Active transport is more important when calcium intake is low or at times of great need. Active mechanisms are stimulated by pregnancy, lactation, growth, physical activity, and calcium deficiency but reduced by inadequate vitamin D intake or poor sun exposure (Gropper, Smith, & Groff, 2005).

Bioavailability of calcium largely depends upon age and need. Children absorb approximately 60 to 75%, pregnant women 50%, and young adults 30% of the amount consumed (Gropper, Smith, & Groff, 2005; Thompson, Manore, & Sheeshka, 2005). The body can generally increase calcium absorption when need is high. Absorption may also increase when dietary calcium intake is low but the ability to increase calcium absorption decreases with age. Calcium absorption may be as low as 25% in the elderly (Thompson, Manore, & Sheeshka, 2005).

Bioavailability also depends on calcium's chemical form, single dose amount, or consumption throughout the day, and on dietary factors. Calcium is only absorbed if it is present in ionic form. The acidic environment of the gut releases dietary calcium to its soluble form and helps absorption (Gropper, Smith, & Groff, 2005). Solubilization does not ensure better absorption however, as precipitates may still form in the intestine. If precipitated, bioavailability may be limited as precipitates are excreted (Anderson, 2004; Gropper, Smith, & Groff, 2005). If a single intake amount of calcium is high, absorption is lower. Single dose amounts usually refer to supplemental calcium and the body cannot absorb more than about 500 mg at any one time (Institute of Medicine, 1997; Thompson, Manore, & Sheeshka, 2005). Overall, the body absorbs approximately 25 to 35% of total food calcium in the diet (Gropper, Smith, & Groff, 2005).

Dietary factors that may inhibit absorption or cause precipitates to form include magnesium, phytates, oxalates, fatty acids, and fibre. Magnesium competes with calcium for intestinal absorption; phytates, oxalates, and fatty acids bind calcium; and high fibre increases transit time (Gropper, Smith, & Groff, 2005). Foods containing these inhibitors include legumes, whole grains, celery, and squash. Dietary factors that enhance calcium absorption include vitamin D and lactose. Vitamin D is the controlling signal and lactose possibly improves calcium solubility (Gropper, Smith, & Groff, 2005).

2.6.1.4 Calcium Deficiency Disease

There are no reported short-term symptoms of poor calcium intake because even when consumption of calcium is low the body tightly regulates blood calcium (Whitney & Rolfes, 2002). A chronic dietary deficiency depletes the bones of calcium. Long-term repercussions of poor calcium intake are loss of bone mass leading to osteoporosis which has no cure. Adequate calcium, vitamin D, and weight bearing exercise may slow down or stabilize bone loss (Thompson, Manore, & Sheeshka, 2005).

In osteoporosis the bones become porous and thin. Loss of bone is asymptomatic and often goes undiagnosed until well advanced. X-rays are unable to detect decreases in bone density until 30 to 50% of bone is lost (Gropper, Smith, & Groff, 2005). Diagnosis is most often the result of a fracture. Canada reported 25,000 hip fractures in 1993, 70% of which were osteoporosis associated (Thompson, Manore, & Sheeshka, 2005). Because bones are a dynamic tissue an intake of sufficient calcium throughout life is important to minimize loss. Two times more females than males are affected by osteoporosis with the highest prevalence in post-menopausal women. Mineral loss may begin as early as age 20 years and by about 50 years of age, persistent gradual demineralization occurs (Whitney & Rolfes, 2002; Gropper, Smith, & Groff, 2005).

Calcium plays a part in other deficiency diseases including rickets, osteomalacia, and tetany (Gropper, Smith, & Groff, 2005). Rickets is a disease that occurs in children as a result of a vitamin D deficiency. Bones fail to mineralize because without sufficient vitamin D, absorption of calcium is too low to support bone formation. Demineralization of bone also occurs so that blood calcium may remain constant (Thompson, Manore, & Sheeshka, 2005). Osteomalacia is the adult form of rickets where soft bones are the result of an uncalcified bone matrix. Symptoms include bone pain and greater risk of fractures. Osteomalacia occurs most frequently in women who have low calcium intakes, poor sun exposure, and repeated pregnancies and periods of lactation (Whitney & Rolfes, 2002). A decrease in plasma calcium resulting from insufficient vitamin D may cause tetany which is intermittent muscle contractions. Tetany may also be associated with a deficiency of magnesium (Gropper, Smith, & Groff, 2005).

Long-term calcium deficient diets have also been associated with hypertension, colon cancer and obesity (Gropper, Smith, & Groff, 2005). Calcium and blood pressure

have an inverse relationship, where blood pressure increases as calcium intake decreases. Blood pressure has been lowered by supplemental calcium in people that had inadequate dietary calcium. Evidence is insufficient but adequate calcium may provide protection against colon cancer through its ability to bind bile acids and free fatty acids. The calcium and obesity relationship is still under investigation however, inadequate intake of calcium and dairy products have been associated with higher weights in humans (Gropper, Smith, & Groff, 2005).

2.6.1.5 Dietary Reference Intake for Calcium

Calcium is one micronutrient where available data were insufficient to establish an EAR and thus an RDA, so an AI was developed instead. Ideally, the most appropriate level of calcium intake would be an amount which leads to the fewest bone fractures later in life however, attaining such information is difficult. There was uncertainty about study methods, conflicting results between observational (survey) and experimental data, and a lack of longitudinal data (Institute of Medicine, 1997). The AIs were predicted based on limited studies about calcium retention, factorial estimates, bone mineral density, or bone mineral content. The AI represents an approximate calcium intake that appears sufficient to maintain calcium nutriture (Institute of Medicine, 1997).

The AI for women of childbearing age is 1,000 mg per day. Specific indicators for adults 19 through 30 years are calcium retention and factorial estimates and for adults age 31 to 50 years bone mineral density was also evaluated (Institute of Medicine, 1997). The balance studies helped identify the intake associated with desirable calcium retention, the point at which there is no net loss of calcium. It seems apparent from the limited data that the plateau intake is not below 1,000 mg (Institute of Medicine, 1997). Two bone mineral density intervention trials also supported intakes at or above 1,000 mg. Subjects for these calcium balance and density studies were primarily women, so recommendations are not gender specific (Institute of Medicine, 1997).

The AI for calcium does not consider differences in bioavailability between food groups (Institute of Medicine, 1997). The diets in most published studies did not describe specific foods and the primary dietary sources of calcium in are milk, milk products, and grains. Vegans may have reduced calcium bioavailability but there is a variety of calcium

containing foods and absorption from soybeans is relatively high. Overall dietary calcium content is more important than bioavailability as absorption efficiency is similar for most foods (Institute of Medicine, 1997).

2.6.2 Iron

2.6.2.1 Introduction

Iron is a trace mineral and a component of body proteins including hemoglobin, myoglobin, and enzymes. Hemoglobin contains 65% of the iron, 10% in myoglobin, and 1 to 5% as part of enzymes. The remaining iron is in blood or storage (Gropper, Smith, & Groff, 2005). As a component of the body's globins, iron transports oxygen to the tissues. As a cofactor, iron assists in the metabolic pathways that produce energy from foods and an antioxidant. Iron also functions in the synthesis of amino acids, hormones, collagen, and neurotransmitters (Whitney & Rolfes, 2002). As a result of its function, iron has an effect on the immune system and cognitive performance (Anderson, 2004).

Iron is a critical part of red blood cell hemoglobin. The primary role of iron is to bind, transfer, and store oxygen without which survival is not possible. To carry oxygen the hemoglobin depends on the iron present in its heme groups (Thompson, Manore, & Sheeshka, 2005). The body recycles and highly conserves iron and when not functionally used it is stored mainly in the liver, bone marrow, and spleen. Once iron is in the body it is difficult to excrete (Whitney & Rolfes, 2002). The primary mechanism to maintain iron balance is absorption which is influenced by body stores. When iron stores are too small absorption increases and when sufficient absorption decreases (Gropper, Smith, & Groff, 2005).

Iron is widely distributed in food but the average North American diet contains no more than 5 to 7 mg per 1000 kcal (Gropper, Smith, & Groff, 2005). There is suggestion that the prevalence of low dietary iron intake may be increasing. An analysis conducted by Tessier et al. (2002) estimated a 75% prevalence of inadequate absorbable iron intake for female Quebecers age 18 to 50 years. Their research suggests that this might be partly due to lower fat food choices, including less red meat. Women may also fall short of iron requirements because of deliberate calorie restriction (Gropper, Smith, & Groff, 2005).

Childbearing age women are prone to iron deficiency because of repeated blood loss during menstruation. Pregnancy requires additional iron to support increased blood volume, fetal growth, and childbirth blood loss. American studies report iron deficiency affected approximately 11% of adolescents and women of childbearing age (Whitney & Rolfes 2002; Tessier et al., 2002). Bartley, Underwood, and Deckelbaum (2005) reported a 24% prevalence of iron deficiency in European pregnant women and that only adequate pre-conception iron intake reduced pregnancy anemia risk. Prevalence of iron deficiency may be as high as 80% world wide, considered by many to be an epidemic. Insufficient dietary iron intake is still a major contributor to poor outcomes, particularly in terms of cognitive development, for women throughout their life and for their children (Bartley, Underwood, & Deckelbaum, 2005).

2.6.2.2 Food Sources of Iron

Dietary iron is found in two forms in food, heme and non-heme. Heme iron is derived from the flesh of animals (Whitney & Rolfes, 2002) and non-heme iron can be found in animal foods but is the only source of iron in plant foods (Gropper, Smith, & Groff, 2005). Foods of animal origin such as meat, fish, and poultry (MFP) are superior iron sources. About 50% of the iron in MFP is heme. Legumes and some vegetables also contribute to dietary iron but Anderson (2004) estimates that less than half of the iron in plants is actually useable. The best plant foods are unprocessed and whole which provide more nutrients without the added salt, sugar, or flavor of processed versions (Whitney & Rolfes, 2002).

The best source of iron is organ meats such as liver, kidney, and heart (Anderson, 2004). Although organ meats are excellent iron sources, they are not particularly popular in North American diets (Gropper, Smith, & Groff, 2005). Canned clams, shrimp, kidney beans, tomato juice, green beans, broccoli, and parsley are among the top sources of iron especially on an energy basis (Whitney & Rolfes, 2002). Dried fruits such as prunes and raisins also contribute iron to the diet. Cast iron skillets and possibly stainless steel pans may add to iron intake when used for cooking (Whitney & Rolfes, 2002).

Vegetarians can obtain enough iron from plant based diets provided they consume sufficient amounts and consume vitamin C. Eating good plant sources with foods such as

orange juice helps to increase absorption of non-heme iron (Anderson, 2004) particularly since Canadians generally consume most of their dietary iron from plant foods. A review by the National Institute of Nutrition (2002) estimated that the typical adult Canadian diet contained about 90% non-heme iron and 10% heme iron. The largest contributions come from legumes, fortified foods, and vegetables.

Fortification has helped increase dietary iron consumption and it addresses public health concerns. Breakfast cereals, fortified with iron since 1976, help prevent nutritional problems and enhance the health of Canadians (Health Canada, 1999). Most of the iron in wheat grain is concentrated in the germ or outside layer which is usually removed during processing. White flour and foods containing white flour such as cereal, bread, pasta, and pre-cooked rice are enriched (Health Canada, 1999). Enrichment means that the iron lost during processing has been added back. Although the iron in plant foods such as these is less absorbable than the iron from animal sources, these plant foods are a significant iron source because they are a major component in the Canadian diet (Thompson, Manore, & Sheeshka, 2005).

2.6.2.3 Bioavailability of Iron

Two pathways of iron absorption exist, depending on the food form. One controls heme and one regulates non-heme absorption (Whitney & Rolfes, 2002; Gropper, Smith, & Groff, 2005). Heme iron is more readily absorbed than non-heme iron. Heme remains soluble and is absorbed intact once free of its globin and non-heme must be released from other food components during digestion. An acidic environment and digestive enzymes in the gut aid in releasing non-heme iron to its soluble form. Absorption of bioavailable iron occurs in an energy dependant carrier mediated process (Institute of Medicine, 2001). About 25% of heme iron and 10 to 17% of non-heme iron may be absorbed from the diet depending upon other dietary factors or on the body's stores (Institute of Medicine, 2001; Whitney & Rolfes, 2002).

Bioavailability of dietary iron also depends on iron status and requirement. The body increases the rate of absorption when iron stores are low and decreases absorption when iron stores are high. Individuals with iron deficiency anemia absorb 30 to 35% of their dietary iron and 10 to 15% is absorbed by those without iron deficiency (Anderson,

2004; Gropper, Smith, & Groff, 2005). Absorption of heme iron is influenced more than non-heme in an iron deficient state. Heme iron absorption is inversely related to the size of iron stores (Gropper, Smith, & Groff, 2005). The body's iron requirement depends on loss, age, and need for instance menstruation, puberty, and pregnancy (National Institute of Nutrition, 2002). Iron absorption is stimulated by these physiologic states. The average bioavailability of iron from heme and non-heme sources in a typical mixed western diet is about 10 to 18% (Institute of Medicine, 2001; Gropper, Smith, & Groff, 2005).

Food components enhancing non-heme iron absorption included vitamin C, sugar, and mixed meals (Gropper, Smith, & Groff, 2005). Vitamin C helps released dietary iron remain soluble and sugar promotes absorption. Mixed meals may enhance non-heme iron absorption because meat, fish, and poultry contain a factor, called the MFP factor, which also promotes absorption. Some dietary components inhibiting non-heme iron absorption include polyphenols, oxalate, phytates, calcium, and phosvitin (Gropper, Smith, & Groff, 2005). Foods containing these are coffee, spinach, whole grains, milk, and egg yolk. The inhibiting factors may form insoluble iron compounds which prevent the iron from being absorbed (Anderson, 2004).

2.6.2.4 Iron Deficiency Disease

When dietary intake of iron is insufficient to meet the body's needs and as iron stores become depleted, a gradual sequential change occurs. The body initially increases absorption efficiency to compensate for low stores but the deficiency will progress if iron intake is not improved (National Institute of Nutrition, 2002). The outcome of severe iron depletion is anemia. Providing high dose supplemental iron until blood parameters return to normal reverses iron deficiency anemia (Stopler, 2004). The most prevalent nutrient deficiencies in the world are iron deficiency and iron deficiency anemia, chiefly amongst children and childbearing age women (Anderson, 2004; Thompson, Manore, & Sheeshka, 2005). Important consequences of iron deficiency include developmental delay, cognitive impairment, adverse pregnancy outcomes, and reduced physical work capacity (Institute of Medicine, 2001).

Anemia itself is not a disease, it is a symptom. It is characterized by a reduction in the number of red blood cells per unit of volume or a decrease in the hemoglobin content

of blood below the level of physiologic need (Carlson, 2004). Symptoms may arise in a variety of situations where blood loss, blood cell destruction, or a decrease in blood cell formation occurs. Anemia may also result from acute or chronic disease but nutritional deficiencies are the major cause of decreased red blood cell and hemoglobin production (Carlson, 2004). Other micronutrient deficits which may lead to anemia include copper, folate, and vitamin B_{12}. Various laboratory tests are available that identify markers of a particular anemia.

There are three stages in the identified sequence of change: depleted iron stores, iron deficiency, and iron deficiency anemia (National Institute of Nutrition, 2002). In the first stage there are usually no physical symptoms because hemoglobin is not affected. In the second stage there is a decline in heme production and iron transport that may lead to symptoms of reduced work capacity. In the last stage, production of normal healthy red blood cells decreases and hemoglobin levels become inadequate (Thompson, Manore, & Sheeshka, 2005). Each of the stages may be identified in a blood test but except for high risk infants and children there is no routine testing so true prevalence for iron deficiency is unknown in Canada (National Institute of Nutrition, 2002) and no national iron status studies have been completed since 1970/72 (Cooper, Cockell, & L'Abbé, 2006).

Unlike calcium, there are early symptoms of iron deficiency. Early symptoms include tiredness, headache, irritability, and depression (National Institute of Nutrition, 2002). Other symptoms might include pale skin, listlessness, behaviour problems, and cognitive impairment. In the anemia stage the red blood cells are few, pale, and small. The capacity of the red blood cells to bind and transport oxygen diminishes and they are unable to transport sufficient oxygen from the lungs to body tissues (Whitney & Rolfes, 2002). Physiological effects of iron deficiency might include impaired immune function, infection resistance, and thermoregulation (Gropper, Smith, & Groff, 2005). Anemic women may be at greater risks for impaired fetal development, low birth-weight babies, premature delivery, or infant mortality (Thompson, Manore, & Sheeshka, 2005).

2.6.2.5 Dietary Reference Intake for Iron

Iron recommendations include an EAR and RDA. The important consequences of iron deficiency are not measurable in a way that can quantify abnormality and regulation of iron is very complex but biochemical indicators can characterize iron status precisely (Institute of Medicine, 2001). Iron deficiency is indicated when two or more biochemical markers are abnormal however, the markers are not sufficient for use in calculating iron requirements. Two methods considered were factorial modeling (loss and accretion) and iron balance but iron balance is difficult to achieve with a nutrient so highly conserved by the body so was not used to estimate the average requirement. The EAR was set based on the maintenance of a normal functional iron concentration but minimal stores (Institute of Medicine, 2001).

The EAR for women of childbearing age is 8 mg daily and the RDA is 18 mg per day and depends upon the physiological requirement for absorbed iron and the absorption rate that maintains iron nutriture (Institute of Medicine, 2001). Because the distribution of iron requirement for menstruating females is not normal, factorial modeling for basal and menstrual iron losses was completed. Basal losses were derived from observations in men which are added to estimates of median iron loss from menstrual studies. The 50^{th} and the 97½ percentile values of the distribution of factorial components requirement divided by the upper limit for iron absorption determine the EAR and RDA respectively (Institute of Medicine, 2001).

Bioavailability of iron was included in the formula and the upper estimate of 18% from a typical mixed diet is used (Institute of Medicine, 2001). Because bioavailability of dietary iron varies and iron loss can occur beyond basal amounts, there are caveats. Since the bioavailability of iron in a vegan or vegetarian diet is only about 5 to 10%, the intake goal is 1.8 times the recommendation; for a subpopulation of intense regular exercisers or athletes, iron requirement may be 30 to 70% greater; and those taking oral contraceptives may have lower requirements (Institute of Medicine, 2001).

2.6.3 Folate

2.6.3.1 Introduction

Folate is a water-soluble vitamin also known as folacin or folic acid. Folate and folacin are generic terms for compounds with similar chemical structures and properties to those of folic acid (Gropper, Smith, & Groff, 2005). Folic acid is the more stable form of folate and refers to the form used in fortification and supplements. Folate is generally used to refer to naturally occurring food folate.

Folate is part of the vitamin B complex. The B complex includes thiamin, niacin, riboflavin, B_6, B_{12}, biotin, and pantothenic acid. Vitamins in this complex are coenzymes in energy metabolism. Because of a close relationship among the B vitamins, inadequate intake of one may impair utilization of another. For example, insufficient B_{12} may result in a functional folate deficiency. Folate and vitamin B_{12} are dependant upon each other for activation and closely interrelated in some metabolic functions (Whitney & Rolfes, 2002; Thompson, Manore, & Sheeshka, 2005).

Folate is involved in the synthesis of genetic material and amino acid metabolism. Folate is vital for healthy cell division, replication, and tissue growth. Folate is crucial to tissues where rapid cell division occurs and carefully regulated when supply of dietary folate is insufficient (Gropper, Smith, & Groff, 2005). The effect of folate may be seen in the nervous system, immune system, infection resistance, and tissue growth. Folate works closely with vitamins B_6 and B_{12} in homocysteine metabolism which is a marker for heart disease risk. Folate is essential for neurotransmitter, red blood cell, white blood cell, and heme formation. Folate is an important part in the prevention of neural tube defects and may help in the prevention of chronic disease (Eichholzer, Tönz, & Zimmerman, 2006).

Since folate is necessary for cell division it follows that the requirement would be increased to meet both maternal and fetal demands during pregnancy. The need for folate is increased whenever an increase in cell multiplication occurs (Gropper, Smith, & Groff, 2005). Intake of folate garners attention because of its relation to neural tube defects that can occur very early in pregnancy. The role folate has in cell division means it is a critical nutrient during the first few weeks of pregnancy, during 17 to 30 days gestation (Whitney & Rolfes, 2002). Because the exact cause of neural tube defects is unknown, an adequate

folate intake does not guarantee normal neural tube development but approximately 70% of all neural tube defects might be prevented with adequate folate (Thompson, Manore, & Sheeshka, 2005).

Women who give birth to babies with neural tube defects often have low serum levels of most micronutrients. This may be indicative of poor diet and the effect of poor nutrition may be magnified in a developing fetus. Feedback mechanisms may reduce the maternal supply to the fetus when dietary nutrients are restricted. Active cell proliferation would be occurring while the maternal diet is limiting access to nutrients (Botto, Moore, Khoury, & Erickson, 1999). Approximately 50% of all pregnancies are unplanned so it is recommended this age group consistently consume adequate folate. To reduce the risk of neural tube defects, all women of childbearing age should consume adequate amounts of dietary folate (Botto, Moore, Khoury, & Erickson, 1999).

Bartley, Underwood, and Deckelbaum (2005) suggest folate intake at the RDA is achievable through food alone. Eating folate rich foods provides variable amounts of the nutrient in addition to the benefits of a varied diet. Adequate amounts of folate might be possible from consuming at least the minimum daily serving recommendations for fruit and vegetables but research indicates women fail to do so. Intake of vegetables and fruit is low and a significant number of women consume inadequate amounts of folate during their reproductive years (Gray-Donald, Jacobs-Starkey, & Johnson-Down, 2000; Jacobs-Starkey, Johnson-Down, & Gray-Donald, 2001). Mandatory fortification appears to have increased folate intake in the population although research indicates that the proportion of childbearing age women consuming insufficient amounts continues to be of public health concern. If childbearing age women substantially changed their eating habits then the full potential of folate might be realized (Botto, Moore, Khoury, & Erickson, 1999).

2.6.3.2 Food Sources of Folate

Folate occurs in a variety of plant and animal foods but folate is most abundant in vegetables and legumes. Typically, raw fresh food is higher in folate as this nutrient may be lost during cooking. Processing, food preparation, and storage may destroy as much as half the folate in foods (Whitney & Rolfes, 2002). The best natural folate sources include liver, deep green leafy vegetables, and brewer's yeast. Fruit is a regularly consumed food

group but generally fruit along with non-organ meats are poor folate sources. Pinto beans, garbanzo beans, okra, black-eyed peas, kidney beans, lentils, spinach, asparagus, turnip greens, bananas, watermelon, and tomato juice are among the best food sources of folate on an energy basis (Whitney & Rolfes, 2002). Other good folate sources are mushrooms, peanuts, citrus fruit, and fortified grain products (Gropper, Smith, & Groff, 2005).

Fortified grain products add a source of folic acid to the food supply. Folic acid is the synthetic form used for supplements and fortification. A voluntary folate fortification program began in Canada in 1997 and was legislated mandatory in 1998. Folate fortified foods include flour and flour products (bread, pasta, and breakfast cereals), and cornmeal (Canadian food Inspection Agency, 2003). There are foods containing greater amounts of folate but fortified foods are consumed regularly in the Canadian diet therefore represent a consistent source of dietary folate (Gropper, Smith, & Groff, 2005; Thompson, Manore, & Sheeshka, 2005).

2.6.3.3 Bioavailability of Folate

Folate absorption occurs by passive and active transport. Respectively, these are simple diffusion and carrier-mediated (Gallagher, 2004). Folate absorption is mainly by active transport but the carriers are saturable and dependant on pH, energy, and sodium, meaning that those carriers have a finite capacity to carry folate and prefer a particular environment. Diffusion is non-saturable and accounts for some absorption, especially at pharmacological doses (Gropper, Smith, & Groff, 2005).

Folate absorption largely depends upon the gut's ability to hydrolyze food folate into free form (i.e. folic acid). Food folate is mostly bound and the intestine only absorbs folic acid. Zinc dependant intestinal enzymes need to hydrolyze the dietary folate prior to absorption (Whitney & Rolfes, 2002; Gropper, Smith, & Groff, 2005). The hydrolyzation process is not that efficient so bioavailability of folate is quite low compared to folic acid. Optimal folic acid absorption occurs in an acidic environment (Gropper, Smith, & Groff, 2005).

The bioavailability of food folate varies considerably; it may be as high as 96% in cooked lima beans to as low as 25% in romaine lettuce. Processing and food storage also have an influence on bioavailability. Estimates are that 50 to 95% of the folate originally

present may be lost during food storage, preparation, and processing (Gropper, Smith, & Groff, 2005). Considering all factors the bioavailability of food folate ranges from 25 to 50% (Whitney & Rolfes, 2002; Gallagher, 2004). Folic acid supplements ingested on an empty stomach are 100% bioavailable; folic acid with food (either supplement with meal or fortified food) is 1.7 times more bioavailable than food folate because it is in free form (Institute of Medicine, 1998). This important as it is the basis for establishing the Dietary Folate Equivalents (DFEs) and setting the DRIs for folate.

Under normal conditions, the body retains absorbed folate. The body recycles by continuously secreting folate into the bile and reabsorbing it inside the small intestine i.e., enterohepatic circulation (Gropper, Smith, & Groff, 2005). The amount of folate ingested and the form of folate appear to have the largest influence on active folate absorption but dietary intake does not appear to influence passive absorption. It is likely that absorption from active transport is greater when dietary intakes are high, physiologic concentrations are not saturated, or if body requirements are not being met. Passive absorption becomes involved at pharmaceutical doses (Institute of Medicine, 1998; Gropper, Smith, & Groff, 2005). Folate requirement increases during rapid growth periods so populations with an increased need for folate include pregnant and lactating women, and infants.

2.6.3.4 Folate Deficiency Disease

A folate deficiency results in impaired genetic material synthesis and reduced cell division. The effects are most apparent in red blood cells, white blood cells, and epithelial cells (stomach, intestine, vagina, and cervix) all of which are rapidly growing cells. Poor folate status generally manifest as anemia, skin lesions, or poor growth (Anderson, 2004).

The classic folate deficiency disease is anemia. As with iron, the formation of red blood cells are affected however, with a folate deficiency the red blood cells are oversize and immature (macrocytic) rather than small (Thompson, Manore, & Sheeshka, 2005). A macrocytic anemia and low red blood cell folate may occur with a vitamin B_{12} deficiency so laboratory tests must distinguish between the two because they both result in the same clinical sign of macrocytic red blood cells (Carlson, 2004). Folate deficiency develops in stages involving depletion and then deficiency. Characteristics of minor folate deficiency are a low plasma folate level and impaired white blood cell formation. Low plasma levels

may occur within one month, the red blood cells begin to show effects of deficient folate after about three months, and after approximately four to five months the bone marrow is affected and anemia occurs (Gropper, Smith, & Groff, 2005).

Some signs of folate deficiency anemia are similar to iron deficiency anemia and include irritability, weakness, fatigue, and pallor. Specific symptoms of folate deficiency anemia are smooth red tongue, confusion, shortness of breath, palpitations, and anorexia (Anderson, 2004; Stopler, 2004). Other folate deficiency symptoms include depression, dementia, and nervous system disorders. Alzheimer's is under investigation as possibly linked to poor folate status (Gropper, Smith, & Groff, 2005). Macrocytic anemia occurs most often in those with gastrointestinal diseases and the aged but is relatively common in the United States (Gropper, Smith, & Groff, 2005). Folic acid supplements replenish folate stores and reverse folate deficiency anemia symptoms.

The role of folate in normal cell division is important for fetal development. It is the potential risk to fetal development that makes sufficient folate intake so important for women of childbearing age. A deficiency at conception may result in neural tube defects in the fetus. Neural tube defect risks are inversely associated with folate intake and status (Institute of Medicine, 1998). The defects are major malformations of the central nervous system that occur very early in fetal development before a woman knows she is pregnant (Thompson, Manore, & Sheeshka, 2005). Not only should women aim for a folate intake at the RDA, those capable of becoming pregnant should include folic acid from fortified foods and/or supplements in addition to eating a varied diet (Institute of Medicine, 1998). Decreasing neural tube defect risks was a primary reason for fortifying the food supply as public education campaigns about supplementation appeared ineffective. Fortification has been historically successful for preventing deficiency diseases and folate fortification has reduced the incidence of neural tube defects where supplementation has not (Persad, Van den Hof, Dubé, Zimmer, 2002; Eichholzer, Tönz, Zimmermann, 2006).

