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Reference Guide to Understanding and Using the Data

2015 Canadian Community Health Survey—Nutrition

June 2017

Canada

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FOREWORD

The Bureau of Food Surveillance and Science Integration (BFSSI), Health Canada is pleased to release the *2015 Canadian Community Health Survey—Nutrition: A Reference Guide to Understanding and Using the Data.* Given the complexity of these data, providing this Guide will promote appropriate use of the data as well as consistent reporting of survey findings.

This document will be of value to researchers and graduate students, policy makers, public health professionals, epidemiologists, educators, students, dietitians, the food industry and the health media. Considering the diversity of the intended audience, this reference guide describes the type of information gathered in the survey, the data collection instruments and methodology and, more importantly, resources and guidance required in the interpretation of the data.

The 2015 Canadian Community Health Survey (CCHS)—Nutrition marks the second national nutrition survey of the 21st century, with the first being conducted in 2004. Like the precedent survey, it is a rich source of detailed information about food and nutrient intakes of the Canadian population aged 1 year and older, including food consumption and dietary supplements; physical (anthropometric) measurements on body weight and height; and other health-related modules that support the interpretation of the 24-hour recalls. As well, resource documents are available from Statistics Canada for those planning to undertake their own analysis of the data.

We are grateful to Dr. Susan Barr, Professor of Nutrition at the University of British Columbia, who served as lead writer, with guidance from Health Canada and Public Health Agency of Canada staff on the development of the content. We appreciate the valuable assistance from Statistics Canada who contributed as reviewers to ensure accuracy of survey specific information.

We look forward to the knowledge translation that will take place over the coming years as a result of using the 2015 CCHS-Nutrition.

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
AI	Adequate Intake
AMDR	Acceptable Macronutrient Distribution Range
AMPM	Automated Multiple-Pass Method
BMI	Body Mass Index (kg/m^2)
BMR	Basal Metabolic Rate
CANSIM	Canadian Socio-economic Information Management
CCHS	Canadian Community Health Survey
CI	Confidence Interval
CNF	Canadian Nutrient File
CFG	Canada's Food Guide
cm	centimetre
CSFII	Continuing Survey of Food Intake by Individuals
CV	Coefficient of Variation
d	day
DA	Dissemination Area
DHA	Docosahexaenoic Acid
DLI	Data Liberation Initiative
DRI	Dietary Reference Intake
EAR	Estimated Average Requirement
EER	Estimated Energy Requirement
EPA	Eicosapentaenoic Acid
FGS	Food Guide Servings
FNDDS	Food and Nutrient Database for Dietary Studies
g	gram
HEI	Healthy Eating Index
hr	hour
ht	height
INMD	Institute of Nutrition, Metabolism, and Diabetes
IOM	Institute of Medicine
IOTF	International Obesity Task Force
ISU	Iowa State University
IU	International Units
kcal	kilocalories
kg	kilogram

Abbreviation	Meaning
LOAEL	Lowest-Observed-Adverse-Effect-Level
m	metre
µg	microgram
mg	milligram
ml	millilitre
NCI	National Cancer Institute
NHANES	National Health and Nutrition Examination Survey
NOAEL	No-Observed-Adverse-Effect-Level
NPN	Natural Product Number
PA	Physical Activity Coefficient
PAL	Physical Activity Level
PEI	Prince Edward Island
PUMF	Public Use Microdata File
RAE	Retinol Activity Equivalents
RDA	Recommended Dietary Allowance
RNI	Recommended Nutrient Intake
RTRA	Real Time Remote Access
SD	Standard Deviation
SE	Standard Error
SIDE	Software for Intake Distribution Estimation
UF	Uncertainty Factor
UL	Tolerable Upper Intake Level
US	United States
USDA	United States Department of Agriculture
WHO	World Health Organization

LIST OF APPENDICES


1. INTRODUCTION TO THE 2015 CANADIAN COMMUNITY HEALTH SURVEY—NUTRITION

The 2015 Canadian Community Health Survey—Nutrition (2015 CCHS-Nutrition) is a nationally-representative survey of the nutrition of people in Canada. The survey provides a rich source of detailed information on food consumption using a 24-hour (hr) dietary recall for the total sample and a repeat sub-sample, nutrient supplement intake, physical measurements, household food insecurity, and other topics that support the interpretation of the 24-hr recall. It also allows the evaluation of changes that have occurred since this survey was last done in 2004. Development and implementation of the 2015 CCHS-Nutrition has been a joint initiative between Health Canada and Statistics Canada, as also occurred for the 2004 CCHS-Nutrition. To facilitate comparison, the 2015 survey used methods that were very similar to the 2004 survey.

This Reference Guide is a revised and updated version of a document published by Health Canada following the 2004 CCHS-Nutrition (Health Canada, 2006). Like its predecessor, the purpose of this Guide is to ensure that the data from the 2015 CCHS-Nutrition are used appropriately, by increasing users' understanding of the nature of the data and the main considerations relevant to their interpretation and use. It aims to help users understand the context in which the data were obtained, what the results do and do not mean, limitations of the data, and considerations regarding comparing findings between the 2004 and 2015 surveys. The guide is directed to anyone wanting to understand and use the 2015 CCHS-Nutrition data, including those who want to use the data summaries (e.g. tables) released by organizations such as Statistics Canada and/or Health Canada, as well as those interested in conducting primary analyses using the data. Target audiences thus include researchers and graduate students, policy makers, public health professionals, epidemiologists, educators, students, dietitians, food industry, and the health media. Because of the diverse target audiences, background information that may be familiar to some readers is included.

Individuals planning to analyze 2015 CCHS-Nutrition are one of the potential audiences for this Reference Guide, and may find it helpful in learning about the survey and the nature of the data. However, it is not intended to provide guidance on how analyses should be conducted. Upon request, Statistics Canada provides supportive documentation for these users, including data dictionaries, specifications of derived variables, and a user guide. General information about the survey can be accessed through the Statistics Canada website on the 2015 Canadian Community Health Survey–Nutrition (CCHS-Nutrition). For more information, contact Client Services, Health Statistics Division, Statistics Canada at 613-951-1746 or by e-mail at STATCAN.hd-ds.STATCAN@canada.ca.

The remainder of this chapter provides an overview of the CCHS program, and more specifically, of 2015 CCHS-Nutrition. Chapter 2 introduces the Dietary Reference Intakes (DRIs), which were used as reference standards for 2015 CCHS-Nutrition, and describes how they can be used in interpreting data from 24-hr recalls. It also discusses issues related to the accuracy of 24-hr recall data that are critical to the interpretation of survey results, and includes a discussion on assessing 24-hr recall data relative to the dietary guidance of Canada's Food Guide. Chapter 3 provides information on the 2015 CCHS-Nutrition data, including a description of the primary data files and how they can be accessed (for those wishing to conduct their own analyses). It also describes how Health Canada, Statistics Canada and the Public Health Agency of Canada will use and disseminate the data. Chapter 4 describes other surveys or data sources that might be compared to the 2015 CCHS-Nutrition (with a focus on the 2004 CCHS-Nutrition), and outlines issues that should be considered in making these comparisons. Finally, Chapter 5 presents brief conclusions. A glossary of terms is provided in **Appendix 1**.

1.1 Overview of the CCHS and CCHS-Nutrition

1.1.1 WHAT IS THE CCHS?

The CCHS program consists of a series of cross-sectional surveys that was initiated in the year 2000, with a main objective of providing timely information on Canadians' health determinants, health status and health system utilization. It stems from a partnership among Health Canada, the Canadian Institute for Health Information, and Statistics Canada. Initially, the CCHS had a 2-year data collection cycle that consisted of two distinct surveys; the first year (cycle X.1, now referred to as the CCHS-Annual Component) was a general health survey that included a sample of approximately 130,000 Canadians, large enough to allow data to be presented at the level of health regions within each of the 10 provinces and 3 territories. The second year of the data collection cycle (cycle X.2) focused on a specific subject matter or population (e.g., mental health, aging, nutrition), had a total sample of approximately 30,000 individuals, and allowed provincial-level estimates.

Beginning in 2007, data for the CCHS-Annual Component survey began to be collected annually instead of every second year, and the sample size was changed to 65,000 per year. This survey, now referred to as the CCHS-Annual Component, is designed to take about 45 minutes to complete. Among other topics, it includes content modules related to nutrition (e.g., food insecurity, food choices, fruit and vegetable consumption, and maternal experiences). Content modules are designated as "core content", "theme content", "optional content" and "rapid response content". Both the core and theme content modules are determined through a consultative process with Health Canada and the Public Health Agency of Canada, and are asked of all respondents. However, the core content remains stable over time, while theme content is included for one or two years and varies from year to year. Optional content modules are chosen by provincial and territorial stakeholders in coordination with the health regions, and are only included in the provinces or territories that choose the module. Finally, the rapid response option is available on a cost-recovery basis, allowing national estimates on emerging or specific issues related to population health. Rapid response modules are asked of all respondents living in the 10 provinces over a three-month period (about 15,000 respondents). This option has become a successful vehicle that is used by Health Canada and the Public Health Agency of Canada as well as by external clients. Two nutrition-related examples include a module on the "awareness and usage of Canada's Food Guide" (completed in 2012) and two modules on food skills (completed in 2012 and 2013). Additional information about the CCHS-Annual Component is available.

The first CCHS-Nutrition was conducted in 2004, and at the time was referred to as Cycle 2.2. These "focused" (X.2) surveys moved to every three years and as of 2016, going forward, will be conducted on an occasional basis: for example, CCHS-Healthy Aging took place in 2008–09, CCHS-Mental Health (first conducted in 2002) was repeated in 2012, and the second iteration of CCHS-Nutrition was conducted in 2015.

1.1.2 WHAT IS THE 2015 CCHS-NUTRITION AND WHAT WERE ITS OBJECTIVES?

An overview of the 2015 CCHS-Nutrition is provided below; detailed information (including a link to the questionnaire) is available on Statistics Canada's website.

The over-arching goal of the 2015 CCHS-Nutrition is to provide reliable, timely information about dietary intake, nutritional well-being and their key determinants, with the purpose of informing and guiding programs, policies and activities of federal and provincial governments. The specific objectives of the 2015 CCHS-Nutrition were to:

- Collect detailed data on the consumption of foods and dietary supplements among a representative sample of Canadians at national and provincial levels.
- Estimate the distribution of usual dietary intake in terms of nutrients from foods, food groups, dietary supplements and eating patterns.
- Gather anthropometric (physical) measurements for accurate body weight and height assessment to interpret dietary intake.
- Support the interpretation and analysis of dietary intake data by collecting data on selected health conditions and socio-economic and demographic characteristics.
- Evaluate changes in dietary intake from the 2004 CCHS-Nutrition.

The 2015 CCHS-Nutrition provides important information on food habits, nutrient intakes, and relative weight status (assessed by body mass index) of Canadians. However, because the nutrient intake data are calculated from self-reported food and beverages consumed by respondents and the survey did not include biochemical measures, clinical assessment, or in-depth anthropometry, the results do not directly reflect Canadians' nutritional status. The Canadian Health Measures Survey (CHMS), which was initiated in 2007, collects direct physical measures (e.g., blood pressure, physical fitness, height and weight, physical activity) and biochemical measures (from blood and urine samples) from approximately 5,000 randomly selected Canadians over two-year periods. It complements the data on dietary intakes obtained in the CCHS-Nutrition by providing information on nutritional status for selected nutrients (e.g., folate, vitamin D, vitamin C, vitamin B_{12}, iron, iodine), which vary from one period to the next. More information on the CHMS is available in Section 4.4 and on the CHMS website.