Lack of adequate dietary folate is also associated with increased heart disease risk and cancer. Without sufficient folate, homocysteine accumulates and appears to promote blood clot formation and arterial blood vessel deterioration (Whitney & Rolfes, 2002) but because of the synergistic relationship between the B vitamins, heart disease risks are also related to vitamin B_6 and B_{12}. Folate might be protective for those most likely to develop

pancreatic or breast cancer because a folate deficiency is thought to increase potential for neoplastic changes in normal cells (Gropper, Smith, & Groff, 2005).

2.6.3.5 Dietary Reference Intake for Folate

The DRIs for folate include both an EAR and RDA. A number of observational, metabolic, and epidemiological studies were reviewed that looked at red blood cell folate, plasma homocysteine, serum and urinary folate, hematological status, neural tube defects, and chronic degenerative disease risk. Although all the studies were important some were not sufficient criterion for setting an EAR (Institute of Medicine, 1998). Urinary folate is not a sensitive enough indicator, hematological findings occur too late in deficiency, and neural tube risk only applies to a specific segment of the population for a very short time. No single laboratory value was appropriate so the main indicators of folate status selected were red blood cell folate, homocysteine plasma concentration, and plasma concentration of folate (Institute of Medicine, 1998).

The EAR for adults 19 to 50 years is 320 μg DFE and the RDA is 400 μg DFE per day. To set the EAR for this age group, metabolic studies of healthy human subjects were evaluated (Institute of Medicine, 1998). The focus was to determine specific quantities of folate intake that maintained normal blood concentrations for the three indicators. Cutoff points for the range of normal values of the indicators were based on known biochemical abnormalities (Institute of Medicine, 1998). Red blood cell folate reflects stores or long-term status, homocysteine increases as folate is depleted, and plasma folate may identify dietary intake. The RDA is two times the coefficient of variation (10%) plus the EAR or 120% of the EAR. Support for EAR and RDA values were also seen in epidemiological data (Institute of Medicine, 1998).

Neural tube defect risk was not used as a criterion to set the EAR because not all childbearing age women are capable of becoming pregnant, many are sterile or are using effective contraceptives long-term (Institute of Medicine, 1998). It is only the women that might become pregnant or plan to become pregnant that may benefit from an intervention aimed at reducing neural tube defects. However, because neural tube defects constitute an important public health problem, 400 μg DFE folic acid daily for women able to become

pregnant is recommended (Institute of Medicine, 1998). This is in addition to the 400 µg DFE consumed in a healthy diet.

Bioavailability was part of determining the EAR and RDA. DFE units adjust for the nearly 50% lower bioavailability of food folate compared to folic acid. Half as much folic acid is required (if it is taken on an empty stomach) to be comparable to food folate (Institute of Medicine, 1998). The formula for DFEs is: 1 µg DFE = 1 µg folate = 0.6 µg folic acid from a fortified food or supplement eaten with a meal = 0.5 µg folic acid from a supplement taken on an empty stomach. When food folate was the sole source of folate in the studies used to determine requirements, correcting data was not necessary as one food folate measure is one DFE unit (Institute of Medicine, 1998). Food labels do not currently make a distinction between folate and folic acid or list folate as DFEs, but it is possible to approximate intake of DFEs if types of food eaten are known.

2.6.4 Vitamin C

2.6.4.1 Introduction

Vitamin C is a water-soluble vitamin needed for normal growth and development. It is commonly called ascorbic acid or ascorbate. Most animals can synthesize vitamin C from glucose but humans are one of the few species who lack an enzyme for vitamin C biosynthesis. Because humans are unable to synthesize the vitamin, they must obtain it through the diet. Other animals unable to make vitamin C include primates, guinea pigs, and fruit bats (Gropper, Smith, & Groff, 2005; Thompson, Manore, & Sheeshka, 2005).

Vitamin C is concentrated in many vital organs including the adrenals, brain, and eyes. Highest concentrations of vitamin C are in the adrenal and pituitary glands; medium levels in body organs and white blood cells; and small amounts are found in the muscles and red blood cells (Gropper, Smith, & Groff, 2005). Tissue concentrations are related to plasma levels and tissue levels normally exceed plasma levels by three to ten times. Both tissue and plasma levels are related to dietary intake (Institute of Medicine, 2000).

Vitamin C has a very complex role in the body and helps with the synthesis and modulation of many components (Institute of Medicine, 2000). The biologic function of vitamin C is based on its reducing or electron donor abilities and functions as a cofactor

and protective agent. Ascorbate is a co-substrate for numerous enzymes, some of which are vital for collagen synthesis (Gallagher, 2004). Collagen is a component of connective tissue including skin, bone, teeth, tendons, and blood vessels. Collagen also helps wound healing and bruise prevention. Vitamin C is required in DNA, hormone, neurotransmitter, carnitine, and amino acid synthesis and is also involved with immune response. Vitamin C has an important role in folate metabolism, influences the absorption of non-heme iron and the distribution of iron in the body. It also acts as an antioxidant, regenerates vitamin E, and may prevent some forms of cancer (Thompson, Manore, & Sheeshka, 2005).

2.6.4.2 Food Sources of Vitamin C

Fruit and vegetables are the primary food sources of vitamin C in the diet. Factors such as soil, season, fertilizer, and proximity to other crops affect how much vitamin C a fruit or vegetable contains. The actual vitamin content in foods varies depending upon the conditions of plant growth and degree of ripeness at harvest (Gallagher, 2004). Vitamin C content also depends on processing, storage, preparation, and cooking. Many commercial foods are processed so close to the supply source that vitamin content is often higher than for shipped or stored fresh foods however, some preservatives used to improve color may destroy the vitamin. Vitamin C is vulnerable to heat and oxygen therefore, fresh raw fruit and vegetables prepared immediately before eating have a higher vitamin density than the cooked versions. The loss of vitamin C from prepared vegetables held refrigerated for 24 hours may be as high as 45 to 52% (Gallagher, 2004).

It is widely recognized that citrus fruits such as limes, lemons, and oranges are a very good source of vitamin C but many other foods are also good. Dark green, orange, and red colored foods such as cranberry, tomato, sweet potato, and spinach are also good sources. The best sources for vitamin C on an energy basis include red bell pepper, kiwi, grapefruit juice, orange, strawberry, and broccoli (Whitney & Rolfes, 2002). Asparagus, kale, papaya, cantaloupe, brussels sprouts, cauliflower, and juice are listed as good foods for this vitamin as well (Gropper, Smith, & Groff, 2005).

Root vegetables contain little or no vitamin C (Thompson, Manore, & Sheeshka, 2005). The potato is not considered a good source but it is an important source because it is such a common staple that it makes a large contribution to vitamin C intake. Until the

mid-1840s potato blight, the deficiency disease scurvy was unknown in Ireland (Whitney & Rolfes, 2002). Fruit beverages and evaporated milk fortified with vitamin C may be a source of the vitamin for some people as well (Canadian food Inspection Agency, 2003). Organ meats such as liver and kidney contain some vitamin C but consumption of these foods is not that common (Gropper, Smith, & Groff, 2005).

2.6.4.3 Bioavailability of Vitamin C

Control of vitamin C absorption is by active and passive transport. Absorption occurs predominantly by active transport which is saturable, sodium, and dose dependent (Gropper, Smith, & Groff, 2005). At low intakes of vitamin C, the active transport system is very efficient and even at moderate intake the active system is efficient. At high intakes passive transport occurs but only contributes a small amount to total absorption (Gropper, Smith, & Groff, 2005). Absorption is inversely related to intake and at doses greater than one gram per day, absorption falls to about 50% or less (Institute of Medicine, 2000). An estimate for absorption variability ranged from 16% at high intakes to 98% at low intakes (Gropper, Smith, & Groff, 2005). The average bioavailability from usual dietary intake is approximately 70 to 95% (Institute of Medicine, 2000; Gallagher, 2004; Gropper, Smith, & Groff, 2005).

Tissue content of vitamin C is precisely regulated. The turnover for vitamin C in the body varies depending on dietary intake and body pool size. Absorption is dependant on dose and renal regulation conserves vitamin C at low intakes and limits blood levels at high intakes (Institute of Medicine, 2000). Excretion increases as intake increases and at moderate to high doses there is efficient renal excretion. At a very low intake, essentially no vitamin C is excreted so minimal loss occurs. The intestine also degrades some of the vitamin C at high intakes which may account for the diarrhea and intestinal discomfort reported by some individuals (Institute of Medicine, 2000).

Vitamin C has two forms, ascorbate and dehydroascorbate. Both vitamer forms are present in food and bioavailable. Dehydroascorbate might be better absorbed than the ascorbate but there is ready conversion between the two forms so very little is lost during metabolism. This is important for limiting losses and maintaining reserves of antioxidants in the body (Gropper, Smith, & Groff, 2005).

2.6.4.4 Vitamin C Deficiency Disease

In the 1700s the importance of citrus fruit was recognized when a British naval physician discovered that something in citrus foods prevented illness in sailors. Nearly two hundred years later vitamin C was isolated and identified as a nutrient (Thompson, Manore, & Sheeshka, 2005). The classic deficiency disease is scurvy and symptoms are related to defects in connective tissue. The characteristic symptom of scurvy is bleeding gums and death results from massive internal bleeding. The cause of death for over half the sailors at sea throughout the 1800s and 1900s was attributable to scurvy (Thompson, Manore, & Sheeshka, 2005).

Scurvy typically appears when the total body pool of vitamin C in the body falls below 300 mg (Institute of Medicine, 2000; Gropper, Smith, & Groff, 2005). Estimates are that this might take a little more than a month or as long as 80 days on a diet lacking in vitamin C (Whitney & Rolfes, 2002; Gallagher, 2004). Well-known scurvy symptoms include bleeding gums, bruises, joint pain, loose and decaying teeth, poor wound healing, thickened skin, ruptured blood vessels, and hemorrhages. Anemia, infections, depression and hysteria are also common (Whitney & Rolfes, 2002; Thompson, Manore, & Sheeshka, 2005). Once diagnosed, scurvy is readily reversed with vitamin C. In developed countries scurvy is rare, but low plasma levels of vitamin C have been observed in institutionalized elderly (Gropper, Smith, & Groff, 2005; Thompson, Manore, & Sheeshka, 2005).

Because vitamin C has numerous and complex functions, much attention focuses toward its relationship to disease. Evidence supporting some of these relationships varies considerably. Some health conditions thought to benefit from vitamin C are colds, cancer, cardiovascular disease, and cataracts (Gropper, Smith, & Groff, 2005). It is controversial but vitamin C may prevent a cold by promoting infection resistance through the immune system. Vitamin C may have protective effects on pulmonary function and cardiovascular disease mortality. NHANES data showed a positive correlation between vitamin C intake and lung function (Thompson, Manore, & Sheeshka, 2005). Low blood pressure and high good cholesterol have been associated with high plasma concentrations of vitamin C. The possible link of the vitamin to cataracts involves its antioxidant role. Experimental results of those relationships conflict and mechanisms that may involve vitamin C are generally unclear. Epidemiological studies have however, provided evidence that including greater

amounts of vegetables and fruit in the diet were associated with a decrease in the risk for some cancers (Gropper, Smith, & Groff, 2005).

2.6.4.5 Dietary Reference Intake for Vitamin C

Vitamin C recommendations also include both an EAR and RDA. For adults 19 to 50 years, requirement is determined based on the tissue level amount deemed sufficient to provide antioxidant protection with minimal urinary losses (Institute of Medicine, 2000). There were many studies evaluating the functions of vitamin C in various body tissues for healthy individuals, smokers, and those with disease. The overall evidence was not robust or specific enough and there were no non-scurvy biomarkers available to set requirements for apparently healthy individuals (Institute of Medicine, 2000). There are no human data to directly quantify dose-response and only one small depletion-repletion study on seven males. In the absence of data and because dietary intake of vitamin C correlates to blood and body pool levels, the best biomarker criterion of vitamin C nutriture is near-maximal white blood cell (neutrophil) concentration (Institute of Medicine, 2000).

For women, the EAR is 60 mg per day and the RDA is 75 mg per day. The EAR for women is extrapolated from data derived of men because there were no data available for women (Institute of Medicine, 2000). It is known that at a given level of intake, blood levels of vitamin C are higher in women than men. The recommendation is an adjustment accounting for differences in body size, lean mass, and total body water between genders (Institute of Medicine, 2000). This level provides adequate antioxidant protection without increasing urinary excretion of the vitamin. Intakes above the excretion threshold, though not carcinogenic or teratogenic, do not increase the body pool size (Institute of Medicine, 2000). The RDA is two times the coefficient of variation (10%) plus the EAR or 120% of the EAR.

The types of foods consumed have not been shown to affect bioavailability of this vitamin and 70 to 95% of the vitamin C in a usual diet is absorbed (Institute of Medicine, 2000). For women smoking more than twenty cigarettes a day, requirement for vitamin C is as much as twice that for a healthy individual. There is a recommendation for smokers (RDA + 35 mg), as the evidence suggests smokers have lower vitamin C status than non-smokers even with comparable dietary vitamin C intake (Institute of Medicine, 2000).

2.6.5 Micronutrient Summary

The importance of micronutrients cannot be overstated. Vitamins and minerals are vital to life and available from foods. Their presence or absence in the diet attests to their importance (Whitney & Rolfes, 2002). Many nutrients work synergistically and an excess or shortage of one may affect the bioavailability of another. Micronutrient bioavailability depends on many factors but knowledge and scientific data continue to accumulate. The DRIs are a goal for good nutrition for healthy individuals and the estimated values allow for many factors including bioavailability, deficiencies, and chronic diseases (Institute of Medicine, 2000).

Adequate amounts of many micronutrients can be achieved through food. In many populations however, this is not usual because of personal choice, culture, or accessibility (Bartley, Underwood, & Deckelbaum, 2005). Diet quality is associated with consumption of vegetables and fruit. Nutrition surveys indicate many North Americans consume fewer than the minimum five daily vegetable and fruit servings and dietary analyses continue to report vegetables and fruit, as well as folate, calcium, and iron intakes remain inadequate for women (Gray-Donald, Jacobs-Starkey, & Johnson-Down, 2000; Bartley, Underwood, & Deckelbaum, 2005).

The rationale for adequate nutrient intake, particularly for women, has been well defined for many micronutrients including calcium, iron, and folate. Studies on the eating habits of childbearing age women reveal inadequacies for nutrients important to a healthy pregnancy. Low iron, calcium, and folate intakes persist as public health concerns among women of childbearing age (Earl, 2004). Recent research also suggests several late-in-life diseases may originate with fetal growth and development problems that are the result of inadequate nutrition. Strong evidence exists that relates maternal nutrient supply and fetal development (Godfrey & Barker, 2000) but the point at which adequate nutrient supply is critical varies for the micronutrients. Reducing risks to fetal health linked with nutrition is best accomplished throughout the childbearing years (Eichholzer, Tönz, and Zimmerman, 2006). This seems especially true of iron and folate which are important in the prevention of anemia and neural tube defects respectively.

3.0 METHODS

3.1 Data Collection

The data analyzed in this study were extracted from published reports of nutrition surveys conducted by the Canadian provinces during the decade of the 1990s. These data were publicly available. This thesis was exempt from ethics review since it involved the secondary use of anonymized data. Article 3.3 of the 1998 Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans specifies that Research Ethics Board review and approval is not required to conduct a secondary analysis of data that cannot be linked to individuals and for which there is no possibility that the individuals can be identified in any public report.

Eight published reports and one draft report were collected from the provincial nutrition surveys conducted between 1990 and 1999. Published reports were as follows: New Brunswick (NB) - Balram, Villalon, McCaie-Burke, Ericson, and Boyne (2005), Québec (QC) - Bertrand (1995), British Columbia (BC) - Forster-Coull, Milne, and Barr (2004), Nova Scotia (NS) - MacLean (1993), Ontario (ON) - Mendelson, Tarasuk, Chappell, Brown, and Anderson (2003), Newfoundland and Labrador (NL) - Roebothan (2003), Saskatchewan (SK) - Stephen and Reeder (2001), and Prince Edward Island (PE) - Taylor, Van Til, and MacLellan (2002). The Alberta (AB) - Gabos, Hansen, Field, and Raine survey has not been published though they provided a draft in June 2006, but only for weighting purposes. Hereafter, the surveys are referred to by province. Requests were sent to the Manitoba (MB) contact individual for a draft report or nutrient data. No replies were returned. Table 3.1 lists the ten provincial nutrition surveys including the year(s) the surveys were conducted and the survey report publication year.

Table 3.1. Provincial nutrition surveys with year(s) conducted and year published

Survey	Survey year(s)	Publication year
Nova Scotia (NS)	1990	1993
Quebec (QC)	1990	1995
Saskatchewan (SK)	1993-1994	2001
Alberta (AB)[a]	1994	n.d.
Prince Edward Island (PE)	1995	2002
Newfoundland and Labrador (NL)	1996	2003
New Brunswick (NB)	1996-1997	2005
Ontario (ON)	1997-1998	2003
Manitoba (MB)[b]	1997-1998	--
British Columbia (BC)	1999	2004[c]

Taken from the provincial nutrition surveys completed between 1990 and 1999

[a] Report unpublished, March 2005 draft data used with permission; n.d. = no date

[b] Report not published, data unavailable

[c] BC published five reports from their survey data: 1. Energy and nutrient intakes; 2. Food group use; 3. Seniors nutrition and health issues; 4. Physical activity and bodyweight; 5. Supplement use

3.2 Summary of Provincial Nutrition Survey Reports

Each collected provincial nutrition survey was reviewed and the methodology charted for comparison (Table A1, Table A2). Summarized information includes subject pool source, exclusions, survey components, reported demographics, nutrient file, and reported omissions. Similarities and differences between the surveys were noted. Table A1 and Table A2 also include the overall percentage of adult respondents with a Body Mass Index (BMI) of greater than 25 or 27 from direct measures. Information on year(s) conducted, age range, sample size, and response rate from individual provincial surveys were tabulated (Table 3.2). Reviewed were background and rationale sections from each survey. The nutrients of concern reported in each provincial nutrition survey report were noted from summary and conclusion sections. Problem nutrients that were common from the 1970/72 NCS and the 1990s and those flagged as of particular concern for women of childbearing age were reviewed.

Table 3.2. Selected reported components of the 1990s provincial nutrition surveys

Survey	Survey date(s)	Response rate (%)	Age range (years)	Studied sample size
NS	1990	80	18-74	2,212
QC	1990	69	18-74	2,118
SK	1993/94	46	18-74	1,798
AB[a]	1994	68	18-74[b]	2,039
PE	1995	71	18-74	1,995
NL	1996	51	18-74[b]	1,927
NB	1996/97	64	18-74	1,816
ON	1997/98	29	18-74	1,187
BC	1999	52	19-84	1,823

Data from provincial nutrition surveys conducted 1990-99; MB unpublished and unavailable
[a] AB report unpublished, data used by permission
[b] subject pool age range, data reported for ages 19-74 years corresponding with DRI age categories

The provincial nutrition surveys were conducted over a ten year period covering the decade of the 1990s. Review of methodology and reporting showed there were many similarities between the provincial surveys. Each survey used valid protocols developed by Health Canada and Statistics Canada. Protocols were used first by NS and retained for subsequent provincial surveys. Each followed a stratified, two-stage, replicate probability sample design with applied design weights to aid selecting representative age and gender sample sizes. An adult target population (18 to 74 years) was selected from the respective Provincial Health Registries with similar exclusion criteria (Tables A1, A2). Also, Health Canada does not have a mandate to survey Aboriginal persons on reserves or individuals serving in the military (Forster-Coull, Milne, & Barr, 2004).

Common survey components included a standardized 24-hour recall with repeat recalls for approximately 30% of subjects for intrasubject variability adjustments, FFQ, supplement use, socio-demographic questions, direct anthropometric measurements, and non-response. A general buy in questionnaire might query activity, health, food security,

attitude, nutrition knowledge, and native food use. Provinces could choose which queries to include. Waist-hip ratio measures were included starting with PE.

The respondent demographic reported by each survey was also similar. Most were married, food-secure, non-smokers, and did not hold a University degree. Except for NL, most survey respondents were not low income (Tables A1, A2). Provinces completed an assessment to see if responders were similar to the general provincial population by using census or other health survey demographic information as a comparison. A review found similarities in smoking, marital status varied, and although most did not have a university degree, these surveys had a higher proportion of University educated than in the general population. Overall, the population parameters were accurately reflected and reasonable nutrient intake estimates were provided (Taylor, Van Til, & MacLellan, 2002; Balram, Villalon, McCaie-Burke, Ericson, & Boyne, 2005; Gabos, Hansen, Field, & Raine, n.d.).

Group mean nutrient intake for adults from the assessment of food only for each adult age and gender group from nine collected provincial surveys were tabulated. Only BC provided mean intake values derived from food and supplements of selected nutrients but these values (Tables B1 to B8) were not weighted or discussed. There were four adult age groups for each gender so eight mean nutrient intake data tables were created listing energy, macronutrients (protein, carbohydrate, fat and fatty acids), sixteen micronutrients, dietary fibre, cholesterol, and alcohol (Tables B1 to B8). The distribution of energy from protein, carbohydrate, fat, and saturated fat reported by the provinces was also included (Table B9). Where data were not explicit, estimates using the Atwater conversion factors were calculated.

Graphs were created from the reported provincial nutrient data to determine if any temporal or geographic patterns in nutrient intake could be seen during the 1990s. Data were graphed in the order the provincial nutrition surveys were conducted as well as west to east geographic order. Graphs including reported mean intake data from the NCS with the reported mean data from each of the collected provincial reports were also generated for some nutrients. These figures in section 4.1 focus on Canadian adult women and the nutrients calcium, iron, folate, and vitamin C. These nutrients were chosen because intake of calcium, iron, and folate were of concern in 1970/72 especially in women (Department of National Health and Welfare, 1975) and vitamin C might be indicative of overall fruit

and vegetable intake. Dietary analyses continue to report intakes of calcium, folate, and iron as public health concerns and vegetable and fruit consumption remains inadequate for most women (Gray-Donald, Jacobs-Starkey, & Johnson-Down, 2000; Earl, 2004; Bartley, Underwood, & Deckelbaum, 2005).

3.3 Weighting of Reported Group Mean Nutrient Intake from Provinces

The reported provincial nutrient data were population weighted to provide one estimated national intake value per nutrient for eight age and gender groups. Population weighting is a statistical process by which data are adjusted to reflect populations when comparing two or more values and/or with reference to the average of those points. This corrects for the fact that most provinces had similar sample sizes no matter how large or small their population. The weighting made an adjustment to ensure each province was represented in proportion to its population size. The Canadian Rural Economy Research Lab (C-RERL), in the Department of Agricultural Economics from the University of Saskatchewan completed population weighting.

Using Statistics Canada (http://statcan.ca/) population census estimates for the year of each provincial nutrition survey, the percentage of individuals in each age and gender group was determined. Census estimates were retrieved from Statistics Canada's CANSIM database (Table C1). Where a province conducted their survey over two years the census of both years was averaged then applied. The weighting for each provincial category or age and gender group was calculated by determining the ratio of estimated subjects in a provincial category to the total of estimated individuals in that category in the country. For example, the weight of a province for young women equaled the number of females 18 to 34 years in X_1 divided by the sum of females 18 to 34 years for X_1 to X_9. The mean nutrient value for each respective provincial age/gender group was multiplied by the calculated weight and the results summed in proportion to their distribution in the population. The new mean intake estimate was a mean of means. The weighting formula in the excel spreadsheet included all ten provincial age and gender categories, allowing for future inclusion of currently unavailable survey data.

For each weighted Canadian nutrient mean, a variance and a standard deviation (SD) were also calculated (Table C2 to C9). The number of subjects (N) was the number

of provinces containing a value for that particular nutrient. The SD does not represent SD of intake. It only indicates variation of the provincial group means around the weighted estimate. These data are now referred to as the Province-derived Nutrition Survey (PNS). PNS mean nutrient intake data is a national estimate for n subjects, i.e. sum of reported provincial respondents for each age and gender category. Table D4 shows the number of total reported respondents provincially and nationally by age and gender.

All provincial nutrition surveys collected dietary intake data from adults 18 to 74 years. This age range was a requirement of Health Canada. BC also elected to include 75 to 84 years because this is an often left out group and greater nutritional risks may occur with age (Forster-Coull, Milne, & Barr, 2004). Because changes to the recommendations used to assess dietary intake began in the latter half of the 1990s, not all provincial teams reported data in identical age categories. Also, not every province published all sixteen micronutrients in their reports (Table B1 to B8). These differences may introduce error into the PNS national estimates of nutrient intake.

For the eight provinces that collected data on adults up to age 74 years of age the census categories selected for weighting purposes were 18 to 34, 35 to 49, 50 to 64, and 65 to 74 years. These age groupings were also used to report group mean intake values by six provincial nutrition surveys; NS, QC, SK, PE, NB, and ON. The provinces of NL and AB collected data from 18 to 74 years but both provincial research teams chose to report using the age categories of the DRIs: 19 to 30, 31 to 50, 51 to 70, and 71+ years (Institute of Medicine, 2000). Both NL and AB reports omitted nutrient intake data of their 18 year old respondents. Although NL and AB data collection occurred before a review of intake recommendations began, the decision to use DRI groups was likely because of prolonged periods between provincial data collection, analysis, and publication. BC collected data from respondents 18 to 84 years and reported data from 19 to 84 years.

3.4 Nutrient Intake of Canadians in the 1990s

Two tables were created that showed a national picture derived from aggregating provincial nutrient intake information, one for adult men and the other for adult women (Appendix D). These estimated values were group mean intakes derived from provincial group mean intakes and subsequently labeled the PNS. The nutrient values in these and

other tables were rounded to no more than three significant digits. The estimated national mean intake values were further collated into tables that included those nutrients reported in both the NCS and the PNS (Appendix E) to examine for trends. For tables in Appendix E, the national mean nutrient values for PNS age groups 35 to 49 years and 50 to 64 years were averaged to create a 35 to 64 year age group for ease of comparison to the adult age group 40 to 64 years reported in the 1975 NCS report. Estimates of distribution of energy for protein, carbohydrate, and fat of males and females were calculated (Appendix E) and derived from the national mean intake estimates using Atwater conversion factors.

3.5 Nutrient Intake of Canadian Women 18 to 34 years in the 1990s

The focus was on women aged 18 to 34 years (childbearing age) from the 1990s and the nutrients calcium, iron, folate, and vitamin C. This age group corresponds to the 20 to 39 year age group reported by the 1970/72 NCS. Three further data presentations were completed to address that focus. Mean nutrient intake estimates for women age 18 to 34 years for energy, dietary fibre, macronutrients (protein, carbohydrate, fat, and fatty acids), sixteen micronutrients, cholesterol, and alcohol were tabled and compared to RDA or AI values where appropriate. Inadequacy was estimated by determining if a mean was less than the RDA or AI. If the nutrient value fell below the RDA or AI, then the nutrient was considered a concern.

Calculations were completed on the data to determine percent difference between national mean nutrient intake (NI) estimates for energy, calcium, iron, folate, and vitamin C for the comparison groups where appropriate. Nutrient density (ND) per 1000 kcal for these four nutrients of each comparison group was also calculated. The percent difference was then re-calculated for ND where appropriate.

$$\% \text{ difference} = \left(\frac{\text{women 18-34 years} - \text{NCS 20-39 years}}{\text{women 18-34 years}} \right) \times 100$$

$$\% \text{ difference} = \left(\frac{\text{women 18-34 years} - \text{women 35-49 years}}{\text{women 18-34 years}} \right) \times 100$$

$$\% \text{ difference} = \left(\frac{\text{women 18-34 years} - \text{women 50-64 years}}{\text{women 18-34 years}} \right) \times 100$$

$$\% \text{ difference} = \left(\frac{\text{women 18-34 years} - \text{women 64-74 years}}{\text{women 18-34 years}} \right) \times 100$$

$$\text{Nutrient Density} = \left(\frac{\text{Nutrient Intake (NI)}}{\text{total energy (kcal)}} \right) \times 1000 \text{ kcal}$$

Percent difference was considered 'notable' if the change in energy intake was greater than 25% in either direction. Micronutrient intake was 'notable' if greater than 10% differences were calculated and 'very notable' if differences were greater than 25% in either direction. The justification for using these particular percentages as cutoff points was based on Canadian regulations. The 2003 Guide to Food Labelling and Advertising based on the Canadian Food and Drug Act and the Food and Drug Regulations (Canadian Food Inspection Agency, 2003). The guide states a claim for more or lower energy may be made if the food provides at least 25% more or less energy than the reference food. A reference food is the regular food item used as a comparison to make a claim. For a food to claim it is higher in a specific vitamin or mineral it must have an absolute difference of greater than or equal to10% of the recommended intake for a specified vitamin or mineral per stated serving size and a greater or equal to 25% increase in vitamin or mineral than the reference food (Canadian Food Inspection Agency, 2003).