1.1.3 WHO WAS INCLUDED IN THE 2015 CCHS-NUTRITION?

The target population for the 2015 CCHS-Nutrition included all individuals aged 1 year and above living in private dwellings in the 10 Canadian provinces, with a desired completed sample size of 24,000 respondents. The survey included strategies to ensure that a minimum number of individuals was sampled in each of 12 age-sex groups: 1 to 3 years (sexes combined), 4 to 8 years (sexes combined), and males and females separately for ages 9 to 13 years, 14 to 18 years, 19 to 50 years, 51 to 70 years, and ≥71 years. These age groups correspond to age ranges for which Dietary Reference Intakes (DRIs) have been established. The target population did not include individuals who were full-time members of the Canadian Forces or who lived in the Territories, on reserves and other Aboriginal settlements, in some remote areas, or in institutions (e.g., prisons or care facilities).

A minimum of 80 respondents in each DRI age-sex group was allocated to each province and the remainder were assigned among the provinces using a power allocation technique, based on the population in each province. Further information on sample size and allocation is available in Chapter 4 of Statistics Canada's *2015 CCHS-Nutrition User Guide* (which is available from Statistics Canada upon request. Within provinces, the sample was proportionally allocated to rural and urban strata based on the number of dwellings in each stratum. No provinces or specific population groups were oversampled.

Table 1.1 shows the actual sample size and the response rate by province. (Detailed information about response rates is found in Chapter 10 of Statistics Canada's *2015 CCHS-Nutrition User Guide*.) In total, 20,487 individuals took part in the survey, and the response rate was 61.6%.

Table 1.1 Sample size and response rate for the 2015 CCHS-Nutrition by province and for Canada

Province	# of Respondents	Response rate (%)
Newfoundland and Labrador	1,306	67.3
Prince Edward Island	1,183	68.3
Nova Scotia	1,498	66.6
New Brunswick	1,322	67.6
Quebec	3,204	63.0
Ontario	4,229	55.0
Manitoba	1,408	60.5
Saskatchewan	1,475	64.0
Alberta	2,266	59.7
British Columbia	2,596	62.2
CANADA	20,487	61.6

1.1.4 HOW WAS THE SURVEY CARRIED OUT?

1.1.4.1 Sampling Frame. A complete description of the sampling frame used for the 2015 CCHS-Nutrition is provided in Chapter 4 of Statistics Canada's *2015 CCHS-Nutrition User Guide*. Briefly, the sampling frame consisted of "clusters" which were created from Census Dissemination Areas (DAs). All of Canada is divided into DAs, which typically include 400 to 700 people. As necessary, neighbouring DAs were combined to form clusters with at least 200 dwellings, within a land area that was not extremely large.

The sampling strategy was designed to provide a sample that represents the population in terms of age, sex, geography, and socioeconomic status. To achieve this, a three-stage sampling design was used to select the sample of respondents in all provinces except Prince Edward Island (PEI). In the first stage, clusters were selected in each province (this stage was not included to select the PEI sample, where all clusters were included). To ensure that seasonality was taken into account, the selected clusters were allocated to one of the six two-month data collection periods. This meant that there was an even distribution of the sample throughout the year, as well as an even representation of rural and urban clusters throughout the year. In the second stage, households were selected from each of the selected clusters (whereas in PEI, households were selected from all clusters). In the third stage, selected households were visited and a list of household members was created. One household member was randomly selected to respond to the survey from eligible members of the household, using selection probabilities that varied by age to achieve targeted sample sizes. For example, since the Canadian population has fewer children aged 1 to 3 years than adult women aged 19 to 50 years, in a household that included both a 1 to 3 year old child and a 19 to 50 year old woman, the probability of being selected would be higher for the child than for the woman.

1.1.4.2 Contacting Participants. Once households had been identified to take part in the 2015 CCHS-Nutrition, an introductory letter and a brochure describing the study were sent to the household. A trained Statistics Canada interviewer made an initial contact (in person or by phone) with the dwelling and obtained basic demographic information on all residents. At this time, a household member aged 1 year or above was selected from eligible household members to participate in the survey, as described above. If the initial contact was in person and the selected respondent was available, the interview was conducted immediately; otherwise, it was rescheduled for a later time.

1.1.4.3 Conducting the Interview. All interviews were computer-assisted, and were conducted between January 2, 2015 and December 31, 2015 on all days of the week, including weekend days. In most cases, primary interviews were conducted in person, and were completed in participants' homes. For children aged 1 to 5 years, the interview was conducted with a parent or guardian only (i.e., it was a "proxy interview"), although children aged 2 years or above who were available at the time of the interview were measured for height and weight. For those aged 6 to 11 years, both the respondent and a parent or guardian participated, whereas respondents aged 12 years or above were interviewed on their own. Proxy interviews were conducted for respondents aged 6 years and above only if the mental or physical health of the selected respondent made it impossible to complete the interview. As described below (Section 1.2), the interview included both a 24-hr diet recall as well as questions that would support interpretation of the data from the 24-hr recall. Although respondents were aware that the interview was about nutrition, they were not informed ahead of time that a 24-hr recall would be conducted.

During the first interview, a random subset of individuals (about 35% of the total sample) was invited to take part in a second interview approximately 3 to 10 days after the first interview, on a different day of the week. This second interview was conducted by telephone and included only a 24-hr recall and questions about nutrition supplements. At the end of the first recall interview, interviewers left a *Food Model Booklet* with the selected individuals in order to facilitate the collection of data on food sizes during the second recall telephone interview. The data from the second recall were used to adjust food and nutrient intake for within-person variability, so that distributions of usual intake, reflecting only between-person variability, could be produced (see section 2.2.2). Previous research has shown that 24-hr recalls obtained using methodology similar to the CCHS-Nutrition yield similar results whether conducted in person or by telephone (Godwin, Chambers, & Cleveland, 2004; Brustad, Skeie, Braaten, Slimani, & Lund, 2003; Tran, Johnson, Soultanakis, & Matthews, 2000). This issue was also examined using data from 2004 CCHS-Nutrition, and was found not to make a notable impact on the estimation of the usual intake distribution (Hayward, 2006).

1.1.4.4 Addressing the Potential for Non-Response Bias. One of the important features of the 2015 CCHS-Nutrition is that it is designed to be a representative population survey. However, if the response rate to a population survey is low, the survey results may not accurately represent the population. This is termed non-response bias, and occurs when characteristics of those who choose to take part in the survey differ systematically from those who choose not to participate. For example, individuals who take part in a nutrition survey might be more interested in nutrition than those who do not participate, and might have better dietary intakes and health behaviours. If this occurred, and particularly if the survey response rate was low, survey results could show more favourable nutrient intakes and health behaviours than would actually exist in the population as a whole. As an example, the prevalence of smoking in a nutrition survey with a low response rate might be reported as 9%, whereas data from another survey (perhaps on another topic) with a higher response rate might reveal a smoking prevalence of 13%.

Response rates in national surveys have been declining over time: For example, the response rate for the CCHS-Annual Component decreased from ~85% in 2001 (Statistics Canada, 2003) to ~60% in 2015 (Statistics Canada, 2017). Possible contributing factors include fewer households with landlines, the availability of call display, general distrust of government, and too many telemarketing calls. Several procedures were used in the 2015 CCHS-Nutrition to obtain as high a response rate as possible. Interviewers were asked to make a number of attempts to contact selected households through personal visits or phone calls. If no one was at home during the initial visit, subsequent visits or calls were made at different times of the day and on different days of the week. Those who initially declined participation received follow-up from a senior interviewer or area supervisor, indicating the importance of their participation and requesting that they take part. If the respondent did not speak English or French, an attempt was made to schedule an interview with an interviewer who could speak the respondent's language. If this was not possible, the interviewer tried to get someone in the household to translate the interview and responses for the participating individual.

When non-response occurs, its impact can be partially mitigated through use of a non-response adjustment that is applied to the survey weights, and this was done in the CCHS-Nutrition. (Survey weights are factors assigned to respondents that specify the 'weight' of responses from a given respondent when the data are analyzed at a population level. Applying survey weights makes the sample representative of the population in terms of socio-demographic characteristics such as sex, age, education, geography, etc.)

1.2 Survey Components and Modules

1.2.1 OVERVIEW OF 2015 CCHS-NUTRITION COMPONENTS AND MODULES

The components and modules included in the 2015 CCHS-Nutrition questionnaire are shown in Table 1.2 (a summary of the 24-hour recall component and the entire questionnaire for the Health component are available online).

The questionnaire focused on obtaining detailed information about the intake of foods, beverages and nutritional supplements (using the '24-hr recall' and 'nutrition supplements' modules). In addition, data were collected to assist in the interpretation of the food/nutrient intake data. For example, certain characteristics (such as smoking status and whether or not a woman has reached menopause) affect requirements for some nutrients. In other cases, it is helpful to understand whether food intake varies among those with differing lifestyle and demographic characteristics (such as different levels of physical activity, body weight status, education, food security, etc.). Information on these characteristics was collected using questions from modules used in the 2004 CCHS-Nutrition. In some cases, the modules used in the 2015 CCHS-Nutrition were modified or abbreviated from the modules used in the earlier survey, or replaced with the shortest standardized ("harmonized") content and concepts for use in all social surveys at Statistics Canada (e.g. Aboriginal group). This meant that the length of the questionnaire could be shorter, while still obtaining the information required to interpret the nutrition data and compare the data with the 2004 CCHS-Nutrition. Key differences between the 2015 and 2004 CCHS-Nutrition surveys are highlighted in Section 4.2 of this document.

Table 1.2 2015 CCHS-Nutrition survey components and modules

Entry Component
• Dwelling information
• Household roster
• Relationship matrix
24-hour Dietary Recall Component
• 24-hr recall by Automated Multiple-Pass Method (AMPM; all respondents)
• AMPM trailing questions (all respondents)
Health Component
• Nutritional supplements (all respondents)
• General health (age ≥12 years)
• Measured height and weight (age ≥2 years)
• Self-reported height and weight (age ≥2 years who could not be measured)
• Adult physical activities (age ≥18 years)
• Physical activity of children and youth (age 6 - 17 years)
• Women's health (females, age ≥9 years)
• Chronic conditions (age ≥19 years)
• Smoking (age ≥12 years)
• Socio-demographic characteristics (all respondents)
• Labour market activities (age 15 to 75 years)
• Food Security (person most knowledgeable about household ≥18 years)
• Income (person most knowledgeable about household ≥18 years) • Administration and data sharing (all respondents)
Exit Component
• Re-contact information
• Thank-you

1.2.2 ENTRY COMPONENT

At the initial contact, the interviewer confirmed information about the dwelling and the address, including the postal code of the dwelling. In addition, a listing was obtained of all individuals who usually lived in the household and their relationships to one another (e.g. mother, brother, daughter-in-law). The interviewer obtained information on each household member's age, sex, marital status, and highest level of education completed, and also ascertained the type of dwelling. One household member was randomly selected to be the survey respondent.

1.2.3 24-HR RECALL DIETARY RECALL COMPONENT

1.2.3.1 Automated Multiple-Pass Method (AMPM) 24-Hr Recall. The 24-hr dietary recall was the first component of the 2015 CCHS-Nutrition for individuals selected as survey respondents. The method for the 24-hr recall was based on the United States Department of Agriculture (USDA) Automated Multiple-Pass Method (AMPM). The AMPM is an automated questionnaire that guides the interviewer through a system designed to maximize respondents' opportunities for remembering and reporting foods eaten in the previous 24 hours.

The five steps in the AMPM, as they occurred in the 2015 CCHS-Nutrition, are:

1. Quick List. This step is designed to get a quick collection of easily-remembered foods, including snacks and water. The respondent reports all foods and beverages consumed in the 24 hour period during the day before the interview in any order he/she wishes (without being interrupted by the interviewer). That is, the respondent is free of the burden of reporting the foods in a chronological order, so his/her mind can be free to reflect on the foods actually eaten.
2. Forgotten Foods. This step is designed to collect foods that may have been forgotten during the "Quick List" step. The respondent answers a series of questions probing for commonly-forgotten foods from various categories: non-alcoholic and alcoholic beverages, sweets, savoury snacks, fruits, vegetables, cheese, bread and rolls, and any other types of foods.
3. Time and Occasion. The respondent reports the time he/she began eating or drinking each of the reported food items, as well as what he/she would call the eating occasion (e.g. breakfast, snack, dinner) for this food. These questions are designed to help the respondent remember and report his/her eating patterns over the 24-hour period of the previous day, as well as to group together the foods and beverages consumed at the same time.
4. Detail Cycle. This step obtains specific details about each food and beverage reported in the previous steps. Different questions are asked depending on the type of food reported (e.g., pizza versus a piece of toast), and include probes for food descriptions (for example, "was the toast at breakfast white, wheat, whole wheat, multigrain, rye, pumpernickel, multigrain or something else?"), food amounts ("how many slices of toast did you eat, and what was the size of the slice?"), additions to the foods ("did you have anything on the toast, such as margarine, jam, peanut butter or something else?"), and preparation methods ("was your fish fried, baked, broiled, sautéed, steamed, raw or something else?"). For some foods (and most mixed dishes), information was obtained on whether the food was home-made, obtained from a restaurant, frozen, prepared from a mix, or something else. A *Food Model Booklet* with pictures of various sizes of glasses, mugs, bowls, mounds/pats/spreads and circles is used to help respondents describe the size or amount of food consumed. It also includes a grid, two wedges, and a page of shapes and chicken pieces. A review of eating occasions and times between occasions is also included in this step to elicit any additional forgotten foods. Once information about the eating occasion is complete, the respondent is asked where the meal or snack was eaten (at home or in other locations). This part of the application flows in a chronological order.
5. Final Review. The final step is included to collect additional foods that may have been consumed, but not remembered or mentioned earlier during the interview.

The following modifications of the USDA AMPM for the 2004 CCHS-Nutrition were also applied to the 2015 CCHS-Nutrition: reviewing the food categories to reflect the Canadian food supply, incorporating metric measures, and translating new elements of the tool into French. Step 4 of the AMPM was also modified: the USDA method asks where each food item or beverage in a given eating occasion (meal or snack) was obtained and whether it was eaten at home or not. In preliminary testing for the 2004 survey, respondents found these questions to be too repetitive, so they were not included in the final interview. Instead, respondents in 2004 were asked where the meal or snack was prepared, but some respondents may have provided information about the location where they consumed their food. For 2015, respondents were asked directly where the meal or snack (i.e., all foods and/or beverages consumed at a single eating occasion) was consumed. The list of eating locations included: at home; someone else's home; restaurant with waiters/waitresses; fast-food/pizza restaurant; restaurant with no additional information; bar/tavern/lounge; grocery store, corner store or other type of store; school cafeteria; cafeteria other than a school cafeteria; child care centre; adult/family care centre; sports or entertainment venue; work (excluding work cafeteria); school (excluding school cafeteria); car or other vehicle; and other (to be specified by the respondent).

Additional modifications for the 2015 survey included a major review to: 1) update the food categories to reflect the Canadian food supply; 2) standardize the display of food size units and related codes on the interviewers' computer screen; 3) add food-specific limits to the selection of food units (e.g. an ear of corn, but not an ear of broccoli); 4) include food-specific limits that may be triggered during the interview and prompt the interviewer to confirm the amount with the respondent if the number of items of a food seemed too small or too large for the unit (e.g. "8" with "cans of beer" consumed in one occasion); and 5) identify some supplemented foods (energy drinks, fortified juices, vitamin waters, sport drinks, chocolate syrup with added nutrients, energy/protein bars, and meal replacement bars and shakes).

It should be noted that the volume of breastmilk consumed by infants over the age of 1 year could not be estimated in the 24-hr recall conducted for the 2015 CCHS-Nutrition (nor for the 2004 survey). As a result, total energy and nutrient intakes of breast-fed infants cannot be estimated and for this reason, breast-fed infants should be excluded from tabulations of usual energy and nutrient intake.

1.2.3.2 AMPM Trailing Questions—Table Salt and Exclusion of Foods. At the end of the 24-hr recall, respondents were asked about their use of table salt and about foods they excluded from their diets.

Three questions were asked about use of **table salt**: 1) The type of salt usually added to the food at the table (e.g., ordinary salt, seasoned salt, a salt substitute); 2) How often salt is added to food at the table (rarely, occasionally or very often); and 3) How often salt is added in cooking or preparing foods (rarely, occasionally, very often or never). Although these questions cannot provide a quantitative estimate of the amount of salt added in cooking or at the table, they can provide an indication of Canadians' discretionary use of salt. It should be noted that respondents' answers to this question were not used to 'adjust' their sodium intakes estimated from the 24-hr recall.

Restricting food choices/food groups or following special diets is important for understanding modifiable factors associated with eating patterns and thus informing dietary guidance. In the 2015 CCHS-Nutrition, respondents were asked if they completely excluded meat, poultry, fish and shellfish, eggs, dairy products, or sources of gluten, where 'completely excluded' meant never eating the food on its own or as part of a prepared dish. This information can assist in the interpretation of the results, by allowing a distinction to be made between those who did not consume a food (e.g., meat or fish) on the day of the recall and those who completely exclude the food from their diets. This becomes relevant when the estimate of the frequency of intake is of concern. For example, Canada's Food Guide suggests that two servings of fish be consumed each week (Health Canada, 2007). In this case, it could be useful to be able to report the proportion of "non-eaters", as well as the prevalence of consumption among those who do eat fish. Another way that the data can be used is in selecting particular sub-populations for consideration, such as those strictly adhering to various types of vegetarian diets (e.g., vegan, lacto-ovo-vegetarian). In this regard, it should be noted that the questions were not intended to identify or estimate vegetarians. Diets of those who consider themselves to be vegetarian fall on a continuum, and meaningful proportions of those who consider themselves to be vegetarian occasionally consume animal foods, either on their own or as part of a mixed dish (Bedford & Barr, 2005). Thus, using the responses to this question to estimate the prevalence of different types of vegetarian diets would likely underestimate the proportions who consider themselves to be vegetarian.

1.2.4 HEALTH COMPONENT

1.2.4.1 Nutritional Supplements and Details. The intake of nutrients from supplements can make important contributions to total intakes, and for some age-sex groups, nutrient supplements are recommended. For example, women who could become pregnant are advised to take a supplement containing folic acid, and adults over the age of 50 years are recommended to take supplemental vitamin D. In the 'nutritional supplements and details' module, participants were asked if they had taken any nutritional supplements (such as vitamins, minerals, fibre supplements, antacids, fish oils or other oils) during the past month, and if so, how many different supplements were taken. Note that use of herbal and/or homeopathic supplements was not determined.

Individuals who had used one or more nutritional supplements during the past month were asked to locate the supplement container(s), from which the Natural Product Number (NPN) was recorded if available. If the NPN was not available, the brand name and concentration of the main ingredients were recorded (e.g., calcium 200 mg, vitamin D 400 IU). For each supplement, respondents stated how many days they took the supplement during the past month, as well as the amount usually taken each time. Next, they were asked if they had taken the supplement yesterday, and if so, the amount taken. Thus, the data could be used to obtain information on the 'average' intake of supplemental nutrients over the past month, as well as supplement intake on the day of the 24-hr recall.

Individuals who completed a second 24-hour recall and had reported using one or more supplements during the first interview were asked about their use of these supplements during the second 24-hr recall. For each supplement previously reported as having been used during the past month, they were asked whether they had used the supplement yesterday (i.e., on the reference day of the second 24-hr recall), and if so, how much of the supplement was taken.

1.2.4.2 General Health. Respondents aged 12 or over were asked to rate their health ("not only the absence of injury, but also physical, mental and social well-being") as excellent, very good, good, fair, or poor.

1.2.4.3 Measured Height and Weight. Measured height (to the nearest 0.5 cm) and weight (to the nearest 0.01 kg) measurements were obtained from all participants aged 2 years or above who agreed to have this done and who were physically able to be measured (e.g. measurements were not taken on those unable to stand unassisted). Among respondents aged ≥2 years, 70% had measured values for height and weight. Reasons for not obtaining measured heights and weights included: the individual refused, there were problems with equipment, the individual was not available at the time of the interview (e.g. a child under 6 years of age was asleep or at daycare), the individual was not physically able to be measured, or the interview was being conducted by telephone. Individuals who did not agree or were not able to be weighed and/or measured for other reasons were asked if they would be willing to self-report their height, weight, or height and weight. These self-reported measures of height and weight are reported separately in the CCHS data.

Data on height and weight were used to calculate Body Mass Index (BMI; weight in kg divided by the square of height in metres [m]), which is an indirect measure of body fat. BMI values are generally classified according to increasing health risks (Health Canada, 2003). For non-pregnant adults aged 18 or above, the internationally accepted (WHO 2000) BMI (kg/m^2) ranges are:

- <18.5 = underweight
- 18.5 to <25 = normal weight
- 25 to <30 = overweight; and
- ≥30 = obese (subcategorized as Class I [30 to <35], Class II [35 to <40] or Class III [≥40].

This classification system is in accord with the weight classification system released by the World Health Organization (WHO) in 2000 (WHO 2000), which has been widely adopted internationally. It should be noted that there are some limitations to its use among certain groups. Health Canada (2003) advises that special considerations are required when applying this system to young adults who have not reached full growth, adults who naturally have a very lean body build, highly muscular adults, adults over 65 years of age, and certain ethnic and racial groups. However, at a population level, as in the 2015 CCHS-Nutrition, it is a useful indicator of weight-related health risk.

Unlike adults, where BMI cut-offs for underweight, normal weight, overweight and obesity are the same regardless of age and sex, BMI cut-offs vary by age and sex for those under 18 years of age. For example, while a BMI of 16 would reflect severe underweight in an adult, it would reflect normal weight status in a 7 year old child. Thus, age- and sex-specific BMI cut-offs to classify children's BMI are used, identified based on the values from the growth curves from specific reference populations. Several different classification systems exist, each relying on a different reference population. In the 2015 CCHS-Nutrition, both WHO (WHO Multicentre Growth Reference Study Group, 2006; de Onis, Onyango, Borghi, Siyam, Nishida, & Siekmann, 2007) and International Obesity Task Force (IOTF) cut-offs (Cole, Bellizi, Flegal, & Dietz, 2000; subsequently updated in Cole & Lobstein, 2012) are calculated.