4.0 RESULTS

Section 4.1 presents provincial data focusing on reported group mean nutrient intakes for energy, calcium, iron, folate, and vitamin C for the adult women. National estimates of group mean intake are given in Section 4.2. The Province-derived Nutrition Survey (PNS) gave overall national estimates of mean nutrient intake of adult Canadian women 18 to 74 years. Young women of the 1970/72 NCS and young women from the 1990s PNS are listed using nutrient intake and nutrient density and compared to a RDA or AI. Nutrient intake and nutrient density also compare the national group mean nutrient estimates of each Canadian adult female age group in the PNS.

4.1 Reported Nutrient Intake of Women by Province

Mean nutrient intake for adult women is presented graphically from the reported data of the provincial nutrition surveys. There are no error bars in these graphs; statistics could not be completed. Figures 4.1, 4.2, 4.3, 4.4, and 4.5 show provincial reported mean intake data for the four female age groups of energy, iron, vitamin C, folate, and calcium. Only data for nine provinces are presented as MB data are unavailable.

Figure 4.1 is a plot of reported mean energy intake from the 1990s provincial nutrition surveys. Also included are reported national mean energy intake estimates for the three age categories in the 1970/72 NCS. Data indicate similar energy consumption patterns between the provinces and the NCS. Each provincial survey showed the same pattern of decreasing energy intake with age. A possible geographic gradient in reported overall energy intake may be indicated, as the difference between the highest and lowest energy intake by age and province was approximately 11% to 16% (190 to 270 kcal).

All provinces generally reported mean energy intake between 1500 and 2000 kcal, about the same as the NCS. For a few provinces the eldest group had reported intakes that were slightly lower. Based on a cutoff difference greater than 25%, it was determined that there were no notable geographic differences in energy intake.

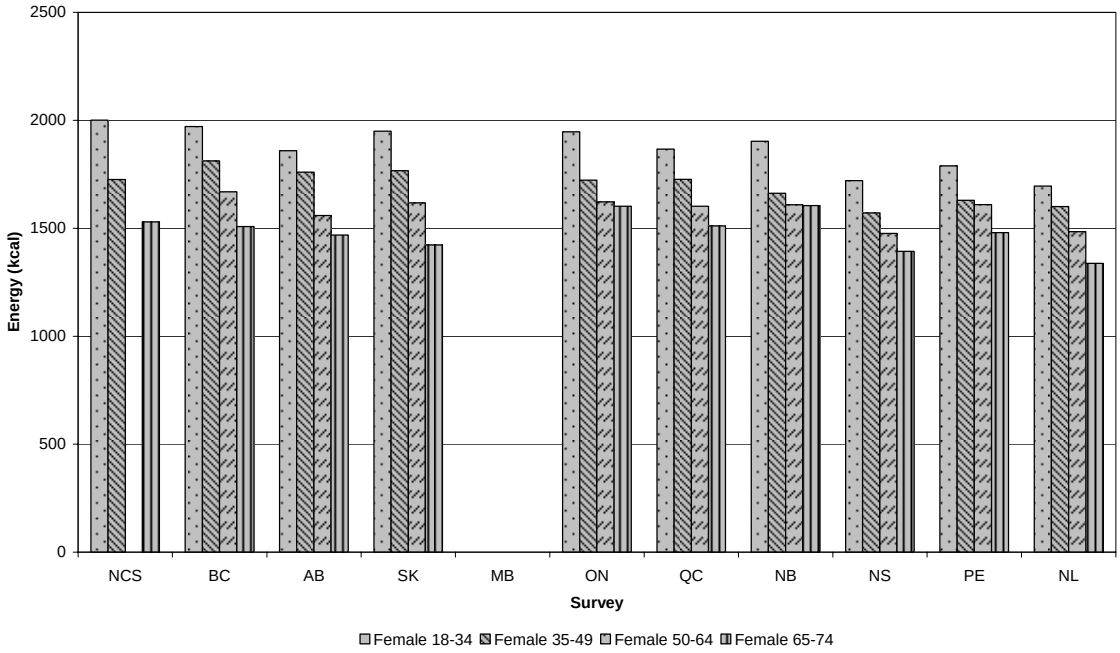

Figure 4.1. Reported mean energy intake in kcal for females from the 1970/72 NCS and provincial nutrition surveys conducted 1990 to 1999 by age and geography (west to east). NCS reported data for age groups 20-39, 40-64, 65+; BC reported data for the age groups 19-30, 31-50, 51-70, 71-84; AB and NL reported data for the age groups 19-30, 31-50, 51-70, 71-74 years respectively. AB used by permission, MB unavailable.

Figure 4.2 shows reported mean iron intake from the provincial nutrition surveys. The pattern of declining intake with age is not as consistent between the provinces as was seen with energy. The majority of provinces show the eldest age group with a lower mean iron intake than the youngest age group. For the most part, mean iron intake was between 10 and 12 mg. For ON, reported mean iron intake was higher than 12 mg for three of four age groups. BC also had higher mean iron intake in three of four age groups. For AB only the youngest age group appeared to have higher than 12 mg iron intake. Data did suggest possible food preference differences in ON compared to the other provinces.

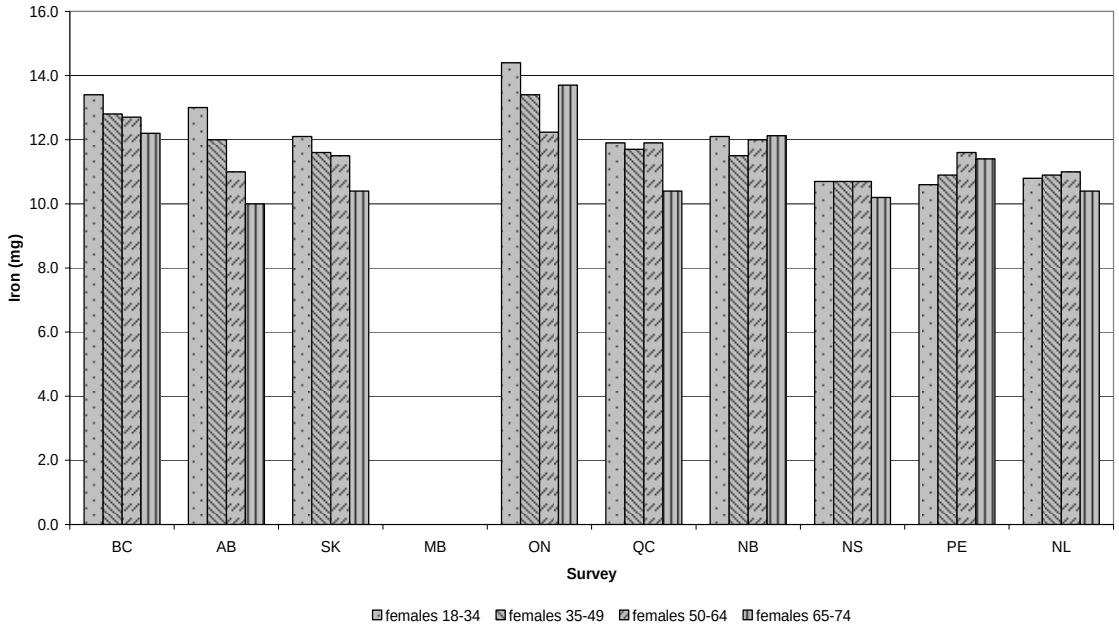

Figure 4.2. Reported mean iron intake in mg for females from the provincial nutrition surveys conducted 1990 to 1999 by age and geography (west to east). BC reported data for age groups: 19-30, 31-50, 51-70, 71-84; AB and NL reported data for age groups 19-30, 31-50, 51-70, 71-74 years respectively. AB used by permission, MB unavailable.

Figure 4.3 indicates possible geographic and age variability from reported mean vitamin C intakes. As with iron, there was no consistent age related pattern between the provinces. In general, the lowest reported mean vitamin C intakes were in the Atlantic Provinces, in particular NS and PE. The majority of provinces reported mean vitamin C intakes between 80 and 110 mg. BC and ON reported mean vitamin C intakes of 120 mg or greater for women age 50 to 64 years and 18 to 34, 50 to 74 years respectively. ON reported the highest mean intakes overall. Since the primary source of vitamin C are fruit and vegetables, results suggest a difference of fruit and vegetable availability or regional food preferences, again particularly in ON.

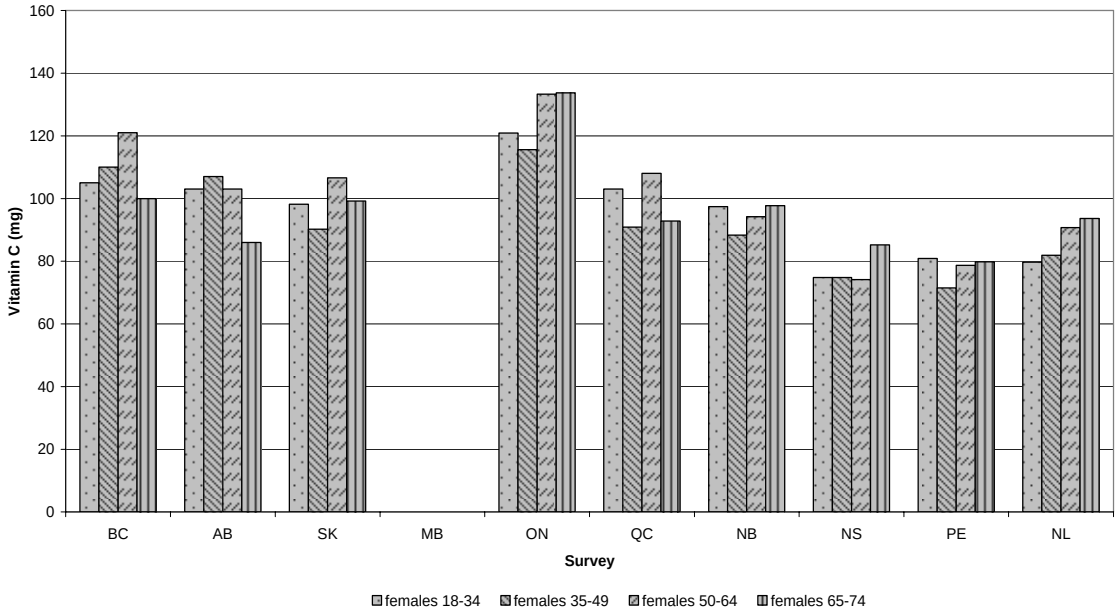

Figure 4.3. Reported mean vitamin C intake in mg for females from the provincial nutrition surveys conducted 1990 to 1999 by age and geography (west to east). BC reported data for age groups: 19-30, 31-50, 51-70, 71-84; AB and NL reported data for age groups 19-30, 31-50, 51-70, 71-74 years respectfully. AB used by permission, MB unavailable.

Figure 4.4 presents the provincially reported mean intake of folate over time as well as by geography. Data were graphed in the order each provincial nutrition survey was completed to demonstrate the effect of folate fortification in assessments of dietary intake. The comparison of provincially reported mean folate intakes were completed in two groups because of fortification. Folate was assessed as micrograms (μg) for seven of the provinces; NS, QC, SK, AB, PE, NL and NB. This grouping represents the pre-folate fortification period. Since a microgram of folate equals one DFE, the data are comparable to that of ON and BC, where mean folate intake was assessed as DFE units, representing post-folate fortification.

Figure 4.4 demonstrates the effect of pre and post folate fortification intake. The seven pre-folate fortification provinces of NS, QC, SK, AB, PE, NL, and NB had similar reported mean folate intakes of approximately 150 to 200 μg. There were no consistent

age related intake patterns seen among these seven provinces but NL shows the distinct pattern of increasing intake with age. The two post-folate fortification provinces of ON and BC do show a decreasing pattern of intake with age and reported folate intake was between approximately 350 and 400 µg DFE. This is approximately 200 µg higher than pre-folate fortification levels. The slightly lower folate intake suggested in the eldest age group from BC may be partly due to BC including women age 75 to 84 years.

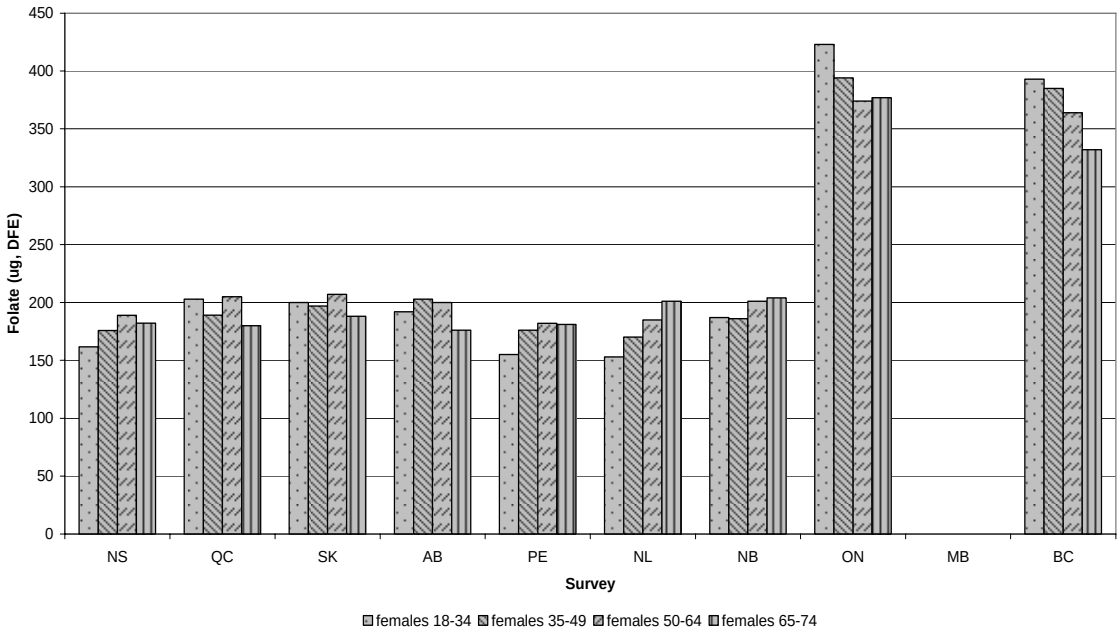

Figure 4.4. Reported mean folate intake in µg or DFE for females from the provincial nutrition surveys by age and order each survey was conducted, 1990 to 1999. BC reports data for age groups 19-30, 31-50, 51-70, 71-84; AB and NL reported data for age groups 19-30, 31-50, 51-70, 71-74 years respectively. AB used by permission, MB unavailable. Folate as µg = NS, QC, SK, AB, PE, NL, NB; Folate as DFE = ON, BC.

Figure 4.5 of provincially reported mean calcium intake shows an overall decline in intake with age, except in NL, where there were similar intakes of calcium across age groups. A geographic gradient in reported mean calcium intake can be seen west to east. Data indicate that NL had the lowest reported mean calcium intake in all four age groups and BC had the highest reported mean calcium intakes amongst the provinces for women

age 18 to 34 years and 65 to 74 years. Mean calcium intakes for BC were between 700 and 900 mg, NL between 500 and 600mg, and mean intake reported by the other seven provinces were intermediate (600 – 800 mg). The highest reported mean calcium intake in NL was under 600 mg; the lowest reported mean intake for BC was greater than 700 mg. This lack of overlap in reported mean intakes of calcium between the provinces of BC and NL supports the possibility of a geographic difference.

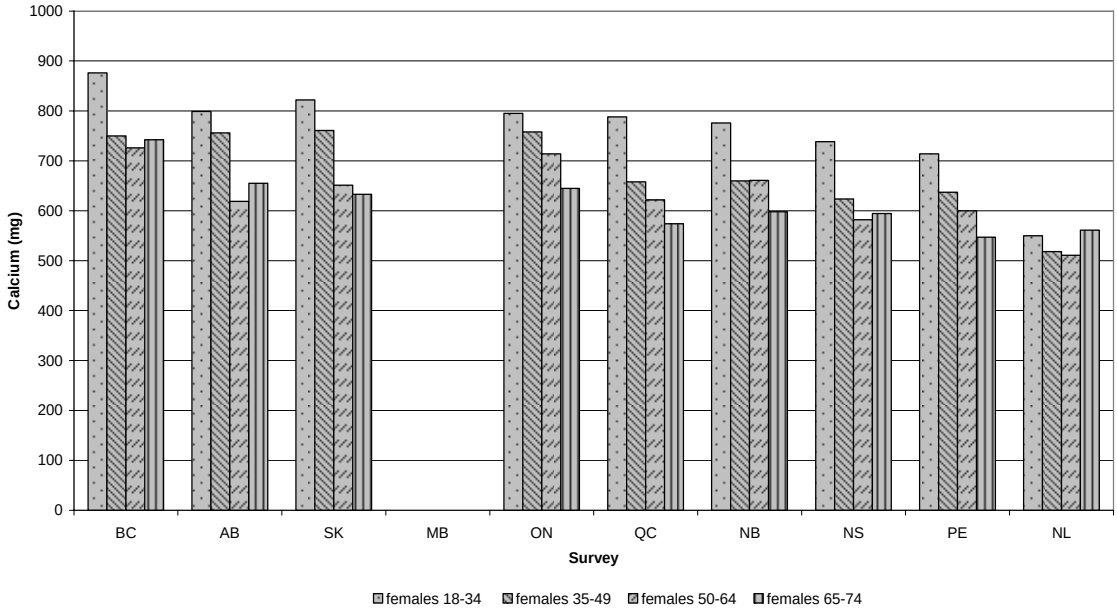

Figure 4.5. Reported mean calcium intake in mg for females from the provincial nutrition surveys conducted 1990 to 1999 by age and geography (west to east). BC reported data using age groups 19-30, 31-50, 51-70, 71-84; AB and NL reported data using age groups 19-30, 31-50, 51-70, 71-74 years respectively. AB used by permission, MB unavailable.

4.2 National Mean Nutrient Intake Estimates

4.2.1 Mean Nutrient Intake of Province-derived Nutrition Survey Adults

Tables 4.1 and D1 show the estimated national mean intake values from food for Canadian adults in the PNS by age. These tables present all of the nutrients reported by the provinces and weighted for the PNS. For both genders, energy intake decreased with age resulting in a corresponding decrease in intake for most nutrients.

For Canadian females (Table 4.1), estimates of mean energy and most nutrients show an overall decrease with age. There was a decline of 23% in energy intake between the youngest and oldest age group. A corresponding decline in nutrient intake is therefore not unexpected. There are exceptions. Estimated national mean dietary fibre intakes show an increase in intake with age. Potassium and magnesium were the only two minerals that did not show a decrease; they were similar across age groups. In the vitamin group, only vitamin A, B_6, $B_{12,}$ and C indicated there was an increase or similarity in intake with age. There was a jump in apparent vitamin B_{12} intake at the eldest age group. This appears to be an anomaly as it is large (33%) and did not occur in all provinces; only ON, PE, and NL reported it.

For the adult Canadian men (Table D1), national mean energy and the majority of nutrients showed the same pattern of decreasing intake with age. Elderly men consumed about 32% less mean energy than the youngest men. For the men there was no noticeable increase in dietary fibre. Unlike the women, only vitamin A and B_{12} show no age related decrease in mean intake. Vitamin B_{12} intake in men did not show the anomaly seen in the women's intake.

Folate intakes are shown twice. This is because some provincial surveys collected data previous to mandatory folate fortification of flour and flour products in the Canadian food supply. Intakes assessed prior to fortification are derived from NS, QC, SK, AB, PE, NL, and NB and were provided as µg of folate. For the two assessments conducted after fortification (ON, BC), intakes are provided as DFEs. Reported post-fortification mean intake values are approximately 200 µg DFE higher in women and 200 to 300 µg DFE higher in men than those reported pre-fortification.

Table 4.1. National mean intake values from food of Canadian females in the Province-derived Nutrition Survey[1]

Age Group	**18-34**	**35-49**	**50-64**	**65-74**
	n = 2482	n = 2491	n = 2361	n = 1527
Energy, kcal	1900	1740	1610	1540
Protein, g	73	70	67	64
Carbohydrate, g	250	222	211	206
Total fat, g	67	62	56	52
SFA, g	23.5	21.8	19.0	17.7
PUFA, g	10.9	10.2	9.55	9.07
MUFA, g	26.6	24.3	21.9	20.4
Cholesterol, mg	227	232	220	194
Dietary Fibre, mg	13.3	14.9	15.5	16.3
Sodium, mg	2840	2580	2310	2350
Potassium, mg	2570	2700	2760	2720
Calcium, mg	794	722	676	638
Phosphorus, mg	1180	1130	1080	1070
Magnesium, mg	261	275	272	267
Iron, mg	13.1	12.5	12.0	12.0
Zinc, mg	9.48	9.45	9.21	8.59
Vitamin A, RE	1030	1250	1110	1240
Thiamin, mg	1.52	1.36	1.44	1.33
Niacin, NE	32.3	31.5	30.5	29.4
Riboflavin, mg	1.71	1.60	1.57	1.43
Vitamin B6, mg	1.45	1.51	1.57	1.55
Pantothenic Acid, mg	4.18	4.05	4.15	3.94
Folate, μg[2]	194	190	202	182
Folate, DFE[2]	417	391	371	365
Vitamin B12, μg	4.65	3.87	3.45	5.17
Vitamin C, mg	108	105	118	110
Alcohol, g	4.7	4.4	4.3	2.7

[1] Mean estimates are the population weighted values of group means from n un-weighted provincial subjects
Estimates of national intake rounded to no more than 3 significant digits
MB not included, data unavailable; AB report unpublished, data used by permission
BC reported groups 19-30, 31-50, 51-70, 71-84 years; AB & NL reported groups 19-30, 31-50, 51-70, 71-74 years
kcal = kilocalorie, g = gram, mg = milligram, μg = microgram
[2]Folate (μg) = NS, QC, SK, AB, PE, NL, NB; Folate (DFE) = ON, BC
DFE (dietary folate equivalents) 1 DFE = 1μg food folate = 0.6μg folic acid fortified food or supplement taken with food = 0.5μg supplement taken on empty stomach
RE (retinol equivalents) 1μg retinol = 6μg β-carotene = 12μg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan

4.2.2 Mean Nutrient Intake of Women 18 to 34 years from the Province-derived Nutrition Survey

Table 4.2 shows estimated national mean nutrient intake values of young 1990s women age 18 to 34 years for all of the nutrients reported in the surveys. Included are two DRI reference values. Mean intake estimates for dietary fibre, potassium, calcium, iron, magnesium, food folate, and pantothenic acid for women of this age group did not exceed the RDA or AI. Although no conclusions about inadequacy in the diet for these nutrients may be made, these appear to be nutrients of concern. Mean intakes of protein, carbohydrate, sodium, phosphorus, zinc, vitamin A, thiamin, niacin, riboflavin, folate as DFE, vitamin B_6, vitamin B_{12}, and vitamin C did meet or exceed the RDA or AI. The proportion of individuals in the group with inadequate intake cannot be ascertained but would likely be low for those nutrients that exceed the RDA or AI.

4.2.3 Nutrient Intake and Nutrient Density for Women 18 to 34 years in the Province-derived Nutrition Survey and 20 to 39 years from the Nutrition Canada Survey

PNS women were compared to the corresponding age group reported in the 1970/72 NCS. Table 4.3 presents national group mean nutrient intake estimates and the percent differences between the two groups. There was only a small difference (5%) in the mean energy intake between PNS women age 18 to 34 years and NCS women age 20 to 39 years. For the four nutrients the differences varied. The difference for iron was not notable as it fell below the 10% cutoff. The differences in mean intake for calcium and vitamin C intake were both notable.

The differences in folate intake were much greater. In assessing pre-fortification (μg food folate), there is a notable difference in mean intake of 25%. When the NCS was compared to the post-fortification PNS value then the difference was very notable (65%). The two values are associated with time and time/fortification. Mean folate differences between the PNS pre (μg) and PNS post (DFE) folate fortification was about 200 μg or 53%. Overall nutrient intake has increased.

Table 4.2. National mean nutrient intake for women age 18 to 34[1] years in the Province-derived Nutrition Survey with the RDA or AI value of the Dietary Reference Intakes

Nutrient	Mean	RDA[2]	AI[3]
Energy, kcal	1900		
Protein, g	73	46	
Carbohydrate, g	250	130	
Total fat, g	67		
SFA, g	23.5		
PUFA, g	10.9		
MUFA, g	26.6		
Cholesterol, mg	227		
Dietary Fibre, mg	13.3		25
Sodium, mg	2840		1500
Potassium, mg	2570		4700
Calcium, mg	794		1000
Phosphorus, mg	1180	700	
Magnesium, mg	261	310	
Iron, mg	13.1	18	
Zinc, mg	9.48	8	
Vitamin A, RE	1030	700 [4]	
Thiamin, mg	1.52	1.1	
Niacin, (mg) NE	32.3	14.0	
Riboflavin, mg	1.71	1.1	
Vitamin B6, mg	1.45	1.3	
Pantothenic Acid, mg	4.18		5.0
Folate, µg[5]	194	400	
Folate, DFE[5]	417	400	
Vitamin B12, µg	4.65	2.4	
Vitamin C, mg	108	75	
Alcohol, g	4.7		

Estimates rounded to no more than 3 significant digits and are population weighted group means of 2,482 provincial subjects
[1]Age group reported for BC, AB, NL was 19-30 years
MB not included, report unavailable; AB unpublished, data used by permission
RDA and AI values taken from the DRI reports of 1997, 1998, 2000, 2001, 2005
[2] RDA (recommended dietary allowance)
[3] AI (adequate intake)
[4] RAE (retinol activity equivalents) 1 RAE = 1 µg retinol, 12 µg β-carotene, 24 µg α-carotene, 24 µg β-crypoxathin
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
DFE (dietary folate equivalents)
1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
[5]Folate, µg = NS, QC, SK, AB, PE, NL, NB; Folate DFE = ON, BC
kcal = kilocalorie; g = gram; µg = micrograms; mg = milligrams; % = percent

Table 4.3. Mean nutrient intake and % difference between young women age 18 to 34[1] years from the Province-derived Nutrition Survey and age 20 to 39 years reported in the 1970/72 Nutrition Canada Survey

	PNS	NCS	% Diff
Energy, kcal	1900	2000	-5
Calcium, mg	794	709	11
Iron, mg	13.1	12.0	8
Folate, µg	194[2]	146[3]	25
Folate, DFE	417[2]	146[3]	65
Vitamin C, mg	108	89	18

Estimates of national intake rounded to no more than 3 significant digits
[1]Age group reported for BC, AB, NL was 19-30 years
PNS is a group mean derived from provincial group means
NCS data taken from mean values reported in Department of National Health and Welfare (1975)
[2] PNS food folate µg = NS, QC, SK, AB, PE, NL, NB; Folate DFE = ON, BC
[3] NCS food folate
DFE (dietary folate equivalents), 1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
kcal = kilocalorie; mg = milligram; µg = microgram; % = percent

Table 4.4 shows differences in intake when nutrient density was calculated for calcium, iron, folate, and vitamin C for both groups. There is a notable difference for calcium, iron, and vitamin C between young PNS and NCS women. For pre-fortification folate (µg) values the difference was very notable (29%). The difference of intake as DFE was also very notable and again the folate fortification effect can be seen. All differences in nutrient density were greater than the differences calculated from nutrient intake seen in Table 4.3. The change in energy intake was not notable, yet the nutrient density of the diets has increased. Nutrient density data suggest that 1990s women made different if not better quality food choices.

Table 4.4. Nutrient density per 1000 kcal and % difference between young women age 18 to 34 years from the Province-derived Nutrition Survey* and age 20 to 39 years from the 1970/72 Nutrition Canada Survey

	PNS	NCS	% Diff
Calcium, mg	418	355	15
Iron, mg	6.9	6.0	13
Folate, µg	102[1]	73[2]	29
Folate, DFE	218[1]	73[2]	67
Vitamin C, mg	57	45	22

*Age group reported for BC, AB, NL was 19-30 years
Nutrient density = nutrient/energy (kcal) x1000
[1]PNS food folate µg = NS, QC, SK, AB, PE, NL, NB; Folate DFE = ON, BC
[2]NCS food folate
DFE (dietary folate equivalents), 1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
kcal = kilocalorie; mg = milligram; µg = microgram; % = percent

Figures 4.6 and 4.7 are plotted national mean nutrient intakes for young women of the NCS and PNS. Figure 4.6 showed calcium did not exceed the AI (1000 mg) for either survey. Pre-fortification folate did not exceed 400 µg DFE (RDA) in either survey. Mean folate intake exceeded the RDA for PNS women assessed post-fortification. In Figure 4.6 the impact of fortification on mean folate was seen. In Figure 4.7, mean intake of iron for both the NCS and PNS did not exceed the RDA (18 mg) for that mineral. Vitamin C did exceed the RDA of 75 mg for both the NCS and PNS young women so the probability of inadequate intake of vitamin C in this age group was likely low.