The WHO cut-offs were derived from the WHO BMI growth curves for children aged 0 to <5 years (WHO Multicentre Growth Reference Study Group, 2006) and 5 to 19 years (de Onis, Onyango, Borghi, Siyam, Nishida, & Siekmann, 2007). These cut-offs are used internationally, and have been used by Health Canada and the Public Health Agency of Canada to classify children's BMI since 2012 (Roberts, Shields, de Groh, Aziz, & Gilbert, 2012). The WHO cut-offs for children are designed to intersect with adult values at the age of 19.

The WHO growth standards for children were not available when 2004 CCHS-Nutrition was conducted; accordingly, children's BMI from that survey was classified using the IOTF cut-offs defined by Cole et al. (Cole, Bellizi, Flegal, & Dietz, 2000). It should be noted that the IOTF cut-offs classify fewer children as overweight or obese when compared to the WHO cut-offs (Shields & Tremblay 2010; Roberts, Shields, de Groh, Aziz, & Gilbert, 2012). To facilitate comparisons between the 2004 and 2015 CCHS-Nutrition data, children's BMI from the 2015 survey will be classified using the IOTF cut-offs (Cole et al., 2000) as well as the WHO cut-offs.

The WHO growth standards and cut-offs use different terms to describe BMI classifications for preschool children (<5 years of age) and school-aged children (age 5 to 17 years). For children over the age of 5 years, the terminology is similar to that used for adults, but more conservative terms are used in younger children (Table 1.3). For this reason, it is important to present data separately for these two age groups.

Table 1.3 WHO Terminology used to describe BMI in preschoolers and school-aged children

BMI Z Score (SD units)[1]	Age 2– <5 years	Age 5 – 17 years
<-2	Thinness[2]	Thinness[2]
-2 to <+1	Normal[2]	Normal[2]
+1 to <+2	At risk of overweight	Overweight
+2 to <+3	Overweight	Obese
≥+3	Obese	Severely obese

1 A Z-score represents the number of SD units a given observation is from the mean. For example, if mean BMI for 15-year-old boys was 20 and the SD was 3.5, a BMI of 28 would be +2.3 SD units above the mean, and thus classified as obese (28-20/3.5 = 2.3).

2 In situations when the prevalence of thinness is very low, the thinness and normal categories may be collapsed to a single value, described as "neither overweight nor obese".

1.2.4.4 Adult Physical Activity. Respondents aged 18 or above were asked about physical activity done across the domains of leisure, work, housework or transportation. They were asked to report how many times in the past 7 days they had participated in moderate or vigorous physical activity (where moderate activity was defined as causing an increase in breathing and heart rate). Those who had participated 1 or more times reported the average amount of time they were active on each occasion (as ≤15 minutes, 16–30 minutes, 31–60 minutes, 61 minutes–2 hours, or >2 hours). The data are used to classify individuals as to whether or not they meet the recommendation for ≥150 minutes of moderate or vigorous physical activity per week (Canadian Society Exercise Physiology, 2012).

1.2.4.5 Physical Activity of Children and Youth. The survey questions for physical activity of children and youth aged 6 to 17 years were based on questions asked in The Health Behaviour in School-Aged Children study, a cross-national survey conducted in collaboration with the WHO. For these questions, physical activity was defined as "activity that increases their heart rate and makes them feel out of breath some of the time", and that could take place while playing sports, doing school activities, playing with friends, working, helping family with chores, or walking to school. Specific examples provided were running, brisk walking, dancing, swimming, rollerblading, skateboarding, biking, soccer, basketball and football. Respondents were first asked about the number of days in the past week and in a typical week that they were physically active for a total of at least 60 minutes each day. Next, they were asked about the number of hours a week that they were physically active ("out of breath or warmer than usual") during each of free time at school, class time at school, outside of school in organized activity, outside of school in unorganized activity, and (for those aged 12 to 17 years) outside of school while doing paid or unpaid work or while helping family with chores. Finally, to estimate "screen time", they were asked about the average number of hours a day spent watching television, using a game console, computer, tablet or hand-held electronic device (including smart phones). This included time spent using these devices to play games, watch videos or movies, do homework, e-mail, chat online and surf the internet. The data are used to classify children aged 6 to17 years as to whether or not they meet recommendations for ≥60 minutes daily physical activity, and for ≤2 hours of screen time per day (Canadian Society of Exercise Physiology, 2012). No data were obtained on the physical activity of children under the age of 6 years.

1.2.4.6 Women's Health. The iron requirements of girls and women are influenced by whether they are having menstrual cycles, are pregnant or lactating, or use birth control pills. Thus, girls aged 9 to 14 years were asked whether they had started having menstrual cycles. Those who had, along with all women aged 15 years or above, were asked how old they were when they had their first period. Women were asked if they were currently pregnant or breastfeeding, whether they had given birth in the past five years, whether they had used birth control pills within the past month, and whether their periods had stopped.

1.2.4.7 Chronic Conditions. Chronic health conditions can influence the food choices of an individual. In this module, participants aged 19 years and above were asked if they currently have the following chronic health conditions (diagnosed by a health professional): high blood pressure, diabetes, heart disease, cancer, or osteoporosis (which was queried only for respondents aged 50 years or above).

1.2.4.8 Smoking. Smoking affects vitamin C requirements, and is also of interest for other health-related reasons. Participants aged 12 years or above were asked if they had smoked a total of 100 or more cigarettes during their lifetime, and whether they currently smoked cigarettes daily, occasionally, or not at all.

1.2.4.9 Socio-demographic Characteristics. Socio-demographic questions included the respondents' country of birth, whether they are a landed immigrant in Canada, if they are an Aboriginal person (First Nations, Métis or Inuk [Inuit]), the racial or cultural group(s) they belong to, whether they speak English and/or French well enough to conduct a conversation, the language spoken most often at home, and the language first learned at home that could still be understood. Questions about education included if the respondent was currently attending school, college, CEGEP or university, if they were a full-time or part-time student, the type of educational institution they are attending or previously attended, and the highest certificate, diploma or degree obtained.

1.2.4.10 Labour Market Activities. For those between the ages of 15 and 75 years, employment status during the past week was ascertained.

1.2.4.11 Food Insecurity. Household food insecurity occurs when there is inadequate or uncertain access to food because of financial constraints. Thus, food insecurity is an important determinant of nutritional health through its impact on the quality and quantity of food purchased and consumed. Accordingly, questions on the household's experience of food insecurity in the previous year were included and provide insight into nutritional vulnerability of household members.

The 2015 CCHS-Nutrition included the 18-item US Household Food Security Survey Module developed by the USDA Food and Nutrition Service and Economic Research Service. This module was also used in the 2004 CCHS-Nutrition and subsequent cycles of the CCHS-Annual Component. Additional information about the survey module and information on how the responses are used to determine food security status in Canada is available online. The module contains 18 questions about the food security situation in the household over the past 12 months, ranging in severity from worrying about running out of foods to children not eating for a whole day. Ten of the items are related to the experiences of adults in the household or the household in general, while eight are specific to the experiences of children under the age of 18 years.

Responses to these questions are used to classify the food security status of child and adult household members, as well as the household overall, as: 1) "food secure" (no, or only one, indication of difficulty with income-related food access); 2) "food insecure, moderate" (indication of compromise in quality and/or quantity of food consumed); or 3) "food insecure, severe" (indication of reduced food intake and disrupted eating patterns).[1]

The value in including this module in 2015 CCHS -Nutrition is not for ongoing monitoring of prevalence of household food insecurity in Canada—that is done through the CCHS Annual Component, but rather, for the opportunity it provides to assess the association between household food insecurity and dietary intakes of child and adult members. Inclusion of the module provides one of the only ways of assessing nutrition vulnerability related to food access.

1.2.4.12 Income. Total household income before taxes and the sources of income were queried.

1.2.4.13 Administration (data sharing). Participants were informed about data linkage which could potentially link information collected during the interview to other survey or administrative data such as past and continuing use of health services. Those who did not object to the statement were asked to provide their provincial health number. In addition, permission was asked to share the respondent's interview information with provincial Ministries of Health, l'Institut de la statistique du Québec (Quebec respondents only), Health Canada, and the Public Health Agency of Canada.

[1] The classification described in this section has been used since 2004, including in the reporting of data from the CCHS-Annual Component. In recent years, some sources have included "marginal" food insecurity in their reporting to recognize vulnerability of individuals in households reporting *any* indication of food insecurity (Tarasuk et al., 2016 http://nutritionalsciences.lamp.utoronto.ca/wp-content/uploads/2014/05/Household_Food_Insecurity_in_Canada-2012_ENG.pdf). When this is done, the "food secure" category is subdivided into "food secure" (no indication of food insecurity) and "food insecure, marginal" (an affirmative response to one item in the module). Health Canada is exploring the inclusion of this in future monitoring.


2. USING 24-HR DIETARY INTAKE DATA TO ASSESS FOOD AND NUTRIENT INTAKES[2]

The majority of this chapter describes how 24-hr dietary intake data can be assessed using the Dietary Reference Intakes (DRIs) to estimate the prevalence of inadequate and excessive nutrient intakes in the population. A description of assessing food intake relative to recommendations provided by Canada's Food Guide is also provided.

An overriding consideration for this discussion is that because both DRIs and nutrient intake estimates have limitations, any dietary findings suggestive of inadequacy or excess need to be confirmed with objective measurements of nutrient status before they are used to develop or assess public health policy (Mackerras & Rutishauser, 2005).

2.1 Introduction to Dietary Reference Intakes (DRIs)

This section presents an overview of the DRIs, the nutrient reference standards used for assessing nutrient intakes in the 2015 CCHS-Nutrition. Understanding the definitions of each of the DRIs and how they were derived is important in interpreting nutrient intake data from the survey. For additional information, the DRI reports should be consulted (Institute of Medicine [IOM], 1997, 1998a, 1998b, 2000a, 2000b, 2001, 2003, 2005a, 2005b, 2011). A summary volume that provides key information for each nutrient is also available (IOM 2006). These reports can be ordered or accessed online through the National Academies Press website (enter "dietary reference intakes" in the 'search titles' box). The Dietary Reference Intake page on the Health Canada website also provides useful information on DRIs and links to the IOM reports.

The DRIs are a set of nutrient reference standards that can be used for planning and assessing diets of apparently healthy Canadians and Americans. As summarized in Table 2.1, the DRIs include estimates of requirements (Estimated Average Requirement, EAR), recommended intakes (Recommended Dietary Allowance, RDA; Adequate Intake, AI), and thresholds above which adverse effects of excessive intake may occur (Tolerable Upper Intake Level, UL). In addition, macronutrients and essential fatty acids have an Acceptable Macronutrient Distribution Range (AMDR), and for energy, an Estimated Energy Requirement (EER) is described.

The development of the DRIs involved Canadian and US scientists. The purpose was to update, expand on, and replace the former Recommended Nutrient Intakes for Canadians and Recommended Dietary Allowances for Americans. A series of reports on groups of related nutrients was released between 1997 and 2005 (IOM 1997,

[2] Portions of this chapter are modified from Barr 2006a, Barr 2006b.

1998a, 2000a, 2001, 2005a, 2005b). Subsequently, an updated report on calcium and vitamin D was released in 2011 (IOM, 2011). Reports were also published on using a risk assessment model to establish Upper Levels (IOM, 1998b), and on using DRIs in dietary assessment and planning (IOM, 2000b, 2003).

Table 2.1 Dietary Reference Intakes: definitions*

Estimated Average Requirement (EAR): the average daily nutrient intake level that is estimated to meet the requirements of half of the healthy individuals in a particular life-stage and gender group.

Recommended Dietary Allowance (RDA): the average daily dietary nutrient intake level that is sufficient to meet the nutrient requirement of nearly all (97 to 98 percent) healthy individuals in a particular life-stage and gender group.

Adequate Intake (AI): the recommended average daily nutrient intake level based on observed or experimentally determined approximations or estimates of nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate; used when an RDA cannot be determined.

Tolerable Upper Intake Level (UL): the highest average daily nutrient intake level that is likely to pose no risk of adverse health effects to almost all individuals in the general population. As intake increases above the UL, the potential risk of adverse effects may increase.

Acceptable Macronutrient Distribution Range (AMDR): a range of intakes for a particular energy source that is associated with reduced risk of chronic disease while providing adequate intakes of essential nutrients.

Estimated Energy Requirement (EER): the average dietary energy intake that is predicted to maintain energy balance in a healthy adult of a defined age, gender, weight, height, and level of physical activity consistent with good health. For children and pregnant and lactating women, the EER is taken to include the needs associated with deposition of tissues or secretion of milk at rates consistent with good health.

* Modified from IOM, 2006.

Appendix 2 shows the DRIs for all nutrients. Although all DRIs are expressed as amounts per day, they are more appropriately considered as average intakes (e.g., over a period of weeks or months). Note that most nutrients have several DRIs (e.g. vitamin C has an EAR, an RDA, and a UL); thus it is inappropriate to refer to "the DRI" for a nutrient. As described below in more detail, each DRI has a specific definition and uses.

2.1.1 ESTIMATED AVERAGE REQUIREMENT (EAR)

The EAR is defined as "the daily intake value that is estimated to meet the requirement, as defined by the specified indicator of adequacy, in half the apparently healthy individuals in a life stage or gender group" (IOM, 2005a). Several aspects of this definition warrant further elaboration:

- *Requirement:* A requirement is defined as "the lowest continuing intake value of a nutrient that, for a specified indicator of adequacy, will maintain a defined level of nutriture in an individual." The specified indicator of adequacy is identified for each nutrient, although in some cases it may differ among different age groups. Selecting an indicator of adequacy addresses the question "Requirement for what?" For example, in selecting an indicator of adequacy for iron, scientists on the nutrient panel might have considered the amount of iron required to prevent anemia (i.e. to maintain a certain hemoglobin concentration), to maintain biochemical function (as reflected by a specified transferrin concentration), or to maintain iron stores (as reflected by a specified serum ferritin concentration). In each case, the average requirement would differ, with a considerably higher intake required to maintain iron stores than to prevent anemia. Accordingly, it is important to understand the indicator of adequacy that was used to establish the requirement for a given nutrient. **Appendix 3** provides information on the indicators that were used to set the EARs.

- *Half the apparently healthy individuals:* Requirements vary among individuals in a given life- stage and gender category. Although the word "average" is used in the EAR, the definition of the EAR implies a median value rather than an average. The EAR is expected to meet or exceed the requirements of 50% of healthy individuals in an age-sex group, and to fall below the requirements of the other 50%. The median and the average will be the same when the requirement distribution is symmetrical, which is assumed to be the case for most nutrients.

In the context of reporting the results of a population-based survey, the primary use of the EAR is in estimating the prevalence of inadequate nutrient intakes in a group (see Section 2.2.2).

2.1.2 RECOMMENDED DIETARY ALLOWANCE (RDA)

The RDA is defined as "the average daily intake level that is sufficient to meet the nutrient requirement of nearly all (97 to 98 percent) apparently healthy individuals in a particular life-stage and gender group" (IOM, 2005a). The RDA for most nutrients is set based on the EAR. If the requirement distribution is assumed to be normally distributed and the standard deviation (SD) is available, the RDA is defined at an intake level 2 SD above the EAR: RDA = EAR + 2 SD (see Figure 2.1).

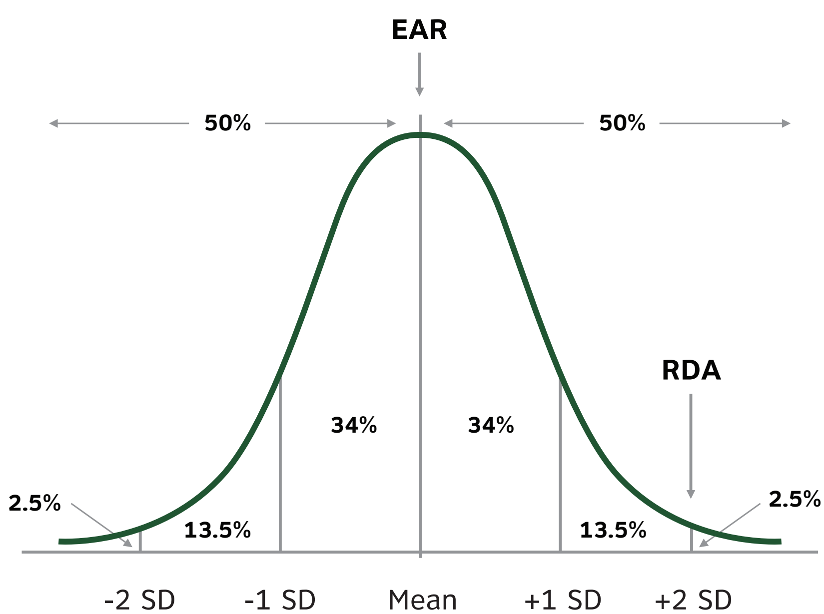


Figure 2.1 Normal distribution of requirements

For most nutrients, the requirement distribution is thought to resemble the *normal curve*. Accordingly, half the individuals in an age-sex group have requirements below the EAR (the mean of the distribution), and requirements of the other half exceed the EAR. The requirements of most people (68%) fall within 1 standard deviation (SD) of the mean, and 95% have requirements that are within 2 SD of the mean. Small proportions (a total of 5%) have requirements that are unusually low or unusually high (more than 2 SD below or above the mean). Thus, by setting the RDA at a level 2 SD above the mean, the requirements of ~97.5% of the group are met or exceeded.

If there are not sufficient data to determine the SD, a coefficient of variation (CV; SD/EAR x 100%) of 10% is generally used in place of the SD. This estimate is based on the variability of other biological factors. In this case, the RDA is set as the EAR plus twice the CV of 10%: RDA = EAR + 2 (0.1 x EAR) = 1.2 x EAR. In some cases, when there is evidence of greater variability (but still insufficient data to accurately identify the SD), a larger CV will be assumed. For example, for vitamin A the CV was assumed to be 20%; thus, the RDA = 1.4 x EAR (IOM, 2001).

Finally, if the requirement distribution is known to be skewed, other approaches are used to identify the 97th to 98th percentile of the requirement distribution. For example, in women of reproductive age, iron requirements are skewed because of great variability in menstrual blood losses (and therefore iron losses) (IOM, 2001). Thus, the RDA is set at the 97th to 98th percentile of the requirement distribution to cover the needs of those with the highest losses. For women aged 19 to 50 years, the EAR for iron is 8.1 milligrams (mg)/d, but the RDA is 18 mg/d, more than twice the EAR (IOM, 2001).

The primary use of the RDA is as a recommended intake for individuals, since it is set at a level that will meet or exceed the requirements of almost all healthy individuals. It is not used to assess the intakes of groups (see Section 2.2.3).

2.1.3 ADEQUATE INTAKE (AI)

For some nutrients, sufficient scientific evidence was not available to determine an EAR. In these situations, an AI was set instead. The AI is defined as "the recommended average daily intake value based on observed or experimentally determined approximations or estimates of nutrient intake by a group (or groups) of healthy people that are assumed to be adequate—used when an RDA cannot be determined" (IOM, 2005a).

As a recommended intake for individuals, the AI is expected to meet or exceed the amount needed to maintain a defined nutritional state or criterion of adequacy in almost all members of an apparently healthy population. (The nutritional states or criteria of adequacy for nutrients with AIs are listed in **Appendix 3**.) In other words, it is likely that the AI would be at or above the RDA if it had been possible to determine the requirement distribution and set a RDA. This is particularly likely to be the case if an AI was set based on average intakes of free-living individuals. For example, AIs for infants aged 0 to 6 months were set for all nutrients (except vitamin D) as the average intake by full-term infants born to presumably healthy, well-nourished mothers and exclusively fed human milk. Under these conditions, infants grow well and it is therefore assumed that their intake from human milk meets or exceeds their requirements. The extent to which the intake from human milk may exceed the requirement is not known, and likely will not be determined as the ethics of human experimentation would preclude testing levels that could be inadequate for infants. Another example is the AI for pantothenic acid for adults, which was set at 5 mg/d based on the dietary intakes and urinary excretion of small groups of US adults and adolescents (IOM, 1998a). Pantothenic acid deficiency has not been reported in free-living North Americans (IOM, 1998a); thus, it is probable that the average requirement, if it was determined, would be considerably lower than the AI. However, for some nutrients (e.g., fibre), AIs were not set based on average intakes of healthy groups.

The AI is similar to the RDA in that both are recommended intake levels for individuals, expected to meet or exceed amounts needed to maintain a specified indicator of adequacy in almost all individuals. However, there is much less certainty about AIs than RDAs, and the presence of an AI is an indication that additional research is required. This occurred in the case of calcium and vitamin D, both of which had AIs when the first DRI report was released in 1997. Subsequently, additional research was conducted which allowed EARs and RDAs to be identified (IOM 2011). Eventually, it is hoped that additional knowledge of nutrient requirements will allow the remaining AIs to be replaced by EARs and RDAs.

2.1.4 TOLERABLE UPPER INTAKE LEVEL (UL)

The UL is the "highest average daily nutrient intake level that is likely to pose no risk of adverse health effects to almost all individuals in the general population. As intake increases above the UL, the potential risk of adverse effects may increase" (IOM, 2005a). Although the UL is thought to represent an intake that the body can biologically tolerate, it is not a recommended intake: there are no established benefits to healthy individuals of intakes that exceed the RDA or AI.

It is important to note that the UL is intended to apply to chronic consumption rather than to intakes on any given day, and that it does not apply to individuals who are being treated while under medical supervision. For example, the UL for iron for adults is 45 mg/d (IOM, 2001), an amount which may be exceeded by individuals being treated by a physician for anemia. However, these individuals could be monitored for adverse effects, and would not maintain their high intake levels indefinitely (presumably, high-dose iron supplements would be discontinued after the anemia had been treated).

The ULs for nutrients are based on evaluations conducted using a risk assessment framework (IOM, 1998b). An important feature of this process is the concept that adverse effects of nutrients are not expected until intake exceeds a threshold. Just as requirements for nutrients vary among individuals, it appears that the thresholds for adverse effects also vary. An intake that might be tolerated by one individual could result in adverse effects in another. The intent is to set the UL so that it is below the threshold of even the most sensitive members of a group.