4.2.4 Nutrient Intake and Nutrient Density of Province-derived Nutrition Survey Females by Age

Mean nutrient intake estimates for energy, calcium, iron, folate, and vitamin C for women are in Table 4.1 or Table D2. Except for vitamin C, intake declined with age. Women age 18 to 34 years consumed about 19% more energy than women age 65 to 74 years. Intake of calcium, iron, folate (µg), and folate (DFE) were 20%, 8%, 6%, and 13% higher in the youngest than eldest group respectively and mean vitamin C intake was 2% lower. Only the differences for calcium and folate DFE were notable.

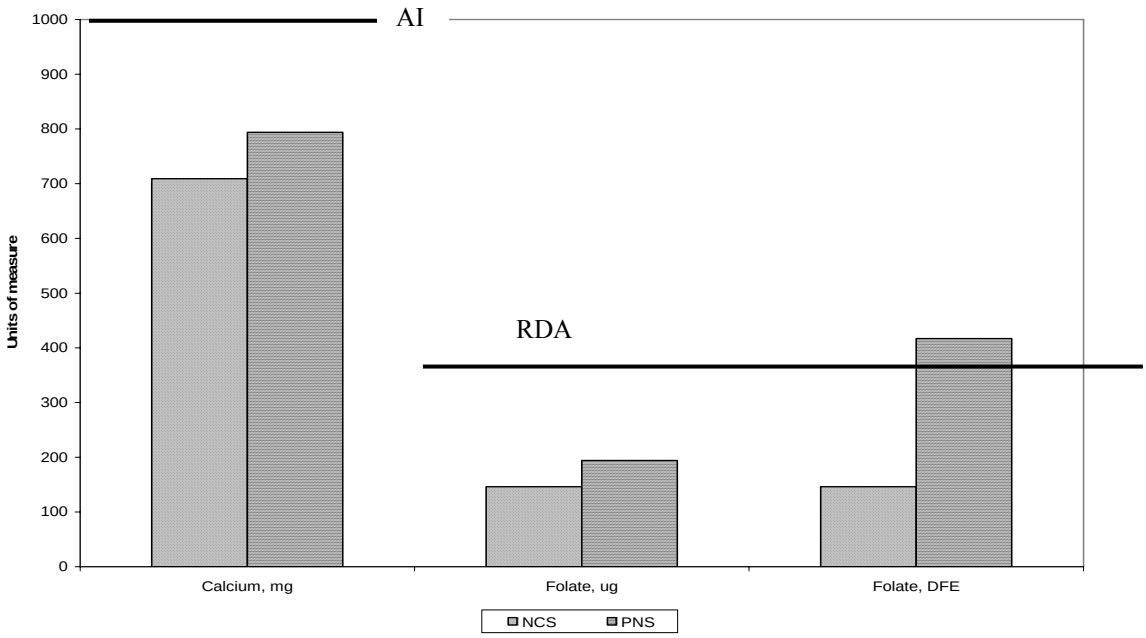

Figure 4.6. Comparison of national mean nutrient intake of calcium and folate for women age 20 to 39 years (Nutrition Canada Survey) to women age 18 to 34 years (Province-derived Nutrition Survey) and the appropriate Dietary Reference Intake value

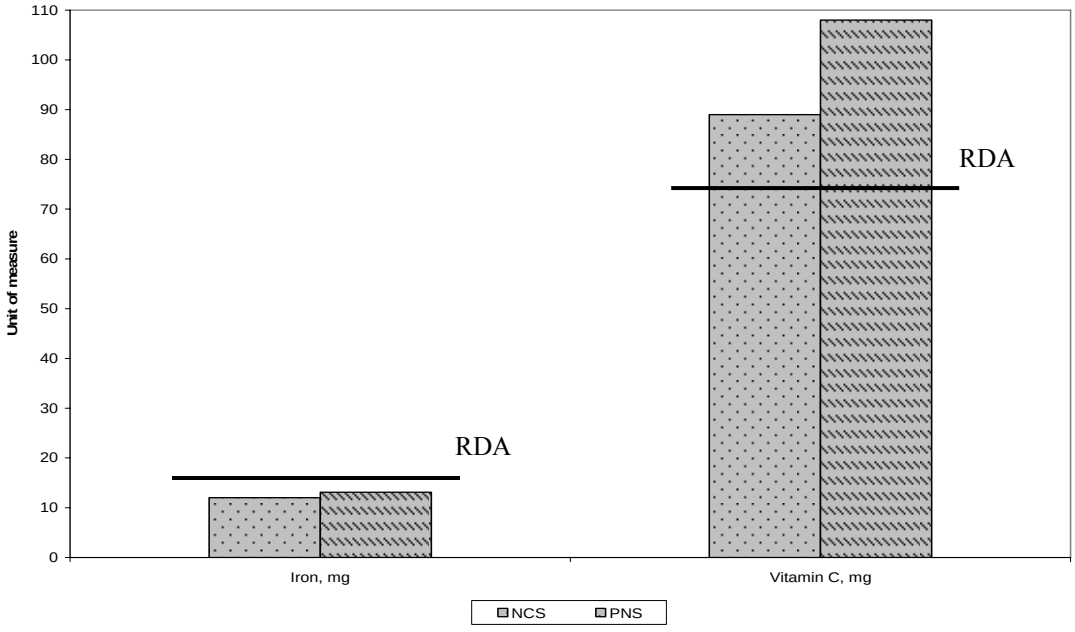

Figure 4.7. Comparison of national mean nutrient intake of iron and vitamin C for women age 20 to 39 years (Nutrition Canada Survey) to women age 18 to 34 years (Province-derived Nutrition Survey) and the appropriate Dietary Reference Intake value

Table 4.5 presents mean energy and nutrient density for calcium, iron, folate, and vitamin C for the four age groups. The youngest age group consumed the lowest nutrient density per 1000 kcal of energy than the other three female age groups except in calcium. The differences between age groups in calcium intake (≤1%) were not notable. The eldest group consumed up to 20% more iron, folate, and vitamin C per 1000 kcal of energy than the youngest group.

Table 4.5. Summary of national mean energy intake and nutrient density (per 1000 kcal) for calcium, iron, folate, and vitamin C for Province-derived Nutrition Survey women by age category

	PNS			
	18-34	**34-49**	**50-64**	**65-74**
Energy, kcal	1900	1740	1610	1540
Calcium, mg/1000 kcal	418	415	420	414
Iron, mg/1000 kcal	6.9	7.2	7.5	7.8
Folate, µg[1]/1000 kcal	102	109	125	118
Folate, DFE[1]/1000 kcal	218	225	230	237
Vitamin C, mg/1000 kcal	57	60	73	71

ND values derived from estimated national NI values (AB included by permission; MB not unavailable)
PNS: BC age groups = 19-30, 31-50, 51-70, 71-84 years; AB, NL age groups = 19-30, 31-50, 51-70, 71-74 years
[1]PNS Folate µg = NS, QC, SK, AB, PE, NL, NB and Folate DFE = ON, BC
DFE (dietary folate equivalents), 1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
kcal = kilocalorie; mg = milligram; µg = microgram

Figure 4.8 and Figure 4.9 show nutrient intake and nutrient density values from Table 4.1 and Table 4.5 for calcium, iron, folate, and vitamin C. With the exception of vitamin C, nutrient intake decreased with age. Intake of vitamin C is similar across the age groups. These figures demonstrate that as women age they may be making better quality food choices as even with a decrease in energy, women appear to maintain or increase the nutrient density of their diets for all four of these nutrients.

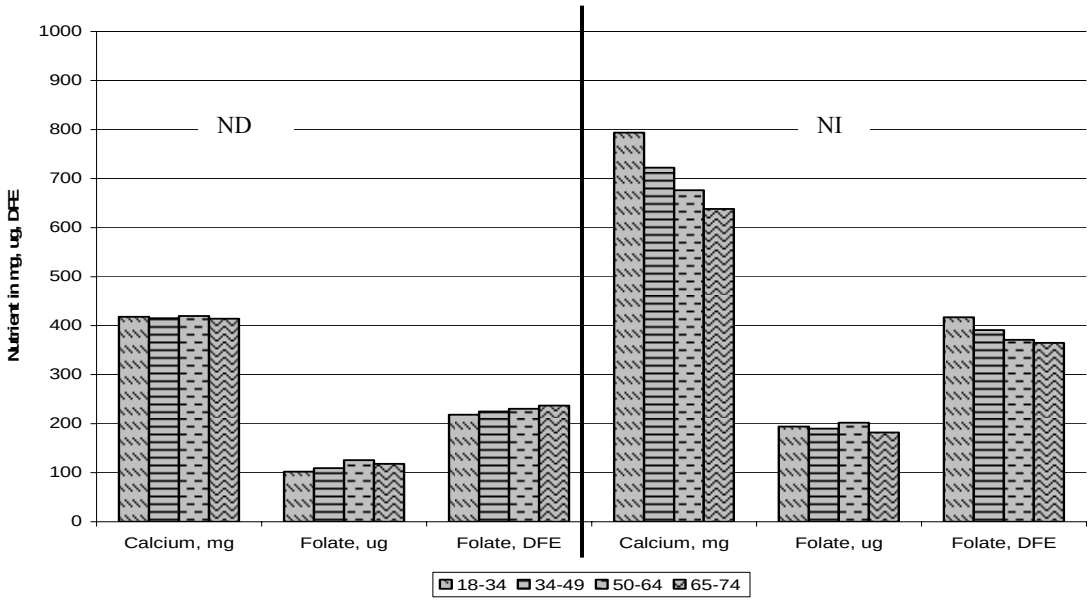

Figure 4.8. Nutrient density and nutrient intake for calcium, folate in μg, and folate in DFE of Province-derived Nutrition Survey women by age group. Vertical line indicates separation of nutrient density (ND) on the left and nutrient intake (NI) on the right. ND: intake per 1000 kcal; NI: estimated national mean.

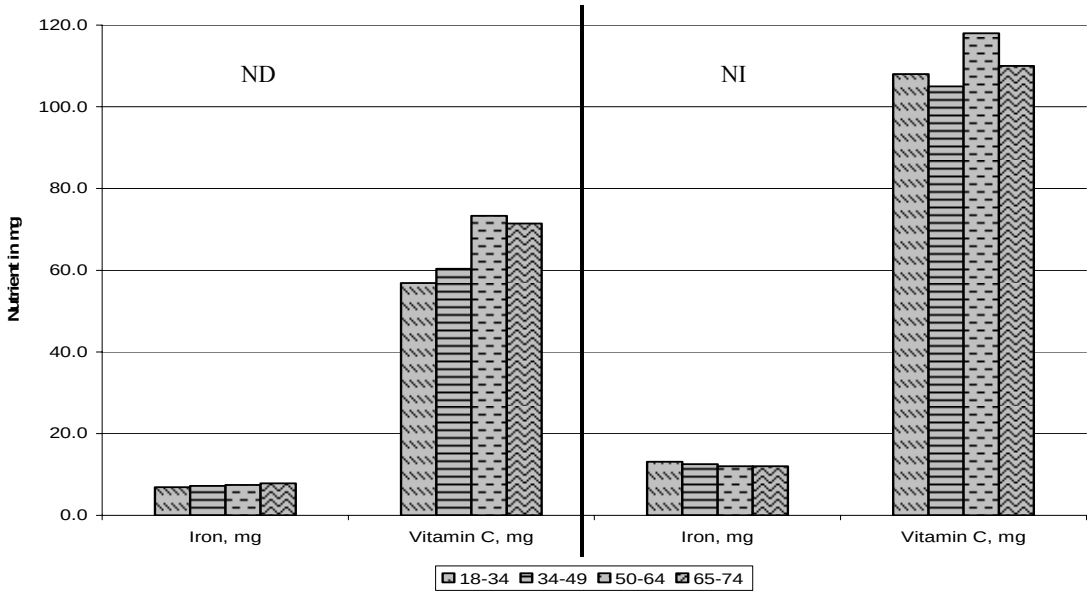

Figure 4.9. Nutrient density and nutrient intake for iron and vitamin C in mg of Province-derived Nutrition Survey women by age group. Vertical line indicates separation of nutrient density (ND) on the left and nutrient intake (NI) on the right. ND: intake per 1000 kcal; NI: estimated national mean.

5.0 DISCUSSION

This is the first time a comparison of the available provincial nutrition surveys has been done for all reported nutrients. This aggregation to produce a national data set called Province-derived Nutrition Survey (PNS) and then comparing it to the Nutrition Canada Survey (NCS) is also a first. Because each provincial research team owns the data they collected during the 1990s, Heath Canada cannot aggregate the raw data. Health Canada provided expertise for survey methodology development, ensured provincial uniformity, completed data entry, and maintains the foods database.

This discussion focuses on energy and the micronutrients iron, vitamin C, folate, and calcium for women of childbearing age. The provincial nutrition surveys measured a group of adult women age 18 to 34 years. To compare a similar age group from previous data, it was necessary to use women 20 to 39 years reported by the NCS. Although some women in provincial survey age groups 35 to 49 years may be classified as childbearing age, the second adult age group reported by the NCS (40 to 64 years) was too broad for a comparison group. The nutrients iron, folate, and calcium were public health concerns for adults, particularly for women, in both 1970/72 and the 1990s. Vitamin C was included in our analysis since it is a primary fruit intake indicator and very important to enhance non-heme iron absorption. Among the food groups, fruit is correlated to absorbable iron as are vegetables (Tessier, O'Brien, Zee, Marin, Tremblay, Desrosiers, 2002). Usually, fruit and vegetables are reported as one food group in diet surveys and may be reflective of overall diet quality (Fitzgerald, Maclean, & Veugelers, 2002). Similarities in nutrient intakes and patterns among provinces and across age and gender groups were seen in the information. Differences of women 18 to 34 years from males or other female age groups are noted as appropriate.

5.1 Energy Intake of Canadian Adults

Energy is measured to estimate total intake, energy balance, intake distribution, food availability, underreporting, and nutrient density. Estimating energy allows for the bodyweight assessment of healthy populations. Underreporting may be evaluated using ratios of energy intake to basal metabolic rate where those below a specified cutoff are probably underreporters and those above are likely adequate reporters (Briefel, Sempos, McDowell, Chien, & Alaimo, 1997; Gray-Donald, Jacobs-Starkey, & Johnson-Down, 2000). Energy is important to measure as reports indicate the incidence of overweight and obesity has increased (Briefel & Johnson, 2004). Intake distributions provide information on the proportion of energy derived from protein, carbohydrate, and fat and if distribution falls within the acceptable range (Gray-Donald, Jacobs-Starkey, & Johnson-Down, 2000; Institute of Medicine, 2005). Others may examine trends by time, age, key food item, or restaurant use (Harnack, Jeffery, & Boutelle, 2000; de Castro, 2002; Nielsen, Siega-Riz, & Popkin, 2002).

Nutrient intake generally correlates with energy consumption (Carter & Whiting, 1998) but not always. Measuring energy allows direct nutrient intake comparisons using a nutrient density method. This method emphasizes the nutritional quality of the diet and values resulting of this method are independent of consumed energy (National Research Council, 1981; Drewnowski, 2005). Macronutrient intake was not a focus of this thesis, but differences in food choices affect energy distribution and may influence estimates of some nutrients more than others.

5.1.1 Mean Energy Intake between the Provinces

Overall reported energy intake for adult women ranged from approximately 1500 to 2000 kcal. Women 18 to 34 years consumed on average between 1700 and 1970 kcal. Men reported consuming approximately 2000 kcal to 3000 kcal. For both genders and all nine provinces, the expected age related decline in energy intake was seen. There were no notable differences in reported mean energy between provinces by time or geography for adults in the 1990s.

For women 18 to 34 years, reported mean energy intake was 13% higher in 1999 than in 1990 but estimates reported by the provinces surveyed between these years show

no consistent increasing pattern. The difference between the provincial survey reporting the highest and the survey reporting the lowest mean energy intake was also small (14%) for women of this age group. The potential west/east gradient in energy intake in women (Figure 4.1) is not very notable as the differences in energy intake between the provinces were less than 25%. NS and NL did report the two lowest mean energy intakes in each of the four female age categories but the reports of these two provinces indicated that lower mean energy values were resultant of underreporting and therefore equivalent to the other provinces (Fitzgerald, Maclean, & Veugelers, 2002; Roebothan, 2003). Neither the males nor the three other female age categories showed differences more than 25% for patterns described for women 18 to 34 years.

Available per capita energy in the Canadian food supply began to show increases from 1991 to 2000 but the total rise was estimated about 300 to 400 kcal over these years (Statistics Canada, Agriculture Division, 2005). Every person does not consume equally from the available food supply but data reveal total food disappearance had not changed remarkably. Distribution of mean energy reported by the provinces (Table B9) also show similar proportions in age and gender groups. Some provincial researchers compared data to other published provincial group mean data and they considered reported mean energy intakes comparable for the groups observed (Stephen & Reeder, 2001; Taylor, Van Til, & MacLellan, 2002; Mendelson, Tarasuk, Chappell, Brown, & Anderson, 2003; Roebothan, 2003; Balram, Villalon, McCaie-Burke, Ericson, & Boyne, 2005).

5.1.2 Mean Energy Intake between the Province-derived Nutrition Survey and the Nutrition Canada Survey

Energy intake for PNS women 18 to 34 years was only about 5% lower than the comparative age group from the NCS. Energy intake differences in the other female age groups ranged 1 to 3% and male groups ranged 4 to 16%. Since a few provincial surveys observed that reported mean energy appeared lower in some age and gender groups from what the NCS reported (MacLean, 1993; Stephen & Reeder, 2001; Mendelson, Tarasuk, Chappell, Brown, & Anderson, 2003) this thesis compared the reported provincial mean energy estimates to NCS regional mean energy estimates (Tables F1 to F3). The regional NCS data compared to each respective province by age and gender showed mean energy

intakes were within 15% for females and 24% in males. In the national data estimates, the expected higher reported intake in males than females and age related decline in energy intake was evident.

The level of estimated available energy from the Canadian food supply remained stable from 1976 to 1991 and rose slightly (~9%) by 1996 (Statistics Canada, Agriculture Division, 2005). Total food disappearance did not change markedly over this time. There are not enough Canadian data to determine trends in Canadian energy intake as there is a lack of nutrition monitoring in the country (McAmmond, 2000). FHC on the other hand, indicated most age/gender groups reported lower national mean energy intake in 1997/98 than 1970/72 (Gray-Donald, Jacobs-Starkey, & Johnson-Down, 2000) but significance or magnitude of these apparent differences is unknown. In addition, it is possible that people in the 1990s were more likely to underreport energy intake than in the 1970s (Fitzgerald, Maclean, & Veugelers, 2002; Balram, Villalon, McCaie-Burke, Ericson, & Boyne, 2005).

American trend research suggests true energy intake actually increased with time because energy availability in American food supplies has increased, underreporting has increased, and it would be consistent with the upward obesity trend (Harnack, Jeffery, & Boutelle, 2000; Nielsen, Siega-Riz, & Popkin, 2002; Briefel & Johnson, 2004). However, conclusions made based on energy people reported eating do conflict as Warwick & Reid (2004) pointed out many reviews which showed energy intake increasing, decreasing, not changed, or could not be concluded. Variations in survey methodology may affect energy intake estimates but it is most likely that true intake lies between the food available to us for consumption and that reported as consumed.

Many factors influence the incidence of underreporting so it may be different by province and/or time. Usually, underreporting increases as excess body mass rates climb but between province patterns of underreporting and overweight and obesity rates did not appear predictable (Balram, Villalon, McCaie-Burke, Ericson, & Boyne, 2005). Whether energy consumption really changes over time are unknown and how much underreporting affects it can only be estimated. Underreporting intake occurs with all dietary assessment methods and was likely greater in the 1990s than the 1970s so energy intake in the 1990s was probably higher than that reported by the provinces therefore similar to 1970/72 NCS (Fitzgerald, Maclean, & Veugelers, 2002).

Macronutrient distribution has shifted which may account for discrepancies about reported energy between 1970/72 and 1990s. Several researchers who assessed data from 1970 to 2000 showed that the mean percentages of energy from protein remained similar but fat decreased as carbohydrate concurrently increased (Enns, Goldman, & Cook, 1997; Gray-Donald, Jacobs-Starkey, & Johnson-Down, 2000; Briefel & Johnson, 2004). Given that fat contains the most calories per gram, a decrease in its proportion of energy occurs. Fat or fatty foods are most likely to be underreported because they are often perceived as unhealthy (Lee & Nieman, 2003). Apparent differences in energy intake are probably the result of greater underreporting rather than a decrease in energy intake (Balram, Villalon, McCaie-Burke, Ericson, & Boyne, 2005).

5.1.3 Overall Findings

Overall, energy consumption does not appear influenced by time or geography in comparable age/gender groups. Gender and age affect energy intake, men consume more than women and intake declined with advancing age for both genders. The differences in absolute values of reported mean energy are most likely related to the factors involved in underreporting.

If we assume correlation of energy and nutrients, then as energy intake increases nutrient intake should increase. In theory then, younger age groups would have the better quality diet, the provinces would have similar nutrient intakes, and the 1990s would have similar nutrient intake to the 1970s. Plotting and tabulating the mean nutrient intake data showed that this theory did not always hold. For some provinces and nutrients there were notable differences in nutrient intake (Section 5.2) and nutrient intakes were higher in the 1990s than in 1970/72 for most nutrients (Table E1, E3). Micronutrients are related more to the specific foods that comprise total energy in the diet than to total energy. Decreased energy intake with age may result in lower absolute nutrient intakes but not necessarily a poorer quality diet.

Energy is a potential confounder to direct comparison of nutrient intake. Because energy is common to all groups, the nutrient density method is a valuable tool. This ratio calculates the concentration of a nutrient in each reported group energy intake so that diet quality for each age/gender group might be inferred and compared. Based on differences

in nutrient density we might identify specific food choices that contribute to diet quality. Promoting specific foods to increase nutrient intake rather than total energy may help the consumer substitute foods in their diets with healthier options (Drewnowski, 2005).

5.2 Trends in Nutrient Intake in Reported Provincial Data

Usually, nutrient intake declines with age as energy intake decreases but the age related patterns of decline were not consistent for iron, vitamin C, folate, and calcium in all provinces as seen for reported mean energy. Most provinces did show the eldest group of women with lower mean intake than the youngest for these four micronutrients. Trends by age will be discussed at the national level in Section 5.3 and 5.4. Provincial vitamin C, folate, and iron estimates suggested that Ontario females had higher overall mean intakes of these three micronutrients than other provinces. There was also indication for potential geographic differences in calcium as intakes in BC and NL differed. Temporal trends for the 1990s were not apparent for iron, vitamin C, or calcium but a time influence for folate was evident.

5.2.1 Iron

Reported mean estimates for iron indicated no temporal or geographic differences between the provinces. Iron is derived mainly from meat, fish, poultry (MFP), and grains. Provincial surveys indicated grains were the main source of dietary iron supplying about 40 to 45% and MFP only contributed in the range of 20 to 25% (Stephen & Reeder, 2001; Balram, Villalon, McCaie-Burke, Ericson, & Boyne, 2005; Forster-Coull, Barr, & Milne, 2004). Between 1991 and 2000 the food supply availability of MFP remained similar and grains increased 12 kg per capita (Statistics Canada, Agriculture Division, 2005). Neither estimates of iron intake nor percent contribution to dietary iron appear influenced by food disappearance. The bulk of that increase was through wheat flour and rice and about 1 kg per capita for breakfast cereal. Flour and its products have variable iron levels, rice is not a good source, but breakfast cereals are iron-fortified in Canada (Health Canada, 1999).

5.2.2 Vitamin C

There was a wider range of mean intake among provincial age groups for vitamin C than for some other micronutrients but this is probably normal because assessing usual intake for this micronutrient is difficult. Some foods are highly concentrated in vitamin C and may be eaten only occasionally so the intake distribution may be skewed (Institute of Medicine, 2000). No temporal trends in the provincial mean micronutrient intake data for vitamin C from the first survey conducted to the last survey completed were seen. Fruit is the primary food source of vitamin C. Between 1991 to 2000 the availability of fresh and processed fruit did not increase and fruit juices increased about 5 L per person (Statistics Canada, Agriculture Division, 2005) yet this fruit group provided a similar 50 to 55% of dietary vitamin C among the provinces reporting a contribution value (Stephen & Reeder, 2001; Mendelson, Tarasuk, Chappell, Brown, & Anderson, 2003).

Vitamin C estimates indicated adult women had similar intakes among provinces but Figure 4.3 suggests women in ON and BC had mean intake in the high range and NS and PE had intake in the low range. There was some indication that Atlantic Canada may not consume as many colorful dark green, orange, and red fruit. The largest consumers of fruit include ON and BC while Atlantic Canada consumes the least, with few oranges and other citrus fruit (Statistics Canada, Agriculture Division, 2005). Potatoes appeared to be the key food choice for the vegetable and fruit food group for Atlantic Canadians (Taylor, Van Til, & MacLellan, 2002). Given the popularity of the potato it is an important source of vitamin C (Whitney & Rolfes, 2003; Thompson, Manore, & Sheeshka, 2005).

5.2.3 Folate

Mean folate estimates (Figure 4.4) differentiate between those surveys conducted pre-folate fortification (NS, QC, SK, AB, PE, NL, NB) and those completed post-folate fortification (ON, BC). The slightly lower reported mean for the eldest BC age group was likely the result of presenting data using DRI age categories, as they had a larger group of older adults than in ON.

Folate is mainly derived from vegetables with a major contribution coming from grains during the post-folate fortification period. During the 1990s, consumption of fresh and processed vegetables increased about 10 kg per person and cereals (grains) increased

approximately 12 kg per person (Statistics Canada, Agriculture Division, 2005). Though there was no temporal trend within each folate period, the difference in folate intakes pre and post-folate fortification was about 200 μg. A difference was not unexpected as by late 1998, the Canadian government mandated that flour and flour products be fortified with folic acid (Department of Health, 1998). There was a striking change in the contribution shifts of the food groups largely due to folic acid. Prior to 1997/98, 25 to 33% of dietary folate was from the vegetable/fruit group and 25% from grains (MacLean, 1993; Stephen, & Reeder, 2001; Roebothan, 2003; Balram, Villalon, McCaie-Burke, Ericson, & Boyne, 2005). After introducing folic acid, the amount of folate coming from the vegetable/fruit group was similar but 50 to 60% now came from grains (Mendelson, Tarasuk, Chappell, Brown, & Anderson, 2003; Forster-Coull, Milne, & Barr, 2004). The introduction of the DRIs allowed for the assessment of folic acid through DFE units and because most of the population eats products such as pasta, bread, and cereal the average folate intake would have increased even without a change in food consumption (Briefel & Johnson, 2004). In NS, a review of pregnant women found that folic acid in the food supply decreased neural tube defects by more than 50% where public education campaigns to supplement did not alter incidence significantly (Persad, Van den Hof, Dubé, & Zimmer, 2002). Limited data about dietary intake exist so there is much interest in monitoring folate from food sources so that the effects of this important public health intervention can be evaluated (Briefel & Johnson, 2004).

5.2.4 Calcium

Most data showed an expected decline in micronutrient intake with advancing age largely because consumption of dairy products declines (Jacobs-Starkey, Johnson-Down, & Gray-Donald, 2001). NL however, reported mean calcium intakes that were similar by age group and attributed to increased fluid milk consumption in older adults (Roebothan, 2003). There were no temporal trends in reported calcium intake or in overall dairy food availability. The primary source for dietary calcium is dairy and between 1991 and 2000, food consumption statistics showed annual fluid milk disappearance decreasing by about 5 L per capita and cheese and yogurt up a little (2 kg) but resulting in similar total dairy availability throughout that decade (Statistics Canada, Agriculture Division, 2005).