When possible, the UL is set on the basis of dose-response data that indicate a no-observed-adverse-effect level (NOAEL), which is the highest intake at which no adverse effects have been observed. If a NOAEL is not available, a lowest-observed-adverse-effect level (LOAEL) may be used instead. The LOAEL is the lowest intake at which adverse effects have been observed. In either case, the UL is estimated by dividing the NOAEL or LOAEL by an Uncertainty Factor (UF). The magnitude of the UF (which is always ≥1) varies among nutrients and reflects a number of sources of uncertainty, including the degree of inter-individual variation in sensitivity to the adverse effect, whether extrapolation from animal data occurred, whether a LOAEL was used instead of a NOAEL, and whether data on subchronic instead of chronic exposures were used. Furthermore, the severity of the adverse effect and whether or not it is reversible may also be considered in deriving the UF.

The sources of intake to which the UL applies vary among nutrients. In most cases, the UL applies to intake from all sources (food and fortified food, drinking water, supplements, medications), but if adverse effects are observed only in association with certain sources, the UL may apply only to that source. For example, the UL for folate applies only to synthetic folic acid found in fortified foods and supplements; it does not apply to dietary folate (IOM, 1998a), and the UL for vitamin A applies only to preformed retinol rather than to vitamin A provided by carotenoids (IOM 2001).

At present, ULs have not been set for all nutrients or all age groups. This does not mean that these nutrients are safe in unlimited quantities. While in some cases, adverse effects have not been identified (e.g. vitamin B_{12}), in other situations adverse effects are known to occur but data were insufficient to set an UL (e.g. for many nutrients, ULs have not been set for infants). Thus, in the absence of an UL, extra caution may be warranted in consuming intakes above recommended levels. **Appendix 3** provides information on which nutrients have ULs, the criteria used to set the UL, and if the UL applies only to certain sources of a nutrient.

2.1.5 ACCEPTABLE MACRONUTRIENT DISTRIBUTION RANGE (AMDR)

AMDRs were set for macronutrients, expressed as percentages of total energy intake. An AMDR is defined as "a range of intakes for a particular energy source that is associated with reduced risk of chronic disease while providing adequate intakes of essential nutrients" (IOM, 2005a). Individuals who habitually consume intakes above or below this range may be at potential risk of chronic diseases that affect long-term health, and may also be at increased risk of inadequate intakes of essential nutrients.

The need for guidance on macronutrient distribution becomes evident when one considers that the energy provided by the RDAs or AIs for carbohydrate, protein and the essential fatty acids falls short of the energy required for energy balance in almost all individuals. Furthermore, since food sources of macronutrients also provide other nutrients, meeting the RDA or AI for these other nutrients in many cases necessitates macronutrient intakes that exceed the macronutrient RDAs or AIs. For example, fibre in foods is found in association with carbohydrate, and it is unlikely that a diet providing only 130 g of carbohydrate (the RDA for carbohydrate for adult men) would also provide 38 g of fibre (the AI for men aged 19 to 50 years).

Epidemiological data have provided evidence that the patterns of macronutrient intake may be associated with chronic disease risk, and some experimental data also reveal such associations (IOM, 2005a). Accordingly, the AMDR provides guidance on how to distribute energy intake in a manner thought to be associated with reduced chronic disease risk, as well as with nutrient sufficiency.

2.1.6 ESTIMATED ENERGY REQUIREMENT (EER)

The EER is defined as "the average dietary energy intake that is predicted to maintain energy balance in a healthy adult of a defined age, gender, weight, height, and level of physical activity consistent with good health" (IOM, 2005a). In children and in pregnant or lactating women, the EER also includes energy needed for growth or the secretion of milk at rates consistent with good health. Maintaining energy balance means that energy intake equals energy expenditure; accordingly, if expenditure can be accurately determined, it will equal the requirement for energy intake. Data on total daily energy expenditure measured by the doubly- labelled water technique (considered to be the "gold standard") were used to develop equations to predict EER. Equations were developed for different life-stage and gender groups, and for individuals who are normal weight or overweight (IOM, 2005a).

Use of these equations requires knowledge of the individual's age, height, and weight. It also requires that their physical activity level (PAL; the ratio of total energy expenditure to basal energy expenditure) be estimated as sedentary (PAL 1.0 to <1.4), low active (PAL 1.4 to <1.6), active (PAL 1.6 to <1.9), or very active (PAL 1.9 to 2.5). Methods to determine the PAL category are described in the IOM report (IOM, 2005), and practical guidelines are provided in **Appendix 2**.

As an example, the equation for normal-weight women aged 19 years or above is:

EER (kcal/d) = 354 – (6.91 x age [years]) + PA x [(9.36 x weight [kg]) + (726 x height [m])].

In this equation, PA represents the physical activity coefficient that corresponds to a particular PAL category. The PA for a given PAL category varies depending on age-sex group (see **Appendix 2** for PA values), although the sedentary category always has a PA of 1.0. For adult women, PA is 1.12 for the low active PAL category, 1.27 for the active PAL category, and 1.45 for the very active PAL category. Thus, the EER for a low active 32-year-old woman who is 1.65 m tall and weighs 60 kg would be estimated as 2104 kcal/d (EER = 354 – (6.91 x 32) + 1.12[(9.36 x 60) + (726 x 1.65)] = 2104).

It is important to note that the EER equations predict the average energy requirement of a group of individuals with a defined age, gender, height, weight and PAL category. However, just as for nutrients, there is individual variability associated with energy requirements, and it can be considerable. For normal-weight adult men, the standard deviation (SD) of estimated energy requirements is 199 kcal, while for normal-weight adult women it is 162 kcal (IOM, 2005a). The range within which an individual's requirement likely falls can be estimated at between 2 SD below and 2 SD above their EER. This would represent a range from about 400 kcal below the predicted EER to 400 kcal above the predicted EER for adult men, and between about 325 kcal below and above the predicted EER in adult women. For the example provided above, the woman's actual requirement would likely fall between about 1779 kcal/d and 2429 kcal/d (2104 ± 325 kcal/d).

Finally, unlike other nutrients, there is no RDA estimated for energy. This is because there are adverse consequences to individuals who usually exceed their individual requirement: recommending an intake that exceeded the requirements of all but 2 to 3% of members of a group would be predicted to lead to weight gain in 97 to 98% of group members.

2.2 Using Dietary Reference Intakes and 24-hr Recall Data to Assess Intakes of Groups

2.2.1 OVERVIEW OF ASSESSING NUTRIENT INADEQUACY AND POTENTIAL RISK OF EXCESS

It is well established that single 24-hr recalls (or even several repeated recalls) do not accurately estimate the usual intakes of individuals. Indeed, a very large number of repeated assessments is required to characterize individuals' usual intakes with acceptable precision. For example, between 31 days (for energy) and 433 days (for vitamin A) were needed to estimate an individual's intake within 10% of the true usual intake (Basiotis, Welsh, Cronin, Kelsay, & Mertz, 1987). Twenty-four hour recalls were used in the 2015 CCHS-Nutrition; thus, users should be aware that nutrient intake data contained in the survey do not characterize the usual intake of individuals accurately. Nutrient intake data thus differ from many other variables in the CCHS (such as height, weight, and smoking habits) which are generally considered to accurately estimate the individual's characteristics. As a result, associations that might be expected between nutrient intake and other characteristics will be attenuated.

However, 24-hr recalls are generally considered the method of choice for assessing the intakes of groups. When assessing intakes of large population groups, as was done in the 2015 CCHS-Nutrition, the objective is not to determine the nutrient adequacy of specific individuals. Instead, the relevant questions are "What proportion of the group (e.g. teen females) has usual nutrient intakes that are below requirements?", or "What is the prevalence of inadequate nutrient intakes?" It is important to recall that the requirement for each nutrient is defined based on a specific criterion, and that failing to meet the requirement is not synonymous with the deficiency disease associated with the nutrient. For example, the requirement for vitamin C is based on its role as an antioxidant, and the EAR is the average amount of vitamin C needed to nearly saturate leukocytes (white blood cells) without leading to excessive urinary vitamin C excretion (IOM, 2000a). Those who do not meet their requirement would have leukocyte vitamin C levels below what is considered desirable; most would not have scurvy (the deficiency disease that occurs with a severe shortage of vitamin C). Dietary intake data are one type of data that can be used to assess nutrient intake or inadequacy; biochemical or clinical measures of nutritional status (such as those obtained in the Canadian Health Measures Survey) are usually necessary to confirm the presence of nutritional concerns in the population. In the text that follows, principles that underlie the methods used to assess nutrient intakes of groups in the 2015 CCHS-Nutrition are described, and are highlighted in Table 2.2.

Table 2.2 Principles underlying the use of DRIs for dietary intake assessment of groups

- To estimate the prevalence of nutrient inadequacy or potential risk of excess, a usual intake distribution is needed
- In most cases, total usual nutrient intakes (from food and supplements) should be used to assess nutrient adequacy or the potential risk of nutrient excess.
- When certain assumptions are met, the percent of a group with usual intake below the EAR estimates the prevalence of inadequate intakes
- The AI has limited uses in assessing groups
  - If group median intake meets or exceeds the AI, prevalence of inadequacy is likely low
  - If group median intake is below the AI, nothing can be concluded about inadequacy
  - The percent of a group with intake below the AI cannot be assessed as deficient
- It is not appropriate to use the RDA to assess groups
- The percent of a group with usual intake above the UL may be at potential risk of adverse effects
- The percent of a group with intakes above or below the AMDR may be at potential risk
- It is not appropriate to use the EER to assess energy adequacy of groups
  - BMI (proportion below, within and above recommended ranges) can estimate the adequacy of energy intake
  - Comparing intake to the EER may provide an indication of under-reporting

2.2.1.1 To Estimate the Prevalence of Nutrient Inadequacy or Potential Risk of Excess, a Usual Intake Distribution is Needed. Recall that although DRIs are expressed on a daily basis, meeting or not meeting a dietary requirement depends on an individual's usual intake, rather than their intake on any given day. When single 24-hr recalls or diet records are obtained from members of a group, the variability of the nutrient intakes will reflect both differences between individuals (some individuals usually consume more of a nutrient than others) as well as differences within individuals (on any given day, a particular individual could eat much more or much less of a nutrient than usual). Accurate assessment of nutrient intake in a group requires knowledge of the distribution of usual intakes of the group (in other words, a distribution that reflects only between-person variability).

To obtain a distribution of usual intakes for a group, the distribution of observed intakes (i.e. 1-day intakes obtained from a single 24-hr recall) must be statistically adjusted to remove the effects of within-person variability, so that the distribution reflects only between-person variability (i.e., creating a distribution of "usual" individual intakes). To do this, at least two 24-hr recalls or diet records obtained on non-consecutive days (or at least three days of data from consecutive days) are needed from a representative subsample of the group. As shown schematically in Figure 2.2, the adjusted usual intake distribution is less variable than a distribution using only 1-day 24-hr recalls. This is critical when assessing the prevalence of nutrient inadequacy or excess in a group. It can be seen in the Figure that the proportions of the group with intakes below the EAR or above the UL are lower with the usual (i.e. adjusted) intake distribution, compared to the unadjusted (1-day) distribution. As will be discussed later (see sections 2.2.2 and 2.2.5), these proportions reflect the prevalence of intakes that are inadequate (below the EAR) or potentially excessive (above the UL). Thus, failure to adjust the intake distribution to obtain the usual intake distribution results in incorrect estimates of the prevalence of inadequate or potentially excessive nutrient intakes.

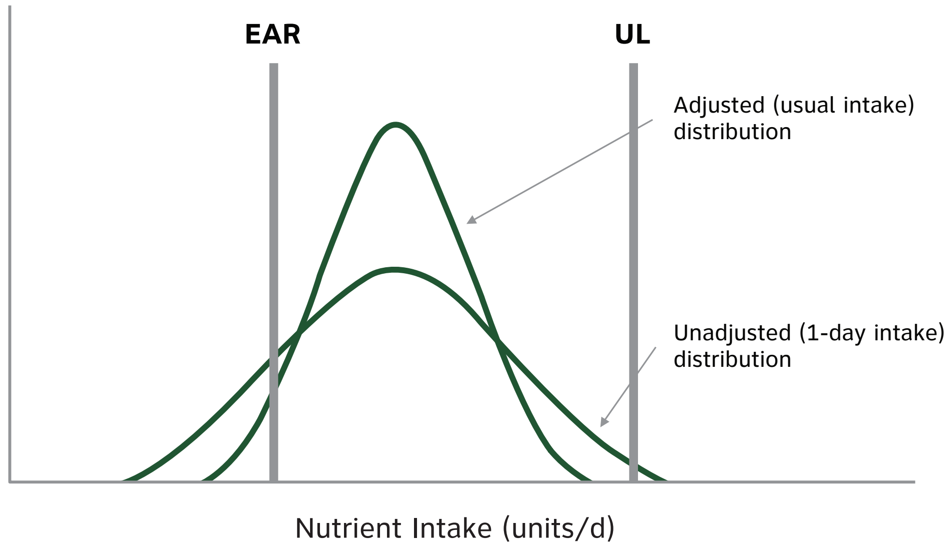


Figure 2.2 Unadjusted and adjusted intake distributions.

An adjusted (usual intake) distribution is less variable than an unadjusted (1-day intake) distribution because within-person variability has been removed. Proportions below the EAR (Estimated Average Requirement) and above the UL (Tolerable Upper Intake Level) are lower with the usual intake distribution.

In the 2015 CCHS-Nutrition, a second 24-hr recall was obtained from 7,623 respondents (i.e. a ~37% representative subsample). These data were used, in conjunction with the first 24-hr recalls for the subsample, to obtain usual intake distributions for various age-sex groups. The adjusted (usual intake) distributions will be presented in the tables of data from the 2015 CCHS-Nutrition that describe usual nutrient intakes of various age-sex groups and will also be used to estimate the proportions with inadequate or excessive intakes.

2.2.1.2 Statistical Methods to Generate Usual Intake Distributions. Several methods to obtain usual intake distributions are available for those who want to analyze the data themselves. Two of the most commonly-used methods are the Iowa State University (ISU) method, which uses Software for Intake Distribution Estimation (SIDE) and the National Cancer Institute (NCI) method. The ISU method, developed in 1996 (Nusser, Carriquiry, Dodd, & Fuller, 1996), was used by Health Canada and Statistics Canada to generate the usual intake distributions for 2004 CCHS-Nutrition, while the NCI method was developed more recently (Tooze, Midthune, Dodd et al., 2006; Tooze, Kipnis, Buckman et al., 2010). Both methods effectively remove within-person variation and generate comparable usual intake distributions for nutrients that are consumed on a daily basis; therefore they would be appropriate for analysis of nutrient intakes from foods in the 2015 CCHS-Nutrition. The NCI method is more computationally intensive, but has advantages as it can also be used to estimate intake of episodically-consumed nutrients and foods. For example, both the ISU and NCI methods would produce comparable usual intake distributions for nutrients such as protein, iron and vitamin C, and for broad food groups such as grain products or vegetables and fruit, as virtually everyone consumes some amount of these nutrients or food groups on a daily basis (Souverein, Dekkers, Geelen et al., 2011). However, for episodically-consumed nutrients (e.g., alcohol) or specific foods/food categories (e.g., orange vegetables, sugar-sweetened sodas, fish), only the NCI method can be used to generate usual intake distributions. Another advantage of the NCI method is that it can include covariates in its model, which can improve accuracy and allows subgroup analysis, whereas the ISU method does not. For example, the NCI method could be used to determine whether characteristics such as education, marital status or race were associated with the usual intake distribution. Health Canada and Statistics Canada have agreed that the NCI method will be the preferred method for use with the 2015 CCHS-Nutrition data.

2.2.1.3 In Most Cases, Total Usual Nutrient Intakes (From Food and Supplements) Should be Used to Assess Nutrient Adequacy or the Potential Risk of Nutrient Excess. In 2004 CCHS-Nutrition, the primary analyses of nutrient intake were limited to intake from food sources alone. Since 40% of adult Canadians reported using vitamin or mineral supplements during the month before the survey (Guo, Willows, Kuhle et al., 2009), it is possible that failure to consider intake from supplements resulted in some overestimation of the prevalence of nutrient inadequacy and some underestimation of the prevalence of potential risk of excess. Hence, to obtain the most accurate estimates of these variables, assessment of usual intake distributions from all sources of intake is recommended.

In some cases, however, it is appropriate to use only certain forms of a nutrient when assessing prevalence of inadequacy or potential risk of excess. For example, while estimates of the prevalence of inadequacy of folate and magnesium should include all sources of these nutrients, the UL for folate is based only on intake of synthetic folic acid used as a supplement or added as a fortificant to food, and the UL for magnesium applies only to supplemental or pharmacologic sources of magnesium.

Another consideration is that knowledge of intake from food sources alone may be useful in assessing the extent to which the diet alone (without supplements) meets nutrient needs, and as a corollary, in formulating recommendations for age-sex groups for whom supplementation may be recommended. Accordingly, the 2015 CCHS-Nutrition analyses will be conducted for food sources of nutrients, and for some key nutrients, for the combination of food and supplemental sources.

2.2.2 WHEN CERTAIN ASSUMPTIONS ARE MET, THE PERCENT OF A GROUP WITH USUAL INTAKE BELOW THE EAR ESTIMATES THE PREVALENCE OF INADEQUATE INTAKES

When certain assumptions (described below) are satisfied, the prevalence of nutrient inadequacy in a group (i.e. the proportion who do not meet the requirement for the specific indicator of adequacy used to set the EAR) can be estimated as the proportion of the group with usual intake below the EAR. This method of assessing the prevalence of inadequate intakes is known as the EAR cut-point method. It is a shortcut to the full probability method, in which the probability of inadequacy is assessed for each individual intake, and the average probability reflects the group prevalence of inadequate intakes (for more information, see **Appendix 4** and IOM 2000b). It should also be noted that neither the EAR cut-point method nor the full probability method can be used to identify individuals with inadequate intakes. Not all individuals with intakes below the EAR have inadequate intakes: some will meet their own (lower than average) requirements. Similarly, not all individuals with usual intake above the EAR have adequate intakes: some will not meet their own (higher than average) requirements. However, when the assumptions that will be described below are satisfied, the proportion of the group with intakes below the EAR will be similar to the proportion that does not meet their requirement (with the caveat that intakes were estimated accurately—see section 2.3).

The assumptions that must be satisfied to use the EAR cut-point method are (IOM, 2000b):

a) ***Intakes and requirements must not be correlated.*** This is thought to be true for most nutrients (e.g., an individual with a higher requirement for iron or magnesium does not intuitively consume more of that nutrient), but is known not to be true for energy, as individuals with higher energy requirements (e.g., very active individuals, larger individuals) have higher energy intakes.

b) ***The distribution of requirements must be symmetrical.*** This is thought to be true for most nutrients, but is known not to be true for iron, particularly for women of reproductive age. Blood (and therefore iron) losses during menstrual flow vary greatly among women, and some women have unusually high losses. As a result, the distribution of iron requirements for reproductive-aged women is skewed rather than symmetrical, and the EAR cut-point method cannot be used to assess the prevalence of inadequacy for that nutrient. Instead, the full probability method must be used.

The distribution of intakes must be more variable than the distribution of requirements. This is thought to be true among groups of free-living (non-institutionalized) individuals, as were studied in the 2015 CCHS-Nutrition. For example, the CV for the requirement distributions of many nutrients, including vitamin B_{12}, is set at 10%. Plus or minus twice the CV includes 95% of the requirement distribution, which means that 95% of adults would have a vitamin B_{12} requirement between 1.6 μg/d (the EAR of 2 μg/d minus 20%) and 2.4 μg/d (the EAR plus 20%). In contrast, the CV for total vitamin B_{12} intake in adults is well over 100%: intakes range from <3 μg/d to >26 μg/d. Note, however, that the assumption that intakes are more variable than requirements might not hold for groups of similar individuals who were fed similar diets (e.g. prison inmates). If the assumption is not met, the probability method must be used instead of the EAR cut-point method.

2.2.3 THE RDA IS NOT USED TO ASSESS GROUPS

The RDA has no role in assessing nutrient adequacy of groups. If an EAR is available and the assumptions for the EAR cut-point method are met, the proportion of the usual intake distribution below the EAR approximates the prevalence of nutrient inadequacy. If an EAR is not available, limited inferences can be made using the AI.

In the past, the RDA, or the Recommended Nutrient Intake (RNI) in Canada, was used incorrectly to make inferences about nutrient inadequacy in groups. It was often assumed that: a) groups with mean intake at or above the RDA had adequate intakes; or b) the proportion of a group with intakes below the RDA was inadequate. The reasons that both of these inferences are incorrect are described briefly below.

a) ***Comparing mean intakes to the RDA:*** Although the mean is an informative measure of central tendency, it is not useful in terms of assessing nutrient adequacy in a group. This is because the prevalence of inadequacy depends on the distribution of usual intakes, not the mean. For example, in the 2004 CCHS-Nutrition, mean vitamin C intake from food sources was 117 mg/d among Canadian women aged 31–50 years, well above the RDA of 75 mg/d. This comparison might lead one to expect that inadequate vitamin C intake was not a problem in this group. However, appropriate analysis of the data revealed that 20% of the group had usual intakes below the EAR of 60 mg/d.

b) ***Using the proportion of the group with intakes below the RDA to indicate the proportion with inadequate intakes:*** This will overestimate the prevalence of inadequacy. In the above example of vitamin C intakes of women, almost 30% of the usual intake distribution fell below the RDA, which is considerably higher than the 20% with usual intakes below the EAR.

In short, the RDA has no role in evaluating the diets of groups.

2.2.4 THE AI HAS LIMITED USES IN ASSESSING GROUPS

When an AI is set for a nutrient, it means that there was insufficient evidence to establish the distribution of requirements for the criterion of adequacy and thereby determine an EAR. For this reason, it is simply not possible to determine the proportion of a group with intakes below requirements. Accordingly, only limited inferences can be made about the adequacy of group intakes.

2.2.4.1 If Group Median Intake Meets or Exceeds the AI, Prevalence of Inadequacy in the Group is Likely Low. If the median intake of a group is at or above the AI, it can be assumed that the prevalence of inadequate intakes in the group is low. This assumption can be made with confidence when the AI was based on the median intake of a healthy group of people who are similar to the group being assessed. For example, the AI for water for adult men was set at 3.7 litres/d, based on median intakes of healthy North Americans that were assumed to be adequate (data on urine osmolality indicated few instances of inadequate water intake) (IOM, 2005b). Accordingly, a group of North American men with median water intake at or above the AI can be assumed to have a very low prevalence of inadequacy.

However, when the AI was not set as the median intake of a group that is 'healthy' with regard to the nutrient, there is less confidence that a median intake at or above the AI is associated with a low prevalence of inadequacy.