Plotted data suggest a geographic difference. Overall mean calcium intake in BC was higher compared to NL; other provinces had intermediate intakes. Figure 4.5 showed mean calcium intake for BC women 18 to 34 years was near 900 mg and mean intake for NL women of the same age less than 600 mg. BC and NL reported dairy contributed 60% of the total dietary calcium (Roebothan, 2003; Forster-Coull, Barr & Milne, 2004) but NL and BC reported consuming very different total amounts. Total dairy made up about 13% of energy in BC and only 9% in NL and the fraction of young NL women consuming less than 600 mg of calcium was three times higher than reported by BC (Roebothan, 2003; Forster-Coull, Barr, & Milne, 2004; Forster-Coull, Milne, & Barr, 2004).

Because survey participants were thought to be motivated and healthy, bias might have influenced reported intake. BC responders were more likely than non-responders to drink milk (Forster-Coull, Milne, & Barr, 2004). In NL and NB also, female responders were more likely to drink milk than those who refused to participate (Roebothan, 2003; Balram, Villalon, McCaie-Burke, Ericson, & Boyne, 2005). The positive bias may have influenced reported calcium intake in BC but a similar effect, upon inspection, was not apparent for NL or NB.

There were other calcium sources such as fortified soy beverages and orange juice permitted for sale in Canada since the late 1990s and thus available to non-milk drinkers (Department of Health, 2001; 2006). Food group information was limited, but a BC food group publication listed calcium fortified orange juice as a source for calcium in the BC nutrition survey (Forster-Coull, Barr, & Milne, 2004). Where BC subjects chose fortified orange juice over regular juice, calcium intake estimates would have been higher without affecting vitamin C. Calcium fortified orange juice might be an explanation for observed increases in calcium intake in some studies (Forshee, Anderson, Storey, 2006). More data for studying the impact of calcium fortified orange juice are required.

5.2.5 Summary of Provincial Trends

There were temporal influences on assessments of folate and a geographic effect for calcium. Support for a temporal effect on folate is largely due to fortification and the relatively large shift in folate contribution from grain which appeared to double. Calcium intake and dairy consumption differences in BC and NL require further investigation. BC

did report greater contributions of dairy to total energy, most likely contributing to higher intake estimates in BC than in NL. Data are suggestive of the NL populace eating fewer dairy products than in BC. Overall disappearance of dairy from the Canadian food supply was similar during the decade and calcium-fortified orange juice was not noted separately in disappearance data. Because provincial nutrition surveys were conducted using similar methodology, comparing them is reasonable (Forster-Coull, Milne, & Barr, 2004; Gabos, Hansen, Field, & Raine, n.d.). Conclusions are tentative however, since without statistical testing, definitive conclusions about apparent differences between group means cannot be drawn (Mendelson, Tarasuk, Chappell, Brown, & Anderson, 2003). Patterns for fruit and potato intake were similar to that reported by the NCS where ON was among the highest consumers of vegetables/fruit and Atlantic Canada consumed the least fruit but preferred potatoes.

This thesis noted women of childbearing age particularly in ON, reported slightly higher mean intakes of iron, vitamin C, and folate. ON is one of the largest consumers of fruit, vegetables, and cereal (Statistics Canada, Agriculture Division, 2005). It is plausible that a large ethnic population influenced reported vegetable and fruit consumption in ON. Of those immigrating to Canada during the 1990s, most were of Asian descent landing in ON (Statistics Canada, Census, 2003). BC is also a large consumer of vegetable/fruit and had a large Asian immigrant population but the effect on iron, vitamin C, and folate were not as apparent as in the ON data.

Some of the influence on intakes of iron, vitamin C, and folate in ON might be the result of bias. Responders in ON reported they would be more likely to have whole grain bread than non-responders though total bread intake was similar between the two groups. Responders may be positively biased and more likely to report eating grains, vegetables, and fruit (Mendelson, Tarasuk, Chappell, Brown, & Anderson, 2003). People responding to a nutrition survey are generally more motivated to participate so this bias may equally be applicable to any survey (Statistics Canada, 2005). The magnitude of this bias is not easy to evaluate as bias for nutrient intake estimates are small and very difficult to detect (Forster-Coull, Milne, & Barr, 2004). ON also reported a low total response rate and in that case, non-response bias may exert greater influence. If ON were biased overall, then elevated mean intakes for nutrients such as magnesium, potassium, and dietary fibre were

expected but none were seen. ON survey respondents reported selecting enriched foods, fortified foods, and ready-to-eat breakfast cereals before any whole grains (Mendelson, Tarasuk, Chappell, Brown, & Anderson, 2003), which would affect folate and iron.

5.3 National Mean Nutrient Intake of Adult Women of the Province-derived Nutrition Survey

National mean nutrient intake estimates for adult women (Table 4.1) were derived from published provincial survey data, that we call the Province-derived Nutrition Survey (PNS). This thesis describes the data for women, but there were differences in patterns of intake between men and women. Women consumed 40 to 50% less energy than men and mean intake of nutrients associated with vegetable/fruit increased with age in women but not for men. Mean nutrient intakes were lower for women than for men except vitamin C. Mean vitamin B_{12} intake showed inconsistencies amongst provinces and genders as there was a jump in intake at the eldest age group for only some provinces and was greater for women (33%) than men (12%). Usual intakes of B_{12} are difficult to estimate (Institute of Medicine, 2000) and provincial explanations for this anomaly were not reported. Young women reported greater absolute intake for energy, iron, folate, and calcium and vitamin C values lower than the eldest group but not all exceeded our cutoff value (Section 4.2.4). Nutrient density controlled for variable mean energy intake showing that women 18 to 34 years did not consume diets that were as nutrient rich as the elder women. Age patterns of energy intake were similar to the NCS but food choice had likely altered the direction of patterns for some nutrients.

Women age 18 to 34 years reported consuming 19% more energy than women 65 to 74 years. This finding is not unexpected as aging is associated with a decline in energy expenditure so less energy is required. Since energy intakes declined, a related decline for nutrient intake was expected. Decline in mean intake was observed for most nutrients, but dietary fibre, potassium, magnesium, vitamins A, B_6, and C were exceptions. An increase in intake of those six nutrients as energy declines may be indicative of increased fruit and vegetable consumption. Vegetable/fruit provide fibre, potassium, magnesium, vitamin A, vitamin C, and some vitamin B_6 (Whitney & Rolfes, 2002). Grains supply magnesium and fibre but there was no increase in folate or iron to support a greater grain intake with

age. Increases in vitamin A, B_6, or B_{12} were not resultant of dairy or MFP as intake was not supported by calcium, protein, phosphorus, iron, zinc, niacin, or thiamin data. Fruit and vegetable intakes increased with age and grains did not but older women were more apt to choose higher fibre grains than the younger women (Forster-Coull, Barr, & Milne, 2004; Johnson-Down, Ritter, Jacobs-Starkey, & Gray-Donald, 2006; Garriguet, 2006).

Micronutrient intake was generally highest for young women but mean iron, pre-fortification folate, and vitamin C intake differences between the youngest and eldest age group were less than 10%. Calcium and post-fortification folate intakes differed 20% and 13% respectively. Using a nutrient density evaluation showed that young women had less iron, folate, and vitamin C per unit and similar calcium in their diets as the eldest women. Greater energy intake may result in higher nutrient intake but the percent change between intake and density (Table 5.1) demonstrated that energy did not translate to better quality. Specifics about age related diet changes are limited since most surveys are cross-sectional rather than longitudinal (Kwon, Suzuki, Kumagai, Shinkai, & Yukawa, 2006) but elderly women were likely making better food choices than the younger women. The older adults were maintaining or improving their diet quality (Figures 4.8 & 4.9). Usually, diet quality is higher in older adults than younger adults (Briefel & Johnson, 2004) and the free-living healthy elderly have a high interest in healthy behavior and a greater willingness to make changes that may improve health (Hetherington, 1998; Kwon, Suzuki, Kumagai, Shinkai, & Yukawa, 2006).

Table 5.1. Percent difference between Women 18 to 34 years and Women 65 to 74 years using Nutrient Intake and Nutrient Density for Calcium Iron, Folate, and Vitamin C

	Nutrient Intake %	**Nutrient Density %**
Calcium, mg	20	<1
Iron, mg	8	-13
Folate, µg[1]	6	-16
Folate, DFE[2]	13	-9
Vitamin C, mg	-2	-25

[1] food folate: NS, QC, SK, AB, PE, NL, NB
[2] food folate and folic acid from fortified foods: ON, BC
Nutrient intake = reported mean intake
Nutrient Density = quantity of nutrient per 1000 kcal reported mean energy
% (percent), mg (milligram), µg (microgram), DFE (Dietary Folate Equivalents)

From the nutrients reported by the Nutrition Canada Survey (NCS), only fibre and vitamin C for adult women showed no age related decline (Table 2.5). Women consumed less energy than men and except for vitamin C had lower mean nutrient intakes. Nutrients mutual to both the Province-derived Nutrition Survey (PNS) and NCS had age patterns of women in the same direction for all nutrients except fibre and vitamin A (Table 5.2). The reporting of food groups differed as seen in Figures G1to G4, but vegetable/fruit declined and intake of grain (breakfast cereals) increased overall with age in the NCS adult women (Department of National Health and Welfare, 1975).

Table 5.2. Pattern of National Nutrient Intake with age for Adult Women from the Nutrition Canada Survey (NCS) and Province-derived Nutrition Survey (PNS)

	NCS 1970/72	**PNS 1990s**
Energy, kcal	↓	↓
Protein, g	↓	↓
Carbohydrate, g	↓	↓
Total fat, g	↓	↓
Dietary Fibre, mg	→	↑
Calcium, mg	↓	↓
Iron, mg	↓	↓
Vitamin A, RE	↓	↑
Thiamin, mg	↓	↓
Niacin, NE	↓	↓
Riboflavin, mg	↓	↓
Folate, µg	↓	↓
Folate, DFE	not applicable	↓
Vitamin C, mg	→	→

↓ (decreased), ↑ (increased), → (similar) with advancing age
NCS reported crude fibre (cellulose)
PNS reported dietary fibre (cellulose, hemicellulose, pectin, lignin, hydrocolloids)
Folate, µg for PNS = NS, QC, SK, AB, PE, NL, NB
Folate, DFE for PNS = ON, BC
RE (Retinol Equivalent): 1µg retinol = 6µg β-carotene (10 IU) = 12µg other carotenes (3.33 IU)
NE (Niacin Equivalent): 1NE = 1mg niacin = 60mg tryptophan
DFE (Dietary Folate Equivalent): 1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
kcal = kilocalorie, g = gram, mg = milligram, µg = microgram

5.4 Comparison of Nutrient Intake of Childbearing age Women from the Province-derived Nutrition Survey and the Nutrition Canada Survey

Childbearing age women from the NCS and PNS showed a similar intake for iron and increases in folate, vitamin C, and calcium (Table 4.3). Reported mean energy intake was similar between these two points but nutrient density indicated that the diet quality of childbearing age women was improved in the 1990s. Survey methodology improvements since 1970 may account for some nutrient changes (Stephen & Reeder; Balram, Villalon, McCaie-Burke, Ericson, & Boyne, 2005) but food consumption habits, fortification, and better selection of nutrient rich foods have likely affected women's dietary intakes.

The increase in iron from the NCS to the PNS was only 8%. Iron fortification in itself did not increase iron intake in adults as the iron content of the typical adult diet did not change during the 1970s and 1980s (Institute of Medicine, 1993). This suggested that adults did not consume much ready-to-eat breakfast cereal in those two decades. During the late 1980s, breakfast cereal and total grain consumption began rising but data showed a concurrent decrease in meat as well. As a result, estimates of available food supply iron were stable from 1976 to 1996 (Statistics Canada, Agriculture Division, 2005). MFP was the primary iron source in 1970/72 and grain products secondary (Department of National Health and Welfare, 1975) and by the 1990s the two food groups reversed. Iron derived from MFP was about half and that of grains doubled from 1970/72 (Mendelson, Tarasuk, Chappell, Brown, & Anderson, 2003). Iron intake has been influenced by fortification in 1976 and shifts in food usage but determining how much of the difference is attributable to each is difficult as there not enough information. Food consumption changes do need further examination because iron sources have implications on iron bioavailability. DRI recommendations were set based on a typical North American diet so tracking change in the typical diet is important.

Folate intakes increased 25% from 1970/72 to 1990s pre-fortification period and by 65% from 1970/72 to 1990s post-fortification period. The differences in folate intake were the result of two factors; women ate better food folate sources (Stephen & Reeder, 2001) and mandatory fortification in 1998 (Department of Health, 1998). Two estimates for folate intake show the impact of change with consumption and fortification. In 1970, per capita consumption of vegetables was about 80 kg and by the mid 1990s was 95 kg;

grain consumption was 50 kg in 1970 rising to about 60 kg by 1996 and another 5 kg by 2000 (Statistics Canada; Agriculture Division, 2005). Most of the food consumption rise occurred previous to folate fortification so the largest part of the post-fortification period percentage is the result of folic acid. Unlike for iron fortification, folic acid is included in a wider range of staple foods so the average folate intakes estimate would have increased even without consumption changes because most people consume those products (Briefel & Johnson, 2004).

The increase in vitamin C between the NCS and the PNS was 18%. Based on food consumption statistics, the increase was not due to fresh or canned fruit because estimates were relatively stable from 1970 to 1996. Alternatively, juice and vegetable consumption rose 14 L and 15 kg respectively between 1970 and 1996 (Statistics Canada; Agriculture Division, 2005). In the 1977 CFGHE (Figure G2), more examples of a variety of brightly colored fruit and vegetables were listed so maybe the guide had an influence on the types of produce disappearing from the food supply.

The 11% increase in calcium intake from the NCS to the PNS was unexpected. A decrease in fluid milk and increases in soft drink consumption (Nielsen & Popkin, 2004; Forshee, Anderson, Storey, 2006) suggested lower calcium was probable. An increase in cheese and yogurt of about 5 kg likely offset any decreases of milk as total dairy product consumption appeared stable from 1976 to 1996 (Statistics Canada; Agriculture Division, 2005). Some of the increase in calcium intake may be the result of small amounts present in enriched foods or fortified soy and orange juice (Briefel & Johnson, 2004).

Differences using nutrient density for iron, folate (μg), folate DFE, vitamin C, and calcium were all greater than by nutrient intake (Table 5.3) suggesting selection of better nutrient sources. For example, purchases for mango, pineapple, kiwi, and papaya went up during the 1990s (Statistics Canada; Agriculture Division, 2005). Availability of iron and folate fortified foods certainly had an effect on intake as some survey subjects were more likely to select fortified and/or enriched foods (Mendelson, Tarasuk, Chappell, Brown, & Anderson, 2003). Food disappearance data collected over this same time period appear to support an increased nutrient intake. Diet quality had apparently improved (Gray-Donald, Jacobs-Starkey, Johnson-Down, 2000; Stephen & Reeder, 2001).

Table 5.3. Direction of nutrient change for women of childbearing age from the Nutrition Canada Survey to the Province-derived Nutrition Survey

Nutrient	Change by Nutrient Intake	Change by Nutrient Density
Energy, kcal	→	
Calcium, mg	↑	↑
Iron, mg	→	↑
Folate, µg[1]	↑	↑↑
Folate, DFE[2]	↑↑	↑↑
Vitamin C, mg	↑	↑

→ (similar); ↑ (notable increased), ↑↑ (very notable increase)
NCS reported only food folate
[1] food folate for the PNS: NS, QC, SK, AB, PE, NL, NB
[2] food folate and folic acid from fortified foods for the PNS: ON, BC
kcal (kilocalorie), mg (milligram), µg (microgram), DFE (Dietary Folate Equivalents)

5.5 Adequacy of Nutrient Intake for Women of Childbearing age

Mean intake estimates do not address the "prevalence of inadequacy" for nutrients but although the proportion of women in the group with inadequate nutrient intake cannot be ascertained, if the mean exceeds the RDA or AI, then probability of inadequacy for the group is likely low for the nutrient (Institute of Medicine, 2000). Estimates for prevalence of inadequacy for iron, vitamin C, and folate reported by some provinces are included as appropriate (Section 5.5.2). The NCS did not estimate prevalence of inadequacy but they reported the percentage of women considered at risk for poor iron, vitamin C, folate, and calcium intake. Prevalence of inadequacy assessments for calcium cannot be provided as an AI cannot be used for this purpose (Institute of Medicine, 2000).

5.5.1 Women 18 to 34 years from the Province-derived Nutrition Survey

Women 18 to 34 years reported consuming some nutrients that did not exceed the DRI recommendations. Nutrients not exceeding AI or RDA values indicated poor overall intake of plant foods and dairy although the mean value for vitamin C suggests relatively good vitamin C sources were reported at the time of the survey. Sodium and phosphorus intake suggested consumption of processed foods were high in this age group.

Mean intake for five micronutrients by women of childbearing age did not exceed the RDA or AI value. Potassium, magnesium, iron, pantothenic acid, and calcium appear to be nutrients of concern. Dietary fibre did not exceed the AI either. Dietary fibre values are probably underestimated by about 5 grams because the foods database used for intake assessment is incomplete for the nutrient (Forster-Coull, Milne, & Barr, 2004; Institute of Medicine, 2005). Even so, mean dietary fibre values would still not exceed the AI. Intake of folate did not exceed the RDA for the pre-fortification period but did exceed the RDA for the post-fortification period. The difference in reported mean folate intake from pre to post-folate fortification was about 200 μg (53%). Collectively the nutrients not exceeding DRI recommendations suggest poor consumption of plant foods (vegetables, fruit, grains, legumes) and dairy. Nutrients found in vegetables include fibre, folate, potassium, and magnesium; fruit has potassium and fibre; grains give fibre, folate, magnesium, and iron; legumes provide fibre, folate, potassium, magnesium, and iron; and dairy supplies mainly calcium (Whitney & Rolfes, 2002). Pantothenic acid is in most foods. Other research had also found a high proportion of women not consuming a sufficient amount of plant foods and dairy. Half or more adult Canadians did not consume the minimum recommendation for vegetables, fruit, grains, or dairy servings with intake less for women (Jacobs-Starkey, Johnson-Down, & Gray-Donald, 2001; Garriguet, 2006). The BC survey published a food group report and for females 19 to 30 years, reported 84% did not consume the minimum serving recommendation for vegetables and fruit, 81% insufficient for dairy, and 53% for grains (Forster-Coull, Barr, & Milne, 2004). The CFG and CFGHE did not seem to result in attainment of the desired level of food group consumption in the population.

Mean intakes of protein, carbohydrate, sodium, phosphorus, zinc, thiamin, niacin, riboflavin, vitamin B_6, vitamin B_{12}, and vitamin C are likely to have a low probability of inadequacy as these exceeded the RDA or AI. It is not possible to compare vitamin A to the RDA because the foods database used for assessment of intake calculates intake in a different unit of measure than the DRIs. Estimations of RAE from RE are possible but it requires an original list of reported foods. Comparisons between the two measures cannot be made (Institute of Medicine, 2001; Forster-Coull, Milne, & Barr, 2004).

Sodium and phosphorus may be a concern for an opposite reason, as mean intake exceeded the UL. Since these data represent usual intake of the group, intakes this high

are a concern because at a continuing intake above the UL, the likelihood of an adverse health effect is increased (Institute of Medicine, 2000). Food provides greater amounts of sodium than the body needs and processed foods contain more than unprocessed versions (Whitney & Rolfes, 2002). Foods rich in protein are a phosphorus source but the mineral is also an additive in processed food. As other micronutrients associated with MFP do not exceed the UL, it is likely that sodium and phosphorus are coming from processed foods. The NFCS, CSFII, and FHC had similar findings. Nielsen, Siega-Riz, and Popkin (2002) showed key shifts for eating habits including increased consumption of salty snacks, cola soft drinks, pizza, and dining out in restaurants. Young adults consume a lot of prepared foods and a high percentage of their dietary energy was from foods with little nutritional value (Johnson-Down, Ritter, Jacobs-Starkey, & Gray-Donald, 2006) with as much as 27% of energy from the other foods group (Pasut, 2001).

5.5.2 Mean Intake of Iron, Folate, Vitamin C, and Calcium versus the Recommended Dietary Allowance or the Adequate Intake

The national mean intake estimates for iron, folate (μg), and calcium show values below the RDA or AI values suggesting that the proportion of young women consuming less than the goal intake was high. Except in the NCS, mean folate (DFE) was higher than the RDA so the likelihood of inadequate intake would be lower largely because of folate fortification. Mean vitamin C intake in the NCS and PNS exceeded the RDA, indicating a low prevalence of inadequacy (Figures 4.6 & 4.7). Evident from both those figures is that the nutrients that were public health concerns in 1970/72 remained a concern and without fortification folate intake would have also remained troubling.

Those childbearing age women considered at nutritional risk in the NCS would be different if assessed using the DRIs but percentages provide some indication of change in population risk. About 76% of young women were considered at risk for poor iron intake in the NCS and two provinces reported prevalence of inadequacy of about 10 to 15% for young women (Mendelson, Tarasuk, Chappell, Brown, & Anderson, 2003; Forster-Coull, Milne, & Barr, 2004). Nutritional folate risk was not completed in the NCS but pre-folate fortification estimates from NL, NB, and PE were 98 to 100% prevalence of inadequacy (Taylor, Van Til, & MacLellan 2002; Roebothan, 2003; Balram, Villalon, McCaie-Burke,

Ericson, & Boyne, 2005). Mean intake above the RDA does not preclude a proportion of the population having an inadequate intake as folate (DFE) prevalence of inadequacy was 33% (Mendelson, Tarasuk, Chappell, Brown, & Anderson, 2003; Forster-Coull, Milne, & Barr, 2004). Even though the adequacy of calcium intake cannot be established intake fell well below the goal level for healthy individuals. The data reviewed for this thesis reveals trends reported by others; dietary intakes of iron, calcium, and folate were insufficient for childbearing age women (Gray-Donald, Jacobs-Starkey, & Johnson-Down, 2000; Bartley, Underwood, & Deckelbaum, 2005) which does not improve the outlook of fetal health or long term bone health.

5.6 Challenges in Analysis and Interpretation

Nutrition surveys have many uses but their interpretation and evaluation should include recognition of sources of error. Potential sources of error may arise in sampling, non-response, measurement, and reporting. Nutrition surveys usually include errors, and most acknowledge and attempt to analyze effect and magnitude of errors. Most provincial nutrition surveys attached technical analysis reports written by the Bureau of Biostatistics and Computer Applications (BBCA) to their reports (Forster-Coull, Milne, & Barr, 2004). No perfect diet assessment method exists and dietary intakes cannot be estimated without error (Beaton, 1994). Standard protocols and quality control procedures minimize sources of error. In addition, multiple measures and statistical techniques help reduce error. Using similar methodologies and protocols amongst the provinces is an important reference for provincial comparisons (Forster-Coull, Milne, & Barr, 2004; Gabos, Hansen, Field, & Raine, n.d.).

The provincial nutrition surveys collected data over a decade. While that might make provincial comparisons and aggregation challenging, it is equivalent to NHANES which previous to 1999 took up to seven years to collect sufficient samples. Researchers often waited ten years to access data that were representative of the American population (Lee & Nieman, 2003) and trends are generally evaluated by decade (Briefel & Johnson, 2004; Nielsen & Popkin, 2004). Currently, NHANES collects data in two year cycles of about 10,000 subjects from 30 counties. Data release is two years after the survey yet the

researchers are still advised to wait for four data years for better populace representation (National Research Council, 2005).

Underreporting is common but differs with survey, time, population group, and individual characteristics (Hirovonen, Männistö, Roos, & Pietinen, 1997; Black & Cole, 2001; Nielsen, Siega-Riz, & Popkin, 2002). It was likely that underreporting differed by province but not enough information was available. Most provincial surveys completed ratios of energy intake to expenditure but no trends were found and effects may vary by nutrient (Stephen & Reeder, 2001; Mendelson, Tarasuk, Chappell, Brown, & Anderson, 2003). Energy intakes are believed to be underreported about 20 to 25% overall by most adults but the effects and magnitude on estimates are difficult to determine and not well understood (Briefel, Sempos, McDowell, Chien, & Alaimo, 1997; Black & Cole, 2001).

The provincial response rates and non-response assessment were different in each survey and the reporting method was not consistent. Non-response and response rate may influence the direction and magnitude of bias but is tough to assess and has no acceptable or unacceptable level (Roebothan, 2003; Forster-Coull, Milne, & Barr, 2004). This thesis found remarkably similar demographic, non-response trait, and reported nutrient intake in all nine provinces although response rates differed. The chart of reported demographics is in Appendix A. Responders and populations were similar regarding smoking but a greater number of responders had University degrees. BC found no positive association between educational level and intake for most nutrients of concern suggesting this difference did not bias results (Forster-Coull, Milne, & Barr, 2004). There was marital status variability but nutritional significance is not clear as little is in the literature (Forster-Coull, Milne, & Barr, 2004). Total bread and milk consumption was comparable between non-responders and responders overall. Statistical significance between some variables may be found but further review is needed to conclude practical and nutritional significance (Forster-Coull, Milne, & Barr, 2004).

Each survey research team selects which nutrients to assess that often reflect the priorities deemed important at the time those surveys were designed. The NCS evaluated nutrients where a biochemical marker(s) could confirm nutriture (Department of National Health and Welfare, 1973). Also omitted were nutrients for which the Canadian Nutrient File (CNF) was substantially incomplete. The NCS omitted folate, the provincial surveys

vitamins D and E, and the CCHS vitamin E and trans fats (Department of National Health and Welfare, 1973; Forster-Coull, Milne, & Barr, 2004; Statistics Canada, 2005). CNF is reasonably complete for the majority of nutrients and it is unlikely a database error would significantly alter the conclusions drawn from population level studies (Statistics Canada, 2005). Seven surveys reported nutrient intakes based on the 1991 CNF (NS, QC, SK, AB, PE, NL, NB) and two surveys (BC, ON) reported using the 1999 version which was the forerunner of the updated 2001 version. This is the same split used to delineate pre-folate fortification from post-folate fortification.

Provinces also selected which nutrients to report and not all provinces reported all nutrients (Tables B1 to B8) but few temporal or geographic differences were apparent for most nutrients once plotted. MB data was also unavailable but reported information was quite similar that influence of one province over another likely was or would be minimal. Folate values were reported twice for this thesis because fortification occurred during the data collection. Post-fortification folate does not represent the intake of adults during that decade because only two provinces comprise the estimate, but were likely reasonable and allowed the impact of change to be evaluated at the time change occurred. Calcium intake requires further investigation as a provincial difference was possible but it is unlikely that our conclusions regarding national intake would have been different had no geographic difference appeared.

Working with raw data is preferred but support for our aggregation and weighting method comes from two sources. The NL survey reported mean energy intakes two ways to compare data to published provincial reports and the DRIs. Group mean energy values of 18-34, 35-49, 50-64, 65-74 year and 19-30, 31-50, 51-70, 71-74 year categories in that report showed difference among each comparable age group were within 5% (Roebothan, 2003). Health Canada provided mean intake of energy, potassium, and sodium derived of 1990s raw data in DRI appendices (Institute of Medicine, 2004 & 2005). Comparing PNS national mean estimates to those in the two DRI books showed differences within 5% for energy, 2% for potassium, and 5% for sodium. It seems the population-weighting method implemented by the C-RERL gave reliable group mean nutrient intake estimates for that decade but this does not imply error was not present nor does it mean our data should be construed as representative.

5.7 Relevance to Practice

Evidence for a trend requires that several data points be available without which, there is the possibility that change is not a trend but occurred by chance. Comparison of common variables between 1970/72 and the 1990s however, begins the process to assess possible trends in nutrient intake and this thesis provides valuable dietary data that lie in time between the NCS and the CCHS. Without any statistical testing, the significance of possible trends cannot be concluded but data strongly suggest that folate fortification had great impact on the dietary intake of Canadian adults. Continued monitoring is important so that apparent geographic and temporal differences may be appropriately evaluated and the methods by which we seek to improve the health of the Canadian population might be tailored. Understanding what Canadians did and are eating is essential and capitalizing on the available information is necessary so that research can build from it (Hendricks, 1993; Johnson-Down, Ritter, Jacobs-Starkey, 2006).

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7.0 APPENDI CES

Appendix A

Summary Charts of Reported Provincial Nutrition Survey Content

Table A1. Summary of reported provincial nutrition survey methodology and subject demographic for Nova Scotia, Quebec, and Saskatchewan

PROVINCE	SURVEY CONTENT In-home interview	SURVEY	SUBJECT POOL AGE RANGE	EXCLUSIONS	DEMOGRAPHIC[1, 2, 3]
NS	24-hr recall (portion sized models) Supplement use FFQ Demographics Anthropometric (actual) Knowledge, attitudes	1990 Apr-Dec 1991 CNF	NS Medical Services Insurance 18-74 yrs	Institutionalized, reserves, armed forces, children, youth, pregnant or lactating women, >75 yrs	Married- 68% Education- 44%, 29%, 27% Not low income Non-smokers- 68% BMI >27 - 46% Supplements - 18%
QC	24-hour recall (portion-sized models) Supplement use FFQ Demographics Anthropometric (actual) Knowledge, attitudes, beliefs, behaviors	1990 **Sept-Dec[4]** 1991 CNF	Régie de l'assurance-maladie du Québec 18-74 yrs **87% French**	Institutionalized, military persons, Inuit & Cree communities, children, youth, pregnant or lactating women, 7 remote regions, >75yrs	Married- 67% Education - 41%, 36%, 24% Not low income BMI >27 - 27% Supplements – 22%-42% (men < women)
SK	24-hr recall (home made food models) Supplement use FFQ Demographics Anthropometric (actual) Physical activity, knowledge, attitudes	1993-1994 May-Aug 93 Feb–March 94 1991 CNF	SK Health Insurance Registration 18-74 yrs 45% refusal rate	Institutionalized, reserves, armed forces, children, youth, pregnant or lactating women, >75 yrs, census district 18 (north)	Married - 70% Education - 28%, 42%, 30% **Income not reported** Non-smokers- 75% BMI >27 - 40%

Data from provincial nutrition surveys conducted 1990-99; Tables B1 through B8 list the nutrients assessed and reported by the provinces
CNF: Canadian Nutrient File; FFQ: Food Frequency Questionnaire; BMI: Body Mass Index
[1] Percentages listed are reported proportions of provincial adult sample
[2] Education is low, medium, and high level = Elementary or some secondary; high school or some post-secondary; University Degree
[3] % Non-smokers not reported in QC survey, not all surveys reported % of population that reported taking supplements
[4] Quebec collected data for only one season due to financial restrictions; it appears that Quebec subjects needed to communicate in French in order to participate
Refusal rate is the percentage of persons contacted for survey that refused to participate

Table A2. Summary of reported provincial nutrition survey methodology and subject demographic for Prince Edward Island, Alberta, and Newfoundland and Labrador

PROVINCE	SURVEY CONTENT In-home interview	SURVEY	SUBJECT POOL AGE RANGE	EXCLUSIONS	DEMOGRAPHIC[1, 2, 3]
AB	24-hr recall (food models) Supplement use FFQ Demographics Anthropometric (actual), WHR Knowledge, health, activity, attitudes, wild game and fish use and intake	1994 Apr-July Oct-Dec 1991 CNF	Alberta Health Care Insurance 18-74 yrs 30% refusal rate	Institutionalized, military persons, indigenous (treaty status), children, adolescents, pregnant or lactating women, >75 yrs	Married - 70% Education - 35%, 43%, 22% Not low income Non-smokers - 74% BMI >25 - 36%
PE	24-hr recall (food models) Supplement use FFQ Demographics Anthropometric (actual), WHR Nutrition knowledge, health, activity, attitudes, food security	1995 April-June Sept-Dec 1991 CNF	PEI Health Registry 18-74 yrs 23% refusal rate	Institutionalized, reserves, military, children, youth, pregnant or nursing women, fasting (medical reason) >75 yrs	Married - 68% Education - 38%, 26%, 37% Not low income Non-smokers - 72% BMI >27 - 50%
NL	24-hr recall (model kits & pictures) Supplement use FFQ Demographics Anthropometric (actual), WHR Nutrition knowledge, health, activity, attitudes	1996 Spring, Fall 1991 CNF	Newfoundland Health Insurance Register file 18-74 yrs 40% refusal rate	Institutionalized, reserves, children, youth, pregnant or nursing women, those in an area not being surveyed, military personnel, >75yrs	Married - 65% Education - 49%, 36%, 13% **Low income but food secure** Non-smokers - 66% BMI >25 - 69% Supplements - 24%

Data from provincial nutrition surveys conducted 1990-99; Tables B1 through B8 list the nutrients assessed and reported by the provinces
AB report unpublished, data used by permission
CNF: Canadian Nutrient File; FFQ: Food Frequency Questionnaire; WHR: Waist Hip Ratio; BMI: Body Mass Index (NL had self-reported data but those data are not included)
[1] Percentages listed are reported proportions of provincial adult sample.
[2] Education is low, medium, and high level = Elementary or some secondary; high school or some post-secondary; University Degree.
[3] % Non-smokers not reported in QC survey, not all surveys reported % of population that reported taking supplements
Refusal rate is the percentage of persons contacted for survey that refused to participate

Table A3. Summary of reported provincial nutrition survey methodology and subject demographic for New Brunswick, Ontario, Manitoba, and British Columbia

PROVINCE	SURVEY CONTENT In-home interview	SURVEY	SUBJECT POOL AGE RANGE	EXCLUSIONS	DEMOGRAPHIC[1, 2, 3]
NB	24-hr recall (model kits) Supplement use FFQ Demographics Anthropometric (actual), WHR Nutrition knowledge, health, activity, food security	1996/1997 Sept 96-Jan 97 Apr -July 97 1991 CNF	New Brunswick Medical Insurance Registry 18-74yrs **English & French** 32% refusal rate	Institutionalized, reserves, children, youth, pregnant or nursing women, hospitalized, non-English or French communicating, military, >75yrs	Married - 70% Education - 32%, 31%, 29% Not low income Non-smokers - 75% BMI >25 - 68%
ON	24-hr recall (models, dishes, pictures) Supplement use FFQ Demographics Anthropometric (actual), WHR Activity, health, barriers to change, food security	1997-1998 Sept 97-June 98 **1999 CNF**	Ontario Health Insurance 18-74yrs 30% refusal rate	Institutionalized, reserves, military, children, youth, pregnant/lactating women, northern Ontario, >75yrs **non-English communicating**	Married - 66% Education – 21%, 60%, 20% Not low income Non-smokers - 77% BMI >25 - 57% Supplements - 52%
MB		1997/1998			
BC	24-hr recall (models, household measure) Supplement use FFQ Demographics Anthropometric (actual), WHR Activity, health, knowledge/attitudes, body image, food security, food safety, dental health, wild food use	1999 April –July Sept -Dec **1999 CNF**	B.C. Health Registry 18-74 yrs & **75-84yrs** **English, French, Chinese, Punjabi** 38% refusal rate	Institutionalized, reserves, armed forces, children, youth, pregnant or lactating women	Married – 65% Education – 41%, 45%, 15% Not low income Non-smokers – 83% BMI >25 – 55% Supplements – 64%

Data from provincial nutrition surveys conducted 1990-99; Tables B1 through B8 list the nutrients assessed and reported by the provinces
MB unpublished and unavailable
CNF: Canadian Nutrient File; FFQ: Food Frequency Questionnaire; WHR: Waist Hip Ratio; BMI: Body Mass Index (ON had self-reported BMI but those data are not included)
[1] Percentages listed are reported proportions of provincial adult sample.
[2] Education is low, medium, and high level = Elementary or some secondary; high school or some post-secondary; University Degree.
[3] % Non-smokers not reported in QC survey, not all surveys reported % of population that reported taking supplements
Refusal rate is the percentage of persons contacted for survey that refused to participate

Appendix B

Reported Mean Nutrient Intake Data from the Provincial Nutrition Surveys

Table B1. Reported group mean nutrient intake from food for males age 18 to 34 years

	NS	Q C	SK	AB	PE	NL	NB	ON	MB	BC	BC[a]
Energy, kcal	3021	2895	3157	3076	2859	2563	2837	2682		2883	
Protein, g	125	116	125	132	118	105	108	105		119	
Carbohydrate, g	343	336	374	410	338	293	350	350		365	
Total fat, g	121	115	118	106	109	92	107	91		100	
SFA, g	43.6	43.2	42.0	37.6	40.1	31.9	37.3	30.3		33.0	
PUFA, g	18.5	17.0	18.0	17.1	15.8	13.7	17.4	15.4		17.0	
MUFA, g	49.2	45.5	47.0	41.0	44.1	38.7	42.7	36.8		41.0	
Cholesterol, mg	401	405	411	395	381	331	355	305		383	
Dietary Fibre,mg	16.0	16.9	17.5	19.0	16.4	13.1	16.1	19.3		21.0	
Sodium, mg		4148	4590	4600	3854		3995	3720		4096	
Potassium, mg		3604	3934	4200	3811		3476	3462		3800	
Calcium, mg	1161	1114	1251	1263	1151	767	943	1015		1193	1179
Phosphorus, mg		1808	1952	2025	1789	1458	1611	1620		1850	1831
Magnesium, mg		341	393	419	353	289	329	365		410	414
Iron, mg	17.7	18.0	18.6	20.0	17.6	15.0	17.0	18.5		19.7	21.0
Zinc, mg		16.1	16.9	19.6	15.3	13.2	14.2	13.9		15.6	19.1
Vitamin A, RE	1157	1489	977	1365	1164	882	1205	1029			
Thiamin, mg	2.1	1.9	2.2	2.2	1.9	1.7	1.9	2.3		2.4	4.1
Niacin, NE	53.6	50.2	52.8	55.0	50.3	46.2	46.3	48.3		55.0	61.0
Riboflavin, mg	2.4	2.5	2.7	2.9	2.5	2.0	2.2	2.4		2.6	4.6
Vitamin B6, mg		2.1	2.2	2.5	2.2	2.1	2.1	2.2		2.6	4.5
Pantothenic Acid, mg		6.2	6.7	7.0	6.3	5.1	5.7			7.2	9.8
Folate, µg	263	272	290	324	244	219	242	*586		*617	*729
Vitamin B12, µg		9.2	6.9	11.3	9.8	5.3	6.7	4.4		5.9	9.9
Vitamin C, mg	116	117	116	162	113	101	112	165		145	214
Alcohol, g	11.6	11.2	17.7	13.2	9.2	21.1	8.0	10.2		10.7	

Data from Provincial nutrition surveys completed 1990-99; AB unpublished data used by permission
MB data unavailable; in the nine available reports missing values were not reported
BC, AB, NL reported data for age group 19-30 years
[a] Intake of food and supplements; some mean estimates lower than food only – high variability in supplement use
kcal = kilocalorie, g = gram, mg = milligram, µg = microgram
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
*DFE (dietary folate equivalents)
1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
SFA = saturated fatty acids; PUFA = polyunsaturated fatty acids; MUFA = mono-unsaturated fatty acids
Atwater factor calculations for BC (g protein, g alcohol); NL (g SFA/PUFA/MUFA); AB (g fat/SFA/PUFA/MUFA)

Table B2. Reported group mean nutrient intake from food for males age 35 to 49 years

	NS	Q	SK	AB	PE	NL	NB	ON	MB	BC	BC[a]
Energy, kcal	2343	2632	2721	2528	2522	2399	2597	2695		2624	
Protein, g	96.5	106	113	107	100	103.4	107	102		102	
Carbohydrate, g	271	306	314	314	297	271	305	348		323	
Total fat, g	92	103	108	93	100	89	100	93		96	
SFA, g	33.4	38.0	38.0	33.7	36.0	29.3	34.6	32.4		31.0	
PUFA, g	14.5	15.7	18.0	14.0	15.3	15.2	15.8	15.0		17.0	
MUFA, g	36.6	41.1	42.0	36.5	40.8	37.6	40.5	36.9		39.0	
Cholesterol, mg	338	354	404	311	371	348	401	327		344	
Dietary Fibre,mg	15.2	16.2	17.4	16.0	16.1	13.8	16.3	20.8		20.0	
Sodium, mg		3753	4209	3800	3366		3570	3724		3674	
Potassium, mg		3380	3642	3600	3359		3334	3678		3594	
Calcium, mg	913	922	994	1031	838	697	868	990		980	994
Phosphorus, mg		1577	1709	1699	1470	1390	1532	1589		1625	1595
Magnesium, mg		321	362	374	318	291	323	383		404	402
Iron, mg	15.0	16.9	17.4	16.0	16.3	14.8	16.7	19.4		18.0	18.7
Zinc, mg		17.5	15.4	14.3	14.1	13.7	13.8	13.6		15.1	15.7
Vitamin A, RE	1157	1301	1026	1400	1186	966	1191	1461			
Thiamin, mg	1.7	1.8	2.1	1.8	1.7	1.6	1.8	2.3		2.1	5.7
Niacin, NE	41.4	46.4	47.8	48.0	43.7	44.9	46.5	48.6		47.0	55.0
Riboflavin, mg	2.0	2.1	2.3	2.2	2.0	1.9	2.1	2.4		2.3	5.9
Vitamin B6, mg		2.0	2.0	2.1	2.0	2.0	2.0	2.2		2.2	5.9
Pantothenic Acid, mg		5.4	6.0	6.0	5.4	5.1	5.6			6.0	10.4
Folate, µg	263	246	260	261	224	210	241	*593		*553	*796
Vitamin B12, µg		6.0	6.7	7.7	9.3	5.6	7.6	6.9		6.4	33.2
Vitamin C, mg	116	96	105	113	91	93	102	147		131	272
Alcohol, g	10.1	12.9	9.4	10.8	7.4	13.7	9.9	14.0		12.7	

Data from Provincial nutrition surveys completed 1990-99; AB unpublished data used by permission
MB data unavailable; in the nine available reports missing values were not reported
BC, AB, NL reported data for age group 31-50 years
[a] Intake data from food and supplements; mean estimates lower than food only – high variability in supplement use
kcal = kilocalorie, g = gram, mg = milligram, µg = microgram
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
*DFE (dietary folate equivalents)
1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
SFA = saturated fatty acids; PUFA = polyunsaturated fatty acids; MUFA = mono-unsaturated fatty acids
Atwater factor calculations for BC (g protein, g alcohol); NL (g SFA/PUFA/MUFA); AB (g fat/SFA/PUFA/MUFA)

Table B3. Reported group mean nutrient intake from food for males age 50 to 64 years

	NS	Q	SK	AB	PE	NL	NB	ON	MB	BC	BC[a]
Energy, kcal	2230	2252	2186	2164	2311	2209	2315	2340		2342	
Protein, g	94	94	92	87	97	101	93	95		93	
Carbohydrate, g	255	262	264	273	274	246	288	302		293	
Total fat, g	88	86	83	79	90	82	87	80		84	
SFA, g	31.4	32.2	29.0	26.4	32.5	26.3	29.1	26.5		27.0	
PUFA, g	13.9	13.1	14.0	12.0	14.0	13.5	15.0	12.8		15.0	
MUFA, g	36.1	33.9	32.0	31.3	36.1	34.4	34.8	32.8		33.0	
Cholesterol, mg	344	356	340	289	351	357	342	313		326	
Dietary Fibre,mg	15.9	16.2	17.2	16.0	16.7	14.4	17.8	20.9		20.0	
Sodium, mg		3406	3289	3400	3161		3186	3358		3501	
Potassium, mg		3191	3327	3300	3273		3234	3538		3509	
Calcium, mg	822	736	793	781	791	607	739	847		858	917
Phosphorus, mg		1349	1421	1377	1416	1297	1378	1463		1492	1500
Magnesium, mg		279	327	326	306	282	316	363		374	391
Iron, mg	14.9	14.9	15.4	15.0	15.7	14.5	16.4	17.2		17.3	17.8
Zinc, mg		12.9	12.4	12.2	12.6	11.7	12.9	12.2		14.8	17.1
Vitamin A, RE	1183	1381	1230	1372	1615	1071	1225	1318			
Thiamin, mg	1.6	1.6	1.7	1.6	1.7	1.6	1.7	2.3		2.1	5.2
Niacin, NE	40.2	41.5	40.3	38.0	42.4	41.4	41.0	44.8		44.0	60.0
Riboflavin, mg	1.9	1.8	1.9	1.9	2.0	1.7	2.0	2.1		2.2	4.6
Vitamin B6, mg		1.9	1.8	1.8	2.0	2.0	1.9	2.1		2.0	6.5
Pantothenic Acid, mg		4.9	5.3	5.0	5.5	5.1	5.2			5.6	11.6
Folate, µg	234	235	243	239	231	212	244	*487		*504	*663
Vitamin B12, µg		5.0	7.2	5.8	8.8	5.4	6.7	6.2		6.6	12.7
Vitamin C, mg	86	86	107	105	88	91	95	138		122	255
Alcohol, g	9.8	11.4	6.4	9.3	4.5	12.2	4.8	9.8		10.4	

Data from Provincial nutrition surveys completed 1990-99; AB unpublished data used by permission
MB data unavailable; in the nine available reports missing values were not reported
BC, AB, NL reported data for age group 51-70 years
[a] Intake data from food and supplements; mean estimates lower than food only – high variability in supplement use
kcal = kilocalorie, g = gram, mg = milligram, µg = microgram
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
*DFE (dietary folate equivalents)
1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
SFA = saturated fatty acids; PUFA = polyunsaturated fatty acids; MUFA = mono-unsaturated fatty acids
Atwater factor calculations for BC (g protein, g alcohol); NL (g SFA/PUFA/MUFA); AB (g fat/SFA/PUFA/MUFA)

Table B4. Reported group mean nutrient intake from food for males age 65 to 74 years

	NS	Q	SK	AB	PE	NL	NB	ON	MB	BC	BC[a]
Energy, kcal	2025	2143	2116	1947	2175	2080	2135	2228		2013	
Protein, g	84	89	85	77	87	85	85	84		76	
Carbohydrate, g	250	269	270	227	275	258	270	274		254	
Total fat, g	75	77	77	76	82	79	77	83		73	
SFA, g	27.4	28.7	27.0	26.0	29.0	22.6	26.8	27.4		24.0	
PUFA, g	11.4	12.2	13.0	10.8	13.0	13.6	12.5	15.1		12.0	
MUFA, g	30.9	29.3	30.0	30.3	32.7	32.4	30.0	33.4		29.0	
Cholesterol, mg	314	357	314	286	341	300	302	334		316	
Dietary Fibre,mg	17.0	18.7	18.0	14.0	18.3	18.0	16.6	17.8		21.0	
Sodium, mg		3243	3332	2800	2884		2871	3001		2637	
Potassium, mg		3177	3239	2600	3239		3143	3429		3284	
Calcium, mg	776	771	812	648	785	569	725	780		796	915
Phosphorus, mg		1390	1366	1144	1365	1195	1320	1345		1333	1333
Magnesium, mg		293	315	260	307	276	285	334		352	373
Iron, mg	15.0	15.6	15.2	13.0	15.4	15.6	15.7	15.7		15.0	19.6
Zinc, mg		12.5	12.4	11.3	11.2	10.9	11.2	11.3		11.3	15.8
Vitamin A, RE	1628	1854	1345	965	1746	1465	1447	1261			
Thiamin, mg	1.6	1.6	1.7	1.4	1.7	1.6	1.6	2.0		1.7	4.7
Niacin, NE	36.3	39.5	36.2	32.0	37.2	35.1	37.3	40.0		36.0	94.0
Riboflavin, mg	1.8	2.0	1.8	1.7	1.9	1.6	1.8	2.1		2.0	5.0
Vitamin B6, mg		1.9	1.7	1.5	1.9	1.7	1.9	2.0		1.9	6.7
Pantothenic Acid, mg		5.5	5.1	4.0	5.8	4.7	5.0			5.4	9.3
Folate, µg	243	254	243	180	237	222	225	*452		*382	*720
Vitamin B12, µg		7.9	6.2	5.9	9.0	8.0	7.8	6.7		5.9	37.4
Vitamin C, mg	87	96	111	81	96	84	88	137		116	350
Alcohol, g	5.6	8.6	4.8	5.6	2.6	2.2	5.6	12.0		9.5	

Data from Provincial nutrition surveys completed 1990-99; AB unpublished data used by permission
MB data unavailable; in the nine available reports missing values were not reported
BC reported data for age group 71-84 years; AB, NL reported data for age group 71-74 years
[a] Intake data from food and supplements; mean estimates lower than food only – high variability in supplement use
kcal = kilocalorie, g = gram, mg = milligram, µg = microgram
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
*DFE (dietary folate equivalents)
1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
SFA = saturated fatty acids; PUFA = polyunsaturated fatty acids; MUFA = mono-unsaturated fatty acids
Atwater factor calculations for BC (g protein, g alcohol); NL (g SFA/PUFA/MUFA); AB (g fat/SFA/PUFA/MUFA)

Table B5. Reported group mean nutrient intake from food for females age 18 to 34 years

	NS	Q	SK	AB	PE	NL	NB	ON	MB	BC	BC[a]
Energy, kcal	1721	1867	1950	1859	1789	1696	1903	1947		1971	
Protein, g	69	76	73	74	71	68	73	72		68	
Carbohydrate, g	206	224	254	259	227	211	241	270		265	
Total fat, g	67	73	69	62	67	64	72	64		69	
SFA, g	24.4	27.4	24.0	22.7	24.5	20.4	25.7	21.0		23.0	
PUFA, g	10.6	11.4	12.0	8.3	10.3	10.9	11.6	11.2		11.0	
MUFA, g	27.4	28.5	27.0	22.7	26.6	25.8	27.7	26.0		27.0	
Cholesterol, mg	222	263	200	204	218	215	246	205		243	
Dietary Fibre,mg	9.6	12.6	12.6	12.0	11.5	10.5	11.7	14.2		16.0	
Sodium, mg		2697	2908	2900	2530		2799	2966		2695	
Potassium, mg		2609	2664	2500	2422		2421	2529		2695	
Calcium, mg	738	788	822	799	714	550	776	795		876	889
Phosphorus, mg		1210	1214	1189	1085	962	1157	1158		1230	1156
Magnesium, mg		242	269	257	228	202	242	269		304	305
Iron, mg	10.7	11.9	12.1	13.0	10.6	10.8	12.1	14.4		13.4	16.3
Zinc, mg		10.0	10.0	10.0	9.0	7.9	9.2	9.0		9.6	13.3
Vitamin A, RE	845	1148	860	1121	962	740	1158	959			
Thiamin, mg	1.2	1.3	1.3	1.3	1.2	1.2	1.2	1.8		1.6	5.5
Niacin, NE	29.0	32.3	31.5	31.0	31.3	29.6	31.8	33.4		31.0	48.0
Riboflavin, mg	1.5	1.6	1.7	1.7	1.4	1.4	1.7	1.8		1.8	5.8
Vitamin B6, mg		1.4	1.3	1.4	1.4	1.2	1.4	1.5		1.5	6.1
Pantothenic Acid, mg		4.2	4.1	4.0	3.8	3.4	4.1			4.5	8.8
Folate, µg	162	203	200	192	155	153	187	*423		*393	*607
Vitamin B12, µg		4.4	3.7	5.8	3.9	3.1	6.5	4.7		4.1	11.0
Vitamin C, mg	75	103	98	103	81	80	97	121		105	207
Alcohol, g	4.4	4.2	5.8	5.3	1.6	3.0	3.1	4.4		7.0	

Data from Provincial nutrition surveys completed 1990-99; AB unpublished data used by permission
MB data unavailable; in the nine available reports missing values were not reported
BC, AB, NL reported data for age group 19-30 years
[a] Intake data from food and supplements; mean estimates lower than food only – high variability in supplement use
kcal = kilocalorie, g = gram, mg = milligram, µg = microgram
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
*DFE (dietary folate equivalents)
1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
SFA = saturated fatty acids; PUFA = polyunsaturated fatty acids; MUFA = mono-unsaturated fatty acids
Atwater factor calculations for BC (g protein, g alcohol); NL (g SFA/PUFA/MUFA); AB (g fat/SFA/PUFA/MUFA)

Table B6. Reported group mean nutrient intake from food for females age 35 to 49 years

	NS	Q	SK	AB	PE	NL	NB	ON	MB	BC	BC[a]
Energy, kcal	1571	1727	1767	1760	1630	1601	1662	1723		1812	
Protein, g	67	73	71	70	65	68	69	70		70	
Carbohydrate, g	188	206	216	227	203	197	208	234		226	
Total fat, g	62	65	69	65	62	58	62	57		69	
SFA, g	21.6	23.7	24.0	21.5	22.1	18.9	21.0	20.2		23.0	
PUFA, g	10.0	10.9	12.0	9.8	10.0	10.0	10.5	9.4		12.0	
MUFA, g	25.0	25.0	27.0	23.5	24.9	24.0	24.4	22.5		27.0	
Cholesterol, mg	234	262	256	212	213	236	220	209		252	
Dietary Fibre,mg	11.6	13.6	13.0	13.0	12.5	10.7	12.5	16.8		15.0	
Sodium, mg		2581	2700	2900	2334		2435	2501		2593	
Potassium, mg		2598	2643	2800	2386		2402	2765		2719	
Calcium, mg	624	658	761	756	637	518	660	758		750	873
Phosphorus, mg		1107	1171	1150	1020	938	1020	1146		1151	1122
Magnesium, mg		241	269	277	229	207	233	290		296	336
Iron, mg	10.7	11.7	11.6	12.0	10.9	10.9	11.5	13.4		12.8	17.0
Zinc, mg		9.7	9.7	9.6	8.5	8.4	8.7	9.2		9.8	13.0
Vitamin A, RE	979	1100	1007	1065	808	926	878	1462			
Thiamin, mg	1.1	1.2	1.2	1.3	1.2	1.2	1.2	1.5		1.4	10.4
Niacin, NE	28.9	32.4	30.9	31.0	28.2	28.7	20.2	32.1		32.0	50.0
Riboflavin, mg	1.4	1.5	1.6	1.6	1.4	1.4	1.4	1.7		1.6	10.3
Vitamin B6, mg		1.4	1.3	1.5	1.3	1.3	1.4	1.6		1.5	10.5
Pantothenic Acid, mg		3.9	4.1	4.0	3.6	3.5	3.7			4.3	14.8
Folate, µg	176	189	197	203	176	170	186	*394		*385	*621
Vitamin B12, µg		3.6	4.6	5.0	4.3	4.0	3.9	3.6		4.1	26.5
Vitamin C, mg	75	91	90	107	72	82	88	116		110	352
Alcohol, g	2.6	7.3	3.1	2.5	2.2	3.3	2.4	3.3			

Data from Provincial nutrition surveys completed 1990-99; AB unpublished data used by permission
MB data unavailable; in the nine available reports missing values were not reported
BC, AB, NL reported data for age group 31-50 years
[a] Intake data from food and supplements; mean estimates lower than food only – high variability in supplement use
kcal = kilocalorie, g = gram, mg = milligram, µg = microgram
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
*DFE (dietary folate equivalents)
1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
SFA = saturated fatty acids; PUFA = polyunsaturated fatty acids; MUFA = mono-unsaturated fatty acids
Atwater factor calculations for BC (g protein, g alcohol); NL (g SFA/PUFA/MUFA); AB (g fat/SFA/PUFA/MUFA)

Table B7. Reported group mean nutrient intake from food for females age 50 to 64 years

	NS	Q	SK	AB	PE	NL	NB	ON	MB	BC	BC[a]
Energy, kcal	1476	1602	1618	1559	1610	1484	1609	1622		1669	
Protein, g	64	67	67	63	65	68	68	67		68	
Carbohydrate, g	185	206	202	203	210	189	211	218		213	
Total fat, g	54	57	61	55	57	51	56	53		60	
SFA, g	19.4	20.8	20.0	19.1	20.2	15.8	19.8	17.4		20.0	
PUFA, g	9.3	10.0	11.0	8.7	10.0	8.9	9.2	9.2		10.0	
MUFA, g	21.2	21.6	24.0	20.8	22.8	21.1	21.5	21.4		24.0	
Cholesterol, mg	211	211	207	189	210	228	223	231		224	
Dietary Fibre,mg	12.6	16.3	14.4	13.0	13.9	12.2	14.0	15.3		17.0	
Sodium, mg		2345	2460	2300	2325		2376	2288		2271	
Potassium, mg		2668	2650	2600	2489		2564	2784		2940	
Calcium, mg	582	622	651	619	600	511	661	714		726	1012
Phosphorus, mg		1049	1072	1034	1023	954	1023	1091		1134	1128
Magnesium, mg		242	270	251	240	219	248	282		308	386
Iron, mg	10.7	11.9	11.5	11.0	11.6	11.0	12.0	12.2		12.7	13.6
Zinc, mg		9.4	9.2	8.5	8.6	8.3	8.5	8.5		11.1	14.4
Vitamin A, RE	1226	1364	912	1139	1159	1104	1168	952			
Thiamin, mg	1.1	1.3	1.3	1.2	1.3	1.2	1.3	1.6		1.5	11.2
Niacin, NE	27.9	30.2	29.4	28.0	28.6	28.8	29.7	31.0		32.0	79.0
Riboflavin, mg	1.4	1.5	1.4	1.4	1.4	1.4	1.4	1.7		1.6	10.0
Vitamin B6, mg		1.5	1.4	1.4	1.4	1.4	1.5	1.6		1.7	11.8
Pantothenic Acid, mg		4.1	4.0	4.0	3.8	3.9	4.0			4.3	16.6
Folate, µg	189	205	207	200	182	185	201	*374		*364	*671
Vitamin B12, µg		3.7	3.7	4.1	4.2	4.2	3.9	2.9		3.9	109.5
Vitamin C, mg	74	108	107	103	79	91	94	133		121	356
Alcohol, g	2.7	4.1	2.5	2.2	1.9	0.7	1.8	5.0		5.2	

Data from Provincial nutrition surveys completed 1990-99; AB unpublished data used by permission
MB data unavailable; in the nine available reports missing values were not reported
BC, AB, NL reported data for age group 51-70 years
[a] Intake data from food and supplements; mean estimates lower than food only – high variability in supplement use
kcal = kilocalorie, g = gram, mg = milligram, µg = microgram
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
*DFE (dietary folate equivalents)
1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
SFA = saturated fatty acids; PUFA = polyunsaturated fatty acids; MUFA = mono-unsaturated fatty acids
Atwater factor calculations for BC (g protein, g alcohol); NL (g SFA/PUFA/MUFA); AB (g fat/SFA/PUFA/MUFA)

Table B8. Reported group mean nutrient intake from food for females age 65 to 74 years

	NS	Q	SK	AB	PE	NL	NB	ON	MB	BC	BC[a]
Energy, kcal	1394	1511	1423	1469	1480	1338	1605	1602		1508	
Protein, g	59	64	58	60	58	65	67	67		63	
Carbohydrate, g	182	198	190	189	200	177	218	219		201	
Total fat, g	50	55	50	51	52	43	54	52		51	
SFA, g	18.3	19.8	17.0	18.0	18.1	13.4	18.4	16.7		17.0	
PUFA, g	7.8	9.4	9.0	8.2	9.0	8.0	9.5	9.2		9.0	
MUFA, g	19.8	20.6	20.0	19.6	20.3	17.4	20.6	20.8		20.0	
Cholesterol, mg	186	203	187	183	197	189	208	188		203	
Dietary Fibre,mg	13.3	14.4	14.7	14.0	13.9	13.4	16.4	17.8		18.0	
Sodium, mg		2232	2240	2000	1977		2310	2549		2230	
Potassium, mg		2480	2464	2500	2351		2615	2948		2726	
Calcium, mg	595	574	633	655	547	561	598	645		742	1056
Phosphorus, mg		1004	981	1024	952	1005	952	1101		1147	1148
Magnesium, mg		216	239	245	222	229	254	297		296	342
Iron, mg	10.2	10.4	10.4	10.0	11.4	10.4	12.2	13.7		12.2	15.1
Zinc, mg		8.8	7.9	7.8	7.8	7.6	8.4	8.5		9.3	16.3
Vitamin A, RE	1101	1257	997	905	1393	1288	1367	1305			
Thiamin, mg	1.1	1.1	1.2	1.1	1.2	1.3	1.4	1.5		1.4	8.3
Niacin, NE	25.3	28.6	25.3	26.0	25.6	29.0	30.1	31.4		29.0	51.0
Riboflavin, mg	1.2	1.3	1.3	1.4	1.3	1.4	1.4	1.5		1.6	8.4
Vitamin B6, mg		1.4	1.3	1.4	1.3	1.5	1.6	1.7		1.5	20.9
Pantothenic Acid, mg		3.8	3.7	4.0	3.9	4.1	4.1			4.2	10.4
Folate, µg	182	180	188	176	181	201	204	*377		*332	*737
Vitamin B12, µg		3.2	3.2	3.8	7.5	6.3	3.5	7.2		4.1	37.6
Vitamin C, mg	85	93	99	86	80	94	98	134		100	361
Alcohol, g	0.9	0.7	1.2	2.1	0.7	0.3	1.2	4.1		4.1	

Data from Provincial nutrition surveys completed 1990-99; AB unpublished data used by permission
MB data unavailable; in the nine available reports missing values were not reported
BC reported data for age group 71-84 years; AB, NL reported data for age group 71-74 years
[a] Intake data from food and supplements; mean estimates lower than food only – high variability in supplement use
kcal = kilocalorie, g = gram, mg = milligram, µg = microgram
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
*DFE (dietary folate equivalents)
1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
SFA = saturated fatty acids; PUFA = polyunsaturated fatty acids; MUFA = mono-unsaturated fatty acids
Atwater factor calculations for BC (g protein, g alcohol); NL (g SFA/PUFA/MUFA); AB (g fat/SFA/PUFA/MUFA)

Table B9. Reported distribution (%) of group mean energy intake of adults by age and gender from the provincial nutrition surveys listed by year conducted

		Males				Females			
		18-34	**35-49**	**50-64**	**65-74**	**18-34**	**35-49**	**50-64**	**65-74**
Protein	NS	16.0	16.0	17.0	16.0	16.0	17.0	17.0	16.0
	QC	15.9	15.9	16.5	16.3	16.1	16.6	16.3	16.6
	SK	15.9	16.7	16.4	16.0	14.8	15.9	16.1	16.0
	AB	15.0	16.0	16.0	16.0	15.0	15.0	16.0	16.0
	PE	16.5	15.8	16.7	15.7	15.8	15.7	16.0	15.4
	NL	16.4	17.3	18.2	16.2	15.9	17.0	18.3	19.0
	NB	15.5	16.8	16.2	16.1	15.4	16.6	16.8	16.4
	ON	15.4	14.9	16.0	14.9	14.6	15.9	16.3	16.3
	MB								
	BC	16.5	15.5	15.9	15.1	13.8	15.5	16.3	16.6
Carbohydrate	NS	45.0	46.0	45.0	49.0	48.0	47.0	49.0	51.0
	QC	46.0	46.0	46.1	49.3	47.5	47.1	50.3	51.3
	SK	46.9	45.3	47.4	49.7	51.8	48.4	49.3	52.0
	AB	50.0	48.0	49.0	47.0	53.0	50.0	51.0	52.0
	PE	47.2	46.8	47.2	50.0	50.2	49.4	51.6	53.3
	NL	45.7	45.3	44.6	49.2	49.4	49.1	50.6	52.2
	NB	49.1	46.7	49.3	50.1	50.2	49.6	51.8	53.5
	ON	51.7	50.9	50.8	48.4	54.7	53.4	52.7	53.5
	MB								
	BC	50.0	48.5	49.1	49.9	52.8	48.9	50.0	51.9
Total Fat	NS	36.0	35.0	35.0	33.0	35.0	35.0	33.0	32.0
	QC	35.4	34.7	33.9	31.6	34.9	33.4	31.6	31.8
	SK	33.5	35.6	34.5	32.8	31.4	34.4	33.7	31.1
	AB	31.0	33.0	33.0	35.0	30.0	33.0	32.0	31.0
	PE	34.1	35.4	34.8	33.4	33.4	34.0	31.6	31.0
	NL	32.2	33.4	33.3	33.9	33.5	32.5	30.7	28.5
	NB	33.8	34.3	33.3	32.2	33.5	33.0	30.8	29.7
	ON	30.2	30.7	30.3	33.1	29.2	29.3	28.9	28.5
	MB								
	BC	30.9	32.5	31.8	31.7	30.9	33.5	31.5	29.6
Saturated Fat	NS	13.0	13.0	13.0	12.0	13.0	12.0	12.0	12.0
	QC	13.3	12.9	12.7	11.8	13.1	12.2	11.4	11.6
	SK	11.9	12.3	12.5	11.2	11.0	12.1	11.1	10.1
	AB	11.0	12.0	11.0	12.0	11.0	11.0	11.0	11.0
	PE	12.1	12.6	12.3	11.4	11.9	11.7	10.7	10.7
	NL	11.2	11.0	10.7	9.8	10.8	10.6	9.6	9.0
	NB	11.7	11.7	10.8	10.8	11.4	11.1	10.8	9.8
	ON	10.1	10.7	10.0	10.9	9.5	10.3	9.5	9.2
	MB								
	BC	10.3	10.6	10.4	10.7	10.5	11.4	10.8	10.1

Data from Provincial nutrition surveys completed 1990-99
AB unpublished data used by permission; MB data unavailable
BC reported age group 19-30, 31-50, 51-70, 71-84 years; AB, NL reported age group 19-30, 31-50, 51-70, 71-74 years
% SFA for BC derived from: % SFA = g SFA x 9/energy (kcal) x 100%

Appendix C

Population-Weighting of the Reported Provincial Nutrient Intake Data

Population-weighting Summary
Canadian Rural Economy Research Lab

The Canada Average value for each age and sex group was calculated by weighting each category by its provinces share of the country's population, then multiplying this weighting by the observed value and summing these values for each observed province. For example, in the Canada Average of "Energy, kcal" using the Male 18 to 34 year age group, the population of males aged 18 through 34 was looked up for each province. The sum of these numbers represents the whole country and the individual provincial values divided by the sum represent the population weight for each province. Each province's population weight is multiplied by each province's observed value of "Energy, kcal". The sum of these values represents the population weighted value of "Energy, kcal" for the country. For each Canada Average calculation, a variance and standard deviation was also calculated using the following formula:

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$$std.dev. = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - \bar{x})^2}$$

Where:

$N =$ the number of individual observations (provinces)

$X_i =$ an individual observation

$\overline{X}$ = the average value

Variance is equal to the standard deviation squared.

These calculations were performed with the spreadsheet package Microsoft Excel. Province population totals for each age group, sex, and year were obtained from Statistics Canada's CANSIM website. CANSIM is a socio-economic database operated by the government of Canada (http://cansim2.statcan.ca/). Specifically, the table consulted was: "CANSIM Table 051-0001 - Estimates of population, by age group and sex, Canada, provinces and territories, annual (Persons unless otherwise noted)" This database is found online at the following address:
http://www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function= getSurvey&SDDS= 3604&lang =en&db=IMDB&dbg=f&adm=8&dis=2

Table C1. Estimates of population by age, gender, and province for Canada in the 1990s

			Males		
	Census	**18-34 y**	**35-49 y**	**50-64 y**	**65-74 y**
NS	1990	132,770	95,013	57,883	29,623
QC	1990	1,024,733	789,235	478,663	202,519
SK[a]	1993/94	125,042	104,124	64,029	36,573
AB	1994	379,105	323,791	165,729	71,081
PE	1995	16,760	14,910	9,078	4,328
NL	1996	75,846	67,165	38,850	16,466
NB[a]	1996/97	97,697	90,877	53,901	23,992
ON[a]	1997/98	1,413,375	1,347,006	819,476	377,581
MB[a]	1997/98	139,957	130,235	78,403	37,583
BC[b]	1999	332,829	652,176	374,285	122,471
TOTAL		3,738,114	3,614,532	2,140,297	922,217
			Females		
	Census	**18-34 y**	**35-49 y**	**50-64 y**	**65-74 y**
NS	1990	130,104	94,840	60,021	35,827
QC	1990	993,353	788,292	509,849	262,855
SK[a]	1993/94	122,032	100,234	64,578	41,522
AB	1994	367,057	309,351	160,737	80,757
PE	1995	16,617	15,151	9,104	4,950
NL	1996	74,902	67,753	38,121	17,958
NB[a]	1996/97	94,145	90,847	53,974	28,344
ON[a]	1997/98	1,388,918	1,368,238	841,626	437,429
MB[a]	1997/98	133,509	128,442	79,070	43,885
BC[b]	1999	325,502	653,860	374,779	161,282
TOTAL		3,646,138	3,617,008	2,191,859	1,114,808

Taken from "CANSIM Table 051-0001 - Estimates of population, by age group and sex, Canada, provinces and territories, annual (Persons unless otherwise noted)." http://www.statcan.ca/cgi-bin/imdb /p2SV.pl?Function=getSurvey&SDDS=3604&lang=en&db=IMDB&dbg=f&adm=8&dis=2

[a] Census number is average of two years

[b] BC census data retrieved for 19-30, 31-50, 51-70, 71-84 year age groups respectively

y = years

Table C2. Characteristics of PNS national nutrient values for males age 18 to 34 years

Variable	Mean	N	Variance	Std. Dev
Energy, kcal	2,834	9	37,610	194
Protein, g	114	9	102.2	10.11
Carbohydrate, g	353	9	1,008	31.8
Total fat, g	103	9	130	11.4
SFA, g	36.2	9	27.6	5.25
PUFA, g	16.4	9	2.22	1.49
MUFA, g	41.2	9	19.2	4.39
Cholesterol, mg	360	9	1,571	39.6
Dietary Fibre, mg	18.3	9	6.58	2.57
Sodium, mg	4,025	7	132,081	363
Potassium, mg	3,640	7	85,738	293
Calcium, mg	1,093	9	25,893	161
Phosphorus, mg	1,751	8	36,083	190
Magnesium, mg	366	8	1,942	44.1
Iron, mg	18.5	9	2.47	1.57
Zinc, mg	15.4	8	4.12	2.03
Vitamin A, RE	1,218	8	44,100	210
Thiamin, mg	2.16	9	0.06	0.25
Niacin, NE	50.43	9	12.1	3.48
Riboflavin, mg	2.50	9	0.07	0.27
Vitamin B6, mg	2.24	8	0.04	0.19
Pantothenic Acid, mg	6.46	7	0.57	0.75
Folate, µg	279	7	1,447	38
Folate, DFE	592	2	664	25.8
Vitamin B12, µg	6.90	8	6.07	2.46
Vitamin C, mg	143	9	818	28.6
Alcohol, g	11.3	9	19.6	4.43
Alcohol, %	2.78	9	1.41	1.19

PNS = population-weighted group mean derived of provincial group means
BC, AB, NL age group 19-30 years
AB unpublished data used by permission
N = number of provinces providing a published value for that nutrient
not all provinces published values for all nutrients; MB data unavailable
Folate µg = NS, QC, SK, AB, PE, NL, NB
Folate DFE = ON, BC
kcal = kilocalorie; g = gram; mg = milligram; µg = microgram; % = percent
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
DFE (dietary folate equivalents) 1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach

Table C3. Characteristics of PNS national nutrient values for males age 35 to 49 years

Variable	Mean	N	Variance	Std. Dev
Energy, kcal	2,634	9	22,039	148
Protein, g	104	9	23.1	4.81
Carbohydrate, g	325	9	1,001	31.6
Total fat, g	96.3	9	37.9	6.16
SFA, g	33.7	9	8.91	2.99
PUFA, g	15.6	9	1.51	1.23
MUFA, g	38.5	9	4.96	2.23
Cholesterol, mg	340	9	1,256	35.4
Dietary Fibre, mg	18.6	9	8.50	2.92
Sodium, mg	3,738	7	66,132	257
Potassium, mg	3,571	7	25,928	161
Calcium, mg	965	9	13,506	116
Phosphorus, mg	1,601	8	12,736	113
Magnesium, mg	367	8	2,007	44.8
Iron, mg	17.9	9	3.65	1.91
Zinc, mg	14.9	8	1.78	1.34
Vitamin A, RE	1,361	8	55,080	235
Thiamin, mg	2.04	9	0.09	0.30
Niacin, NE	47.38	9	7.42	2.72
Riboflavin, mg	2.26	9	0.04	0.21
Vitamin B6, mg	2.13	8	0.01	0.11
Pantothenic Acid, mg	5.70	7	0.15	0.38
Folate, µg	249	7	451	21.2
Folate, DFE	580	2	897	29.9
Vitamin B12, µg	6.67	8	1.47	1.21
Vitamin C, mg	125	9	574	24.0
Alcohol, g	12.8	9	8.00	2.83
Alcohol, %	3.39	9	0.51	0.71

PNS = population-weighted group mean derived of provincial group means
BC, AB, NL age group 31-50 years
AB unpublished data used by permission
N = number of provinces providing a published value for that nutrient
not all provinces published values for all nutrients; MB data unavailable
Folate µg = NS, QC, SK, AB, PE, NL, NB
Folate DFE = ON, BC
kcal = kilocalorie; g = gram; mg = milligram; µg = microgram; % = percent
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
DFE (dietary folate equivalents) 1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach

Table C4. Characteristics of PNS national nutrient values for males age 50 to 64 years

Variable	Mean	N	Variance	Std. Dev
Energy, kcal	2,295	9	5,906	76.9
Protein, g	93.7	9	13.69	3.70
Carbohydrate, g	285	9	494	22.2
Total fat, g	82.6	9	15.6	3.94
SFA, g	28.2	9	7.12	2.67
PUFA, g	13.4	9	1.09	1.05
MUFA, g	33.1	9	3.44	1.85
Cholesterol, mg	327	9	584	24.2
Dietary Fibre, mg	18.8	9	6.93	2.63
Sodium, mg	3,393	7	20,039	142
Potassium, mg	3,411	7	24,056	155
Calcium, mg	808	9	6,971	83.5
Phosphorus, mg	1,427	8	4,796	69.3
Magnesium, mg	338	8	1461	38.2
Iron, mg	16.3	9	1.49	1.22
Zinc, mg	12.9	8	0.90	0.95
Vitamin A, RE	1326	8	27,653	166
Thiamin, mg	1.98	9	0.11	0.34
Niacin, NE	42.90	9	6.37	2.52
Riboflavin, mg	2.01	9	0.03	0.17
Vitamin B6, mg	1.99	8	0.02	0.12
Pantothenic Acid, mg	5.20	7	0.06	0.25
Folate, µg	236	7	120	11.0
Folate, DFE	492	2	165	12.8
Vitamin B12, µg	6.00	8	1.63	1.28
Vitamin C, mg	116	9	537	23.2
Alcohol, g	10.0	9	9.8	3.13
Alcohol, %	3.03	9	0.97	0.99

PNS = population-weighted group mean derived of provincial group means
BC, AB, NL age group 51-70 years
AB unpublished data used by permission
N = number of provinces providing a published value for that nutrient
not all provinces published values for all nutrients; MB data unavailable
Folate µg = NS, QC, SK, AB, PE, NL, NB
Folate DFE = ON, BC
kcal = kilocalorie; g = gram; mg = milligram; µg = microgram; % = percent
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
DFE (dietary folate equivalents) 1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach

Table C5. Characteristics of PNS national nutrient values for Males age 65 to 74 years

Variable	Mean	N	Variance	Std. Dev
Energy, kcal	2,139	9	9,904	99.5
Protein, g	83.6	9	18.1	4.25
Carbohydrate, g	265	9	260	16.1
Total fat, g	78.8	9	11.6	3.41
SFA, g	27.0	9	4.58	2.14
PUFA, g	13.3	9	2.17	1.47
MUFA, g	31.3	9	2.65	1.63
Cholesterol, mg	330	9	656	25.6
Dietary Fibre, mg	18.1	9	3.65	1.91
Sodium, mg	2,999	7	61,808	249
Potassium, mg	3,259	7	80,854	284
Calcium, mg	765	9	7,226	85.0
Phosphorus, mg	1335	8	8734	93.5
Magnesium, mg	317	8	1173	34.2
Iron, mg	15.3	9	0.75	0.87
Zinc, mg	11.6	8	0.37	0.60
Vitamin A, RE	1422	8	82,449	287
Thiamin, mg	1.77	9	0.04	0.20
Niacin, NE	38.2	9	8.51	2.92
Riboflavin, mg	1.99	9	0.05	0.21
Vitamin B6, mg	1.89	8	0.03	0.19
Pantothenic Acid, mg	5.17	7	0.35	0.59
Folate, µg	235	7	632	25.1
Folate, DFE	435	2	3,088	55.6
Vitamin B12, µg	6.85	8	1.48	1.22
Vitamin C, mg	115	9	608	24.7
Alcohol, g	9.44	9	21.6	4.64
Alcohol, %	3.04	9	2.10	1.45

PNS = population-weighted group mean derived of provincial group means
BC, AB, NL age group 71-84, 71-74, 71-74 years respectively
AB unpublished data used by permission
N = number of provinces providing a published value for that nutrient
not all provinces published values for all nutrients; MB data unavailable
Folate µg = NS, QC, SK, AB, PE, NL, NB
Folate DFE = ON, BC
kcal = kilocalorie; g = gram; mg = milligram; µg = microgram; % = percent
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
DFE (dietary folate equivalents) 1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach

Table C6. Characteristics of PNS national nutrient values for females age 18 to 34 years

Variable	Mean	N	Variance	Std. Dev
Energy, kcal	1,902	9	12,520	112
Protein, g	72.8	9	10.2	3.19
Carbohydrate, g	250	9	691	26.3
Total fat, g	67.4	9	14.1	3.76
SFA, g	23.5	9	4.84	2.20
PUFA, g	10.9	9	1.19	1.09
MUFA, g	26.6	9	2.73	1.65
Cholesterol, mg	227	9	488	22.1
Dietary Fibre, mg	13.3	9	4.76	2.18
Sodium, mg	2,842	7	27,505	166
Potassium, mg	2,568	7	12,661	113
Calcium, mg	794	9	9,592	98
Phosphorus, mg	1,181	8	8,944	95
Magnesium, mg	261	8	1,034	32.2
Iron, mg	13.1	9	2.77	1.67
Zinc, mg	9.48	8	0.56	0.75
Vitamin A, RE	1,029	8	27,806	167
Thiamin, mg	1.52	9	0.08	0.28
Niacin, NE	32.3	9	2.97	1.72
Riboflavin, mg	1.71	9	0.03	0.18
Vitamin B6, mg	1.45	8	0.01	0.12
Pantothenic Acid, mg	4.18	7	0.14	0.38
Folate, µg	194	7	743	27.3
Folate, DFE	417	2	623	25.0
Vitamin B12, µg	4.65	8	1.29	1.13
Vitamin C, mg	108	9	392	19.8
Alcohol, g	4.66	9	2.77	1.67
Alcohol, %	1.73	9	0.35	0.59

PNS = population-weighted group mean derived of provincial group means
BC, AB, NL age group 19-30 years
AB unpublished data used by permission
N = number of provinces providing a published value for that nutrient
not all provinces published values for all nutrients; MB data unavailable
Folate µg = NS, QC, SK, AB, PE, NL, NB
Folate DFE = ON, BC
kcal = kilocalorie; g = gram; mg = milligram; µg = microgram; % = percent
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
DFE (dietary folate equivalents) 1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach

Table C7. Characteristics of PNS national nutrient values for females age 35 to 49 years

Variable	Mean	N	Variance	Std. Dev
Energy, kcal	1,737	9	8,760	93.6
Protein, g	70.5	9	7.51	2.74
Carbohydrate, g	222	9	357	18.9
Total fat, g	62.3	9	18.5	4.30
SFA, g	21.8	9	2.71	1.65
PUFA, g	10.2	9	11.5	3.39
MUFA, g	24.3	9	2.52	1.59
Cholesterol, mg	232	9	418	20.5
Dietary Fibre, mg	14.9	9	6.58	2.57
Sodium, mg	2,579	7	34,120	185
Potassium, mg	2,704	7	36,805	192
Calcium, mg	722	9	8,942	94.6
Phosphorus, mg	1,131	8	9,285	96
Magnesium, mg	275	8	1,459	38.2
Iron, mg	12.55	9	1.58	1.26
Zinc, mg	9.45	8	0.41	0.64
Vitamin A, RE	1,251	8	96,483	311
Thiamin, mg	1.36	9	0.03	0.17
Niacin, NE	31.5	9	19.6	4.42
Riboflavin, mg	1.60	9	0.02	0.15
Vitamin B6, mg	1.51	8	0.02	0.15
Pantothenic Acid, mg	4.05	7	0.11	0.34
Folate, µg	190	7	178	13.3
Folate, DFE	391	2	45.6	6.75
Vitamin B12, µg	3.87	8	0.31	0.56
Vitamin C, mg	105	9	420	20.5
Alcohol, g	4.44	9	3.73	1.93
Alcohol, %	1.75	9	0.54	0.74

PNS = population-weighted group mean derived of provincial group means
BC, AB, NL age group 31-50 years
AB unpublished data used by permission
N = number of provinces providing a published value for that nutrient
not all provinces published values for all nutrients; MB data unavailable
Folate µg = NS, QC, SK, AB, PE, NL, NB
Folate DFE = ON, BC
kcal = kilocalorie; g = gram; mg = milligram; µg = microgram; % = percent
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
DFE (dietary folate equivalents) 1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach

Table C8. Characteristics of PNS national nutrient values for females age 50 to 64 years

Variable	Mean	N	Variance	Std. Dev
Energy, kcal	1,614	9	5,240	72.4
Protein, g	66.7	9	4.05	2.01
Carbohydrate, g	211	9	172	13.1
Total fat, g	55.8	9	10.2	3.19
SFA, g	19.0	9	2.54	1.59
PUFA, g	9.55	9	0.53	0.73
MUFA, g	21.9	9	1.55	1.25
Cholesterol, mg	220	9	197	14.0
Dietary Fibre, mg	15.5	9	4.23	2.06
Sodium, mg	2,308	7	5,185	72.0
Potassium, mg	2,757	7	31,311	177
Calcium, mg	676	9	6,552	80.9
Phosphorus, mg	1,079	8	3,986	63.1
Magnesium, mg	272	8	1,013	31.8
Iron, mg	12.0	9	0.62	0.79
Zinc, mg	9.21	8	0.90	0.95
Vitamin A, RE	1,109	8	21,286	146
Thiamin, mg	1.44	9	0.05	0.21
Niacin, NE	30.5	9	3.08	1.75
Riboflavin, mg	1.57	9	0.03	0.16
Vitamin B6, mg	1.57	8	0.02	0.14
Pantothenic Acid, mg	4.15	7	0.04	0.20
Folate, µg	202	7	148	12.2
Folate, DFE	371	2	57.4	7.57
Vitamin B12, µg	3.45	8	0.33	0.58
Vitamin C, mg	118	9	693	26.3
Alcohol, g	4.30	9	4.55	2.13
Alcohol, %	1.83	9	0.84	0.91

PNS = population-weighted group mean derived of provincial group means
BC, AB, NL age group 51-70 years
AB unpublished data used by permission
N = number of provinces providing a published value for that nutrient
not all provinces published values for all nutrients; MB data unavailable
Folate µg = NS, QC, SK, AB, PE, NL, NB
Folate DFE = ON, BC
kcal = kilocalorie; g = gram; mg = milligram; µg = microgram; % = percent
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
DFE (dietary folate equivalents) 1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach

Table C9. Characteristics of PNS national nutrient values for females age 65 to 74 years

Variable	Mean	N	Variance	Std. Dev
Energy, kcal	1,537	9	11,398	107
Protein, g	64.4	9	18.0	4.24
Carbohydrate, g	206	9	291	17.1
Total fat, g	52.1	9	13.2	3.64
SFA, g	17.7	9	3.22	1.79
PUFA, g	9.07	9	0.49	0.70
MUFA, g	20.4	9	1.34	1.16
Cholesterol, mg	194	9	83.4	9.13
Dietary Fibre, mg	16.3	9	5.00	2.24
Sodium, mg	2,351	7	57,468	240
Potassium, mg	2,724	7	63,196	251
Calcium, mg	638	9	4,105	64.07
Phosphorus, mg	1,066	8	7,217	84.95
Magnesium, mg	267	8	1,328	36.44
Iron, mg	12.0	9	2.34	1.53
Zinc, mg	8.59	8	0.47	0.69
Vitamin A, RE	1,236	8	33,486	183
Thiamin, mg	1.33	9	0.03	0.17
Niacin, NE	29.4	9	8.14	2.85
Riboflavin, mg	1.43	9	0.02	0.13
Vitamin B6, mg	1.55	8	0.03	0.17
Pantothenic Acid, mg	3.94	7	0.04	0.19
Folate, µg	182	7	148	12.2
Folate, DFE	365	2	1,228	35.0
Vitamin B12, µg	5.17	8	3.45	1.86
Vitamin C, mg	110	9	454	21.3
Alcohol, g	2.74	9	3.33	1.82
Alcohol, %	1.24	9	0.61	0.78

PNS = population-weighted group mean derived of provincial group means
BC, AB, NL age group 71-84, 71-74, 71-74 years respectively
AB unpublished data used by permission
N = number of provinces providing a published value for that nutrient
not all provinces published values for all nutrients; MB data unavailable
Folate µg = NS, QC, SK, AB, PE, NL, NB
Folate DFE = ON, BC
kcal = kilocalorie; g = gram; mg = milligram; µg = microgram; % = percent
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan
DFE (dietary folate equivalents) 1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach

Table C10. Characteristics of PNS energy distribution (%) for adults age 18 to 74 years

Gender and Age Group	Macronutrient	Percent	N	Variance	Standard Deviation
Males 18-34 y					
	Protein	15.67	9	0.33	0.58
	Carbohydrate	49.11	9	6.87	2.62
	Fat	32.32	9	4.76	2.18
Males 35-49 y					
	Protein	15.52	9	0.90	0.95
	Carbohydrate	48.54	9	5.76	2.40
	Fat	32.59	9	4.33	2.08
Males 50-64 y					
	Protein	16.19	9	0.66	0.81
	Carbohydrate	48.82	9	6.08	2.46
	Fat	32.04	9	4.13	2.03
Males 65-74 y					
	Protein	15.48	9	0.36	0.60
	Carbohydrate	48.84	9	1.09	1.04
	Fat	32.69	9	1.25	1.12
Females 18-34 y					
	Protein	15.11	9	0.63	0.79
	Carbohydrate	51.71	9	6.64	2.58
	Fat	31.57	9	5.27	2.30
Females 35-49 y					
	Protein	15.97	9	0.52	0.72
	Carbohydrate	50.31	9	4.93	2.22
	Fat	31.82	9	4.55	2.13
Females 50-64 y					
	Protein	16.34	9	0.60	0.77
	Carbohydrate	51.24	9	1.78	1.33
	Fat	30.60	9	2.88	1.70
Females 65-74 y					
	Protein	16.42	9	1.04	1.02
	Carbohydrate	52.44	9	0.89	0.94
	Fat	29.93	9	1.97	1.40

PNS = population-weighted group mean derived of provincial group means
BC, AB, NL age groups 19-30, 31-50, 51-70, 71+ years
AB unpublished data used by permission; MB data unpublished and unavailable
N = number of provinces providing a published value for that nutrient; y = years

Appendix D

National Mean Nutrient Intake of the Province-derived Nutrition Survey (PNS)

Table D1. Estimated national mean intake values from food of PNS males by age[1]

Age Group (years)	**18-34**	**35-49**	**50-64**	**65-74**
	n = 2220	n = 2066	n = 2182	n = 1584
Energy, kcal	2830	2630	2300	2140
Protein, g	114	104	94	84
Carbohydrate, g	353	325	285	265
Total fat, g	103	96	83	79
SFA, g	36.2	33.7	28.2	27.0
PUFA, g	16.4	15.6	13.4	13.3
MUFA, g	41.2	38.5	33.1	31.3
Cholesterol, mg	360	340	327	330
Dietary Fibre, mg	18.3	18.6	18.8	18.1
Sodium, mg	4030	3740	3390	3000
Potassium, mg	3640	3570	3410	3260
Calcium, mg	1090	965	808	765
Phosphorus, mg	1750	1600	1430	1340
Magnesium, mg	366	367	338	317
Iron, mg	18.5	17.9	16.3	15.3
Zinc, mg	15.4	14.9	12.9	11.6
Vitamin A, RE	1220	1360	1330	1420
Thiamin, mg	2.16	2.04	1.98	1.77
Niacin, NE	50.4	47.4	42.9	38.2
Riboflavin, mg	2.50	2.26	2.01	1.99
Vitamin B6, mg	2.24	2.13	1.99	1.89
Pantothenic Acid, mg	6.46	5.70	5.20	5.17
Folate, µg	279	249	236	235
Folate, DFE	592	580	492	435
Vitamin B12, µg	6.90	6.67	6.00	6.85
Vitamin C, mg	143	125	116	115
Alcohol, g	11.3	12.8	10.0	9.4

Estimates of national intake rounded to no more than three significant digits
PNS data is a population-weighted group mean derived from the provincial group means
[1] data is the population-weighted values for n un-weighted provincial subject numbers
MB not included, data unavailable; AB report unpublished, data used by permission
BC reported age groups 19-30, 31-50, 51-70, 71-84 years
AB and NL reported age groups 19-30, 31-50, 51-70, 71-74 years
kcal = kilocalorie, g = gram, mg = milligram, µg = microgram
Folate, µg = NS, QC, SK, AB, PE, NL, NB; Folate DFE = ON, BC
DFE (dietary folate equivalents) 1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan

Table D2. Estimated national mean intake values from food of PNS females by age[1]

Age Group (years)	**18-34**	**35-49**	**50-64**	**65-74**
	n = 2482	n = 2491	n = 2361	n = 1527
Energy, kcal	1900	1740	1610	1540
Protein, g	73	70	67	64
Carbohydrate, g	250	222	211	206
Total fat, g	67	62	56	52
SFA, g	23.5	21.8	19.0	17.7
PUFA, g	10.9	10.2	9.55	9.07
MUFA, g	26.6	24.3	21.9	20.4
Cholesterol, mg	227	232	220	194
Dietary Fibre, mg	13.3	14.9	15.5	16.3
Sodium, mg	2840	2580	2310	2350
Potassium, mg	2570	2700	2760	2720
Calcium, mg	794	722	676	638
Phosphorus, mg	1180	1130	1080	1070
Magnesium, mg	261	275	272	267
Iron, mg	13.1	12.5	12.0	12.0
Zinc, mg	9.48	9.45	9.21	8.59
Vitamin A, RE	1030	1250	1110	1240
Thiamin, mg	1.52	1.36	1.44	1.33
Niacin, NE	32.3	31.5	30.5	29.4
Riboflavin, mg	1.71	1.60	1.57	1.43
Vitamin B6, mg	1.45	1.51	1.57	1.55
Pantothenic Acid, mg	4.18	4.05	4.15	3.94
Folate, µg	194	190	202	182
Folate, DFE	417	391	371	365
Vitamin B12, µg	4.65	3.87	3.45	5.17
Vitamin C, mg	108	105	118	110
Alcohol, g	4.7	4.4	4.3	2.7

Estimates of national intake rounded to no more than 3 significant digits
PNS data is a population-weighted group mean derived from the provincial group means
[1] data is the population-weighted values for n un-weighted provincial subject numbers
MB not included, data unavailable; AB report unpublished, data used by permission
BC reported age groups 19-30, 31-50, 51-70, 71-84 years
AB and NL reported age groups 19-30, 31-50, 51-70, 71-74 years
kcal = kilocalorie, g = gram, mg = milligram, µg = microgram
Folate, µg = NS, QC, SK, AB, PE, NL, NB; Folate DFE = ON, BC
DFE (dietary folate equivalents) 1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
RE (retinol equivalents) 1µg retinol = 6µg β-carotene = 12µg other carotenes
NE (niacin equivalents) 1NE = 1mg niacin = 60mg tryptophan

Table D3. Estimated distribution (%) of energy from protein, carbohydrate, and fat from PNS adults by age and gender

	Males				Females			
Age Group (years)	**18-34**	**35-49**	**50-64**	**65-74**	**18-34**	**35-49**	**50-64**	**65-74**
Protein	15.7	15.5	16.2	15.5	15.1	16.0	16.3	16.4
Carbohydrate	49.1	48.5	48.8	48.8	51.7	50.3	51.2	52.4
Fat	32.3	32.6	32.1	32.7	31.6	31.8	30.6	29.9

PNS data is a population-weighted group mean derived from the provincial group means
MB not included, data unavailable
AB report unpublished, data used by permission
BC reported age groups 19-30, 31-50, 51-70, 71-84 years
AB and NL reported age groups 19-30, 31-50, 51-70, 71-74 years

Table D4. Number of respondents reported in the provincial nutrition surveys by age, gender, and order each provincial survey was conducted

	Males				Females			
	18-34y	**35-49y**	**50-64y**	**65-74y**	**18-34y**	**35-49y**	**50-64y**	**65-74y**
NS	255	250	337	227	260	315	327	241
QC	575	175	101	185	593	209	114	166
SK	263	203	204	166	286	273	229	174
AB[1]	206	345	354	70	231	390	369	74
PE	275	261	282	182	258	278	292	167
NL	241	263	254	178	302	258	262	169
NB	163	247	260	183	194	283	297	189
ON	100	117	141	122	182	219	189	117
MB								
BC[2]	142	205	249	271	176	266	282	230
Total	**2220**	**2066**	**2182**	**1584**	**2482**	**2491**	**2361**	**1527**

MB not included data unavailable; AB report unpublished data used by permission
[1]AB reported subject numbers as age groups 19-30, 31-50, 51-70, 71-74 years
[2]BC reported subject numbers as age groups 19-30, 31-50, 51-70, 71-84 years
y = years

Appendix E

National Mean Nutrient Intake Comparison between the PNS and NCS

Table E1. Comparison of estimated national mean nutrient intake from food between the NCS and the PNS for adult Canadian males by age[1]

	NCS 20-39y n = 999	PNS 18-34y n = 2220	NCS 40-64y n = 1222	PNS 35-64y n = 4248	NCS 65+y n = 881	PNS 65-74y n = 1584
Energy, kcal	3370	2830	2670	2460	2060	2140
Protein, g	119	114	94	99	72	84
Carbohydrate, g	351	353	286	305	235	265
Total fat, g	154	103	118	89	89	79
Dietary Fibre, mg[2]	4.61	18.3	4.2	18.7	3.9	18.1
Calcium, mg	1080	1090	883	887	709	765
Iron, mg	18.0	18.5	16.0	17.1	13.0	15.3
Vitamin A, RE	1550	1220	1330	1340	1110	1420
Thiamin, mg	1.57	2.16	1.32	2.01	1.08	1.77
Niacin, NE	48.0	50.4	37.0	45.1	28.0	38.2
Riboflavin, mg	2.59	2.50	2.09	2.14	1.77	1.99
Folate, µg	221	279	183	243	151	235
Folate, DFE		592		536		435
Vitamin C, mg	118	143	101	120	85	115

Values rounded to no more than 3 significant digits
[1] PNS data is the population weighted values for n un-weighted provincial subject numbers
PNS age groups 35-49 years and 50-64 years averaged for ease of comparison to NCS
[2] NC terminology was fibre not dietary fibre
NCS did not report folate in DFE units

Table E2. Comparison of the estimated national distribution (%) of energy between the NCS and the PNS for adult Canadian males by age

	NCS 20-39y	PNS 18-34y	NCS 40-64y	PNS 35-64y	NCS 65+y	PNS 65-74y
Protein	14.1	16.1	14.1	16.0	14.0	15.6
Carbohydrate	41.6	49.8	42.8	49.5	45.7	49.5
Fat	41.1	32.7	39.8	32.7	39.0	33.2

Derived from data in Table D1 using Atwater factors
AB data unpublished used by permission in PNS; MB not included in PNS, data unavailable
PNS: BC age groups = 19-30, 31-70, 71-84 years; AB, NL age groups = 19-30, 31-50, 51-70, 71-74 years
PNS Folate, µg = NS, QC, SK, AB, PE, NL, NB and Folate DFE = ON, BC
DFE (dietary folate equivalents), 1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
RE = retinol equivalents: 1µg retinol = 6µg β-carotene (10 IU) = 12µg other carotenes (3.33 IU)
NE = niacin equivalents: 1NE = 1mg niacin = 60mg tryptophan
kcal = kilocalorie; g = gram; mg = milligram; µg = microgram; IU = international units; y = years

Table E3. Comparison of estimated national mean nutrient intake from food between the NCS and the PNS for adult Canadian females by age[1]

	NCS 20-39y n = 1347	PNS 18-34y n = 2482	NCS 40-64y n = 1500	PNS 35-64y n = 4852	NCS 65+y n = 818	PNS 65-74y n = 1527
Energy, kcal	2000	1900	1730	1680	1530	1540
Protein, g	72	73	63	69	54	64
Carbohydrate, g	227	250	197	217	187	206
Total fat, g	89	67	75	59	63	52
Dietary Fibre, mg[2]	3.2	13.3	3.4	15.2	3.3	16.3
Calcium, mg	709	794	613	699	619	638
Iron, mg	12.0	13.1	11.0	12.3	10.0	12.0
Vitamin A, RE	1290	1030	1030	1180	1010	1240
Thiamin, mg	1.02	1.52	0.90	1.40	0.85	1.33
Niacin, NE	28.0	32.3	25.0	31.4	21.0	29.4
Riboflavin, mg	1.70	1.71	1.49	1.59	1.47	1.43
Folate, µg	146	194	148	196	130	182
Folate, DFE		417		381		365
Vitamin C, mg	89	108	106	112	87	110

Values rounded to no more than 3 significant digits
[1] PNS data is the population weighted values for n un-weighted provincial subject numbers
PNS age groups 35-49 years and 50-64 years averaged for ease of comparison to NCS
[2] NC terminology was fibre not dietary fibre
NCS did not report folate in DFE units

Table E4. Comparison of the estimated national distribution (%) of energy between the NCS and the PNS for adult Canadian females by age

	NCS 20-39y	PNS 18-34y	NCS 40-64y	PNS 35-64y	NCS 65+y	PNS 65-74y
Protein	14.4	15.3	14.6	16.4	14.1	16.8
Carbohydrate	45.4	52.6	45.7	51.7	48.9	53.5
Fat	40.0	31.9	39.1	31.7	37.1	30.5

Derived from data in Table D3 using Atwater factors
AB data unpublished used by permission in PNS; MB not included in PNS, data unavailable
PNS: BC age groups = 19-30, 31-70, 71-84 years; AB, NL age groups = 19-30, 31-50, 51-70, 71-74 years
PNS Folate, µg = NS, QC, SK, AB, PE, NL, NB and Folate DFE = ON, BC
DFE (dietary folate equivalents), 1 DFE = 1µg food folate = 0.6µg folic acid fortified food or supplement taken with food = 0.5µg supplement taken on empty stomach
RE = retinol equivalents: 1µg retinol = 6µg β-carotene (10 IU) = 12µg other carotenes (3.33 IU)
NE = niacin equivalents: 1NE = 1mg niacin = 60mg tryptophan
kcal = kilocalorie; g = gram; mg = milligram; µg = microgram; IU = international units; y = years

Appendix F

Reported Regional Mean Nutrient Intake from the NCS

Table F1. Reported regional mean nutrient intake of males and females age 20 to 39 years from the 1970/72 NCS

	Atlantic	QC	ON	Prairies	BC
			Males 20-39 years		
Energy, kcal	3270	3460	3440	3350	3070
Protein, g	115	114	126	124	109
Carbohydrate, g	351	373	349	337	324
Fat, g	147	158	158	155	135
Fibre, g	4.37	4.25	4.94	4.84	4.43
Calcium, mg	1220	920	1110	1190	1140
Iron, mg	16.0	18.0	19.0	19.0	18.0
Vitamin A, RE	1660	1340	1470	2150	1360
Thiamine, mg	1.48	1.60	1.56	1.67	1.42
Niacin, NE	44	46	51	51	44
Riboflavin, mg	2.67	2.38	2.57	2.95	2.60
Folate, µg	200	219	228	226	211
Vitamin C, mg	112	127	119	114	106
			Females 20-39 years		
Energy, kcal	1910	2200	1950	1950	1760
Protein, g	70	74	72	75	67
Carbohydrate, g	219	261	218	207	198
Fat, g	84	97	88	88	77
Fibre, g	3.21	3.79	2.81	3.19	3.03
Calcium, mg	713	629	745	788	676
Iron, mg	12.0	13.0	11.0	12.0	11.0
Vitamin A, RE	1540	1180	1450	1130	1040
Thiamine, mg	0.96	1.08	0.99	1.05	0.92
Niacin, NE	27	29	28	30	26
Riboflavin, mg	1.70	1.64	1.77	1.75	1.56
Folate, µg	142	153	144	145	142
Vitamin C, mg	79	100	86	90	78

Data taken from 1975 NCS report (Department of National Health and Welfare, 1975)
Values rounded to no more than 3 significant digits
NC terminology was fibre not dietary fibre
RE = retinol equivalents: 1µg retinol = 10 IU β-carotene = 3.33 IU other pre-formed vitamin A
NE = niacin equivalents: 1NE = 1mg niacin = 60mg tryptophan
Folate = food folate (total)
kcal = kilocalorie; g = gram; mg = milligram; µg = microgram; IU = international units
Atlantic = NL, PE, NS, NB; Prairies = AB, SK, MB

Table F2. Reported regional mean nutrient intake of males and females age 40 to 64 years from the 1970/72 NCS

	Atlantic	QC	ON	Prairies	BC
			Males 40-64 years		
Energy, kcal	2910	2770	2510	2750	2590
Protein, g	99	95	91	98	95
Carbohydrate, g	306	314	264	281	269
Fat, g	134	118	109	129	116
Fibre, g	4.63	4.26	3.89	4.33	4.06
Calcium, mg	919	862	896	861	905
Iron, mg	16.0	16.0	15.0	17.0	16.0
Vitamin A, RE	1310	1310	1240	1190	1890
Thiamine, mg	1.39	1.39	1.20	1.45	1.20
Niacin, NE	39	38	35	40	38
Riboflavin, mg	2.18	2.06	1.98	2.23	2.17
Folate, µg	188	179	184	181	186
Vitamin C, mg	95	108	110	80	98
			Females 40-64 years		
Energy, kcal	1720	1810	1730	1550	1740
Protein, g	60	62	67	57	68
Carbohydrate, g	198	221	189	174	198
Fat, g	77	77	77	68	76
Fibre, g	3.24	3.55	3.21	3.21	3.79
Calcium, mg	584	542	671	556	709
Iron, mg	11.0	12.0	12.0	11.0	12.0
Vitamin A, RE	866	1380	830	945	1060
Thiamine, mg	0.85	0.92	0.91	0.81	0.97
Niacin, NE	23	25	26	23	28
Riboflavin, mg	1.37	1.44	1.58	1.32	1.68
Folate, µg	122	163	150	126	154
Vitamin C, mg	76	136	103	80	100

Data taken from 1975 NCS report (Department of National Health and Welfare, 1975)
Values rounded to no more than 3 significant digits
NC terminology was fibre not dietary fibre
RE = retinol equivalents: 1 µg retinol = 10 IU β-carotene = 3.33 IU other pre-formed vitamin A
NE = niacin equivalents: 1NE = 1mg niacin = 60mg tryptophan
Folate = food folate (total)
kcal = kilocalorie; g = gram; mg = milligram; µg = microgram; IU = international units
Atlantic = NL, PE, NS, NB; Prairies = AB, SK, MB

Table F3. Reported regional mean nutrient intake of males and females age 65+ years from the 1970/72 NCS

	Atlantic	QC	ON	Prairies	BC
			Males 65+ years		
Energy, kcal	2120	2250	1920	2100	1930
Protein, g	73	73	74	70	71
Carbohydrate, g	257	258	209	247	227
Fat, g	89	98	85	92	80
Fibre, g	4.24	3.64	3.82	3.86	4.07
Calcium, mg	781	645	695	725	789
Iron, mg	15.0	13.0	12.0	14.0	13.0
Vitamin A, RE	1100	1220	977	1290	1020
Thiamine, mg	1.09	1.15	1.02	1.12	1.07
Niacin, NE	27	30	27	28	28
Riboflavin, mg	1.80	1.85	1.70	1.73	1.80
Folate, µg	159	143	148	156	159
Vitamin C, mg	100	79	88	74	98
			Females 65+ years		
Energy, kcal	1510	1670	1520	1450	1420
Protein, g	49	54	57	52	54
Carbohydrate, g	194	205	185	175	173
Fat, g	62	70	61	62	58
Fibre, g	3.19	3.09	3.51	3.02	3.53
Calcium, mg	612	557	682	547	641
Iron, mg	10.0	10.0	10.0	10.0	10.0
Vitamin A, RE	849	962	1110	1100	772
Thiamine, mg	0.83	0.90	0.88	0.77	0.83
Niacin, NE	18	22	22	20	20
Riboflavin, mg	1.37	1.34	1.65	1.33	1.39
Folate, µg	121	129	135	123	131
Vitamin C, mg	84	93	91	72	83

Data taken from 1975 NCS report (Department of National Health and Welfare, 1975)
Values rounded to no more than 3 significant digits
NC terminology was fibre not dietary fibre
RE = retinol equivalents: 1 µg retinol = 10 IU β-carotene = 3.33 IU other pre-formed vitamin A
NE = niacin equivalents: 1NE = 1mg niacin = 60mg tryptophan
Folate = food folate (total)
kcal = kilocalorie; g = gram; mg = milligram; µg = microgram; international units
Atlantic = NL, PE, NS, NB; Prairies = AB, SK, MB

Appendix G

Canada's Food Guides From 1961 to 1992

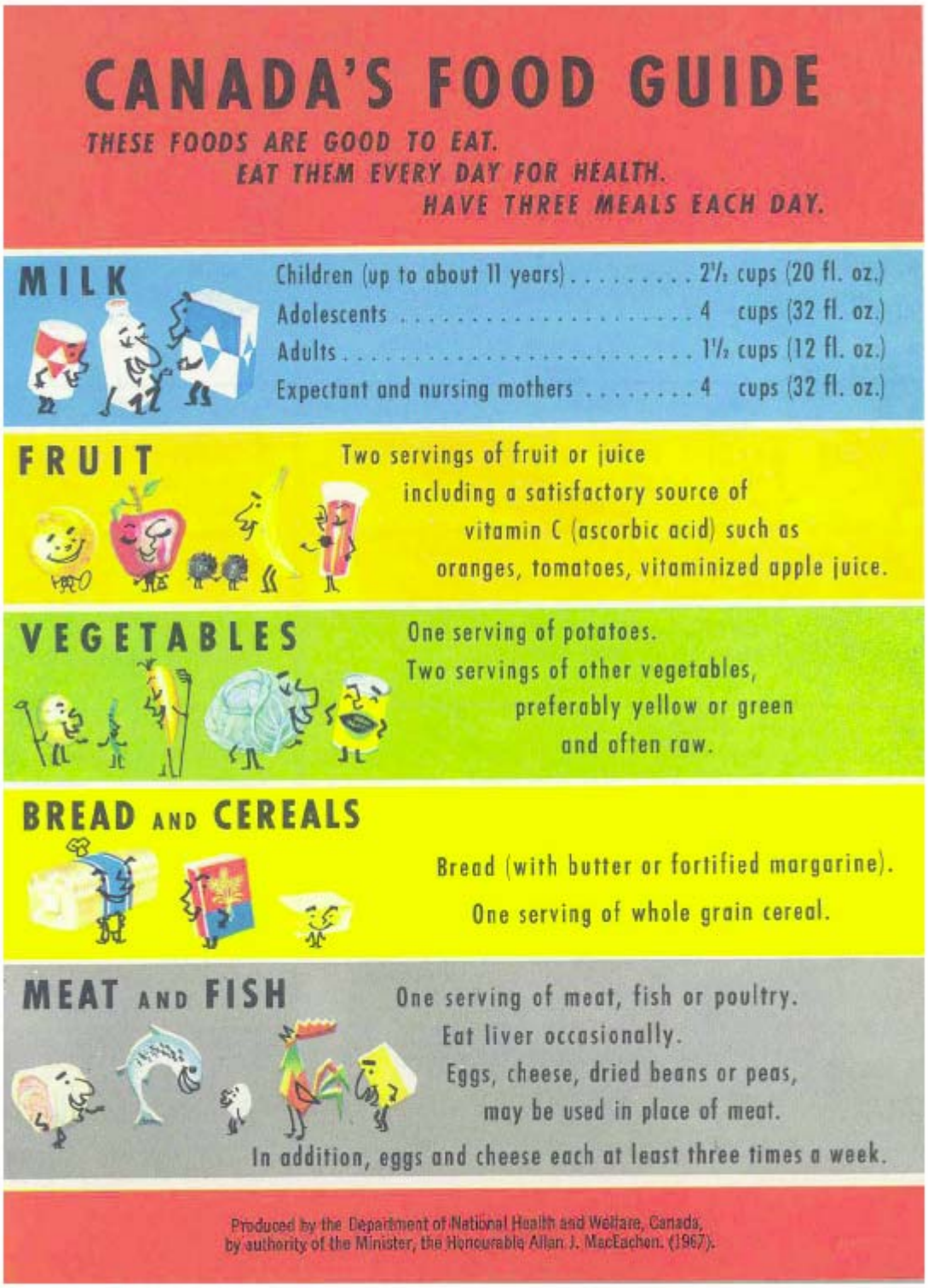

Figure G.1. Canada's Food Guide 1961. Taken from Canada's Food Guides From 1942 to 1992. Health Canada, 2002.

Figure G.2. Canada's Food Guide 1977. Taken from Canada's Food Guides From 1942 to 1992. Health Canada, 2002.

Figure G.3. Canada's Food Guide 1982. Taken from Canada's Food Guides From 1942 to 1992. Health Canada, 2002

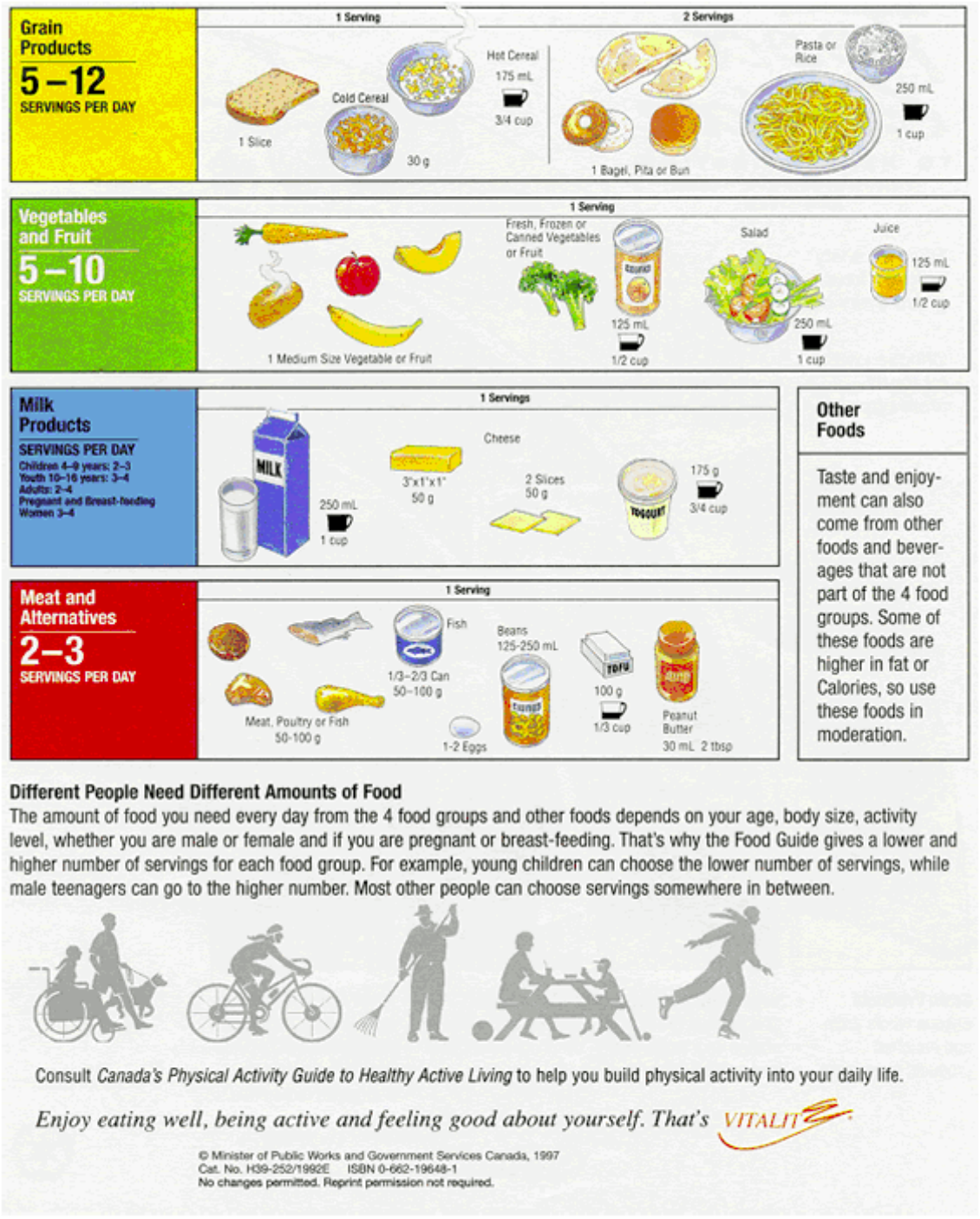

Figure G.4. Canada's Food Guide to Healthy Eating 1992. Taken from Canada's Food Guides From 1942 to 1992. Health Canada, 2002.