2.2.4.2 If Group Median Intake is Below the AI, Nothing Can be Concluded About Inadequacy. When the median intake of a group falls below the AI, no assessments can be made regarding the prevalence of inadequacy. Again, this occurs because we do not know the requirement distribution for the criterion of adequacy, and whether its upper end (if it could be determined) is relatively close to the AI or falls well below it. For example, assume that "Nutrient X" has an AI of 5 mg/d in adults, and that the AI for Nutrient X was based on the intakes of a group of healthy people. If a survey was conducted in which the median intake of Nutrient X in adults was 4 mg/d (below the AI of 5 mg/d), it is quite possible that everyone in the group could still be meeting their needs. This would occur if the average requirement for Nutrient X (if it could be determined) was well below 4 mg/d. Alternatively, if the requirement was closer to 4 mg/d, some proportion of the group would have inadequate intakes (see Figure 2.3).

It follows from the above discussion that individuals with intakes below the AI cannot be assessed as having inadequate intakes. Although the proportion of a group with usual intakes below the AI could be determined, great care should be taken to avoid implying that this proportion does not meet their requirements (i.e. the AI should not be used as a cut-point in the way that the EAR may be).

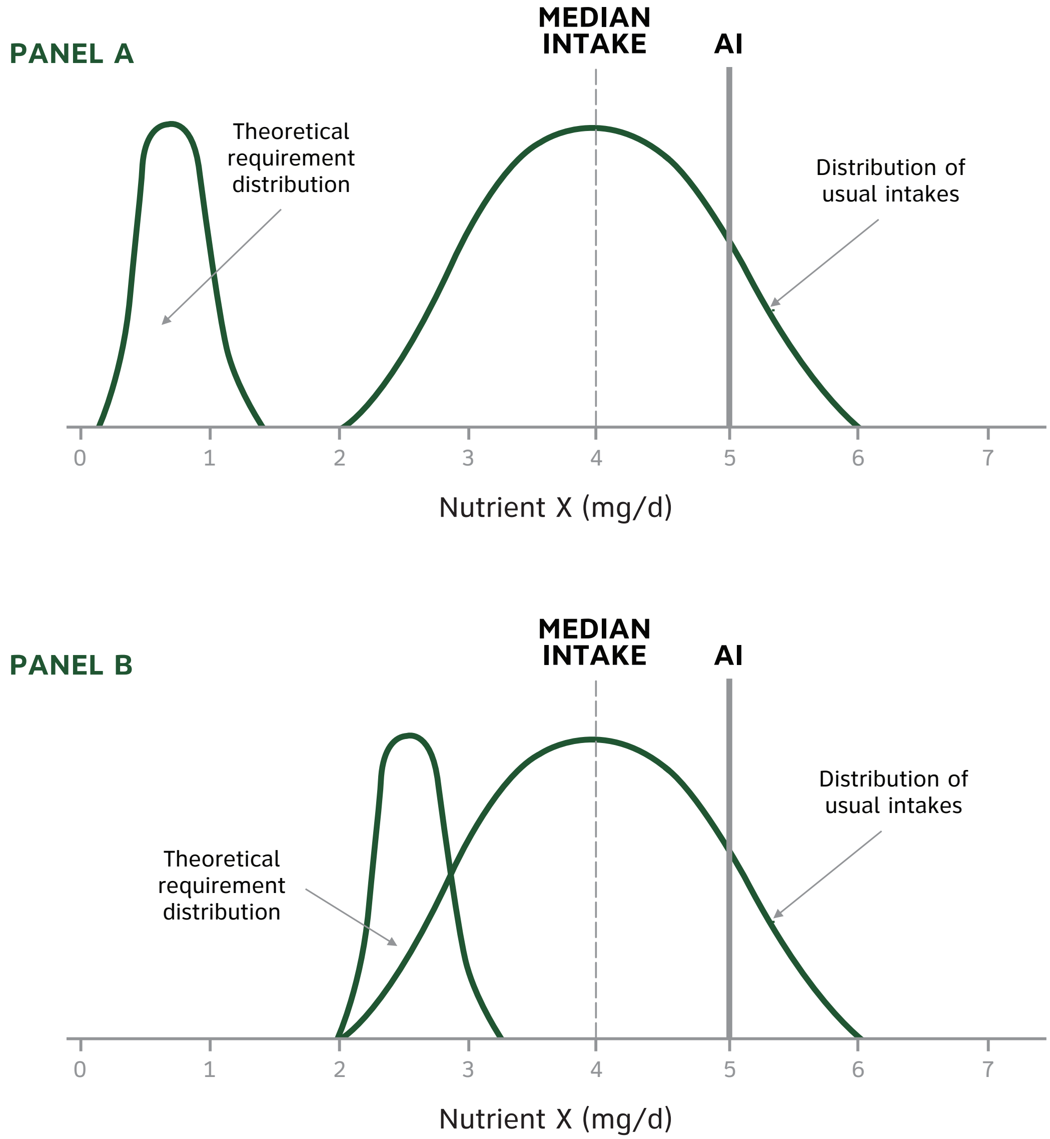


Figure 2.3 Challenges in using the Adequate Intake (AI) in assessment

This Figure shows why it is not possible to assess inadequacy when a group's median intake is below the AI. It depends on whether the requirement distribution (if it could be determined) overlaps the intake distribution. In Panel A, group median intake is below the AI of 5 mg/d, but none of the group would have inadequate intakes (because the theoretical requirement distribution is very low relative to the AI). However, in Panel B, the intake of some proportion of the group would be inadequate, because the theoretical requirement distribution overlaps part of the usual intake distribution. Because the requirement distribution is unknown, a correct interpretation of the distribution of usual intakes is not possible.

2.2.5 THE PERCENT OF A GROUP WITH USUAL INTAKE ABOVE THE UL MAY BE AT POTENTIAL RISK

The proportion of a group with usual nutrient intake above the UL may be at potential risk of adverse health effects from excessive intakes. For example, if 10% of Canadian men had vitamin C intakes from food and supplements above the UL of 2000 mg/d, that proportion would be at potential risk of diarrhea (the adverse effect used to set the UL) (IOM, 2000a). However, because individual sensitivities vary, and because of the use of Uncertainty Factors in setting ULs (see Section 2.1.4), the proportion of the group that actually experiences diarrhea as a result of excessive vitamin C intakes could be considerably lower than the proportion with intakes above the UL.

Another issue to consider when interpreting the proportion of a group with intakes above the UL is that there is considerable uncertainty with regard to some of the ULs for children. In many cases, these were established based on extrapolation from the ULs for adults or infants, and for some nutrients, this resulted in very small margins between the RDA and the UL for young children. For example, for children aged 1–3 years, the RDA for zinc is 3 mg/d and the UL is 7 mg/d. Data from 2004 CCHS-Nutrition revealed that 59% of children aged 1–3 years had zinc intakes above the UL. The adverse effect used to set the UL was risk of reduced copper status; however, few if any studies have been conducted in children to assess the intake at which this effect might occur, and there is little or no evidence of widespread low copper status among young Canadian children. This suggests that there may be a need for additional research to refine the ULs for young children, if possible based on studies conducted in children.

2.2.6 THE PERCENT OF A GROUP WITH INTAKES ABOVE OR BELOW THE AMDR MAY BE AT POTENTIAL RISK

The proportion of a group with usual intake above or below the AMDR may be at potential risk of inadequate intakes of essential nutrients and the development of chronic diseases that affect long-term health. For example, diets below the AMDR for carbohydrate could adversely affect intakes of nutrients such as folate and fibre, and also may be associated with increased risk of chronic disease.

It is important to recognize that AMDR values are not based on specific indicators of adequacy (like the EAR or AI), and that intakes below the AMDR should not be interpreted as evidence of “inadequacy” of the nutrient. For example, the EAR for carbohydrate was set based on brain glucose utilization, whereas the AMDRs for carbohydrate and fat were set based on epidemiological evidence suggesting associations with chronic disease risk (IOM, 2005a).

In addition, it should be noted that applications of the AMDRs for essential fatty acids and protein to group assessment are not the same as for carbohydrate and fat, as they were based on different types of endpoints.

- The lower and upper boundaries of the AMDRs for carbohydrate and fat were based on evidence suggesting increased chronic disease risk (coronary heart disease, diabetes and obesity), so it would be appropriate to interpret that intakes above or below the AMDRs may be associated with increased risk.
- For protein, the lower boundary was based on the percent of energy needed to meet the protein RDA, and the upper boundary was established to complement the lower boundaries for fat and carbohydrate. Thus, while diets below the AMDR for protein may be associated with some risk of insufficient protein intake (which would be more appropriately assessed by determining the prevalence of intakes below the EAR), no specific health risks are associated with intakes above the AMDR.

- The lower boundaries for the essential fatty acids were based on the percent of energy needed to meet the AIs. The AIs, in turn, were based on the median intakes of linoleic and alpha-linolenic acid in the United States (US), where essential fatty acid deficiency is non-existent in the healthy population. Thus, by definition about half the population has intakes of these fatty acids below the AI and therefore outside the AMDR. In other words, in an assessment based on the AI, one would conclude that the US population is "adequate" with respect to linoleic and alpha-linolenic fatty acids, while based on the AMDR a different conclusion (i.e. that 50% of the population has intakes below the AMDR) would be reached. It is not appropriate to infer that this group has inadequate intakes of essential fatty acids, and while there may be a potential for increased risk of certain chronic diseases, more research is required to clearly establish these associations. Therefore, the lower bound of the AMDRs for linoleic and alpha-linolenic fatty acids should not be used in the assessment of population intakes.

2.2.7 IT IS NOT APPROPRIATE TO USE THE EER TO ASSESS ENERGY INTAKE ADEQUACY OF GROUPS

Theoretically, since energy intakes are strongly correlated with requirements in weight-stable individuals, the mean energy intake of a group that is weight-stable (or in the case of children or pregnant women, gaining weight at an appropriate rate) should be equal to its mean energy requirement. It would therefore appear possible to assess the general adequacy of a group's energy intake by comparing it to the mean predicted EER for the group (estimated using individual values for height, weight, sex and age), provided one could estimate activity levels accurately. If mean intake was equal to EER, energy intake could be assumed adequate, while mean intakes considerably below or above mean EER would be assessed as inadequate or excessive, respectively. However, because under-reporting of food intake is ubiquitous (see Section 2.3.1), and because body weight is a valid, reliable measure of energy balance, it is more appropriate to assess the adequacy of a group's energy intake by assessing their relative weight status, most commonly using BMI.

2.2.7.1 BMI can Estimate the Adequacy of Energy Intake. The proportion of a group of adults with BMI below the normal range of 18.5 to <25 kg/m^2 could be assessed as having inadequate energy intake for their activity level, whereas the proportion with BMI above 25 kg/m^2 could be classified as having excessive intake for their activity level. For children and adolescents, age and sex based BMI standards exist and should be used (Cole et al., 2000; WHO, 2006; de Onis et al., 2007). The limitations of BMI noted in Section 1.2.6 should be kept in mind. However at a population level, as in the 2015 CCHS-Nutrition, it gives the best available estimate of adequacy of energy intake.

Users should be cautioned against attempting to relate relative weight status (e.g. BMI) of individuals to 24-hr recall data on energy intake. There are several reasons why this may not be useful: first, as has already been mentioned, data from single 24-hr recalls do not characterize usual intakes of individuals accurately; second, as will be described in Section 2.3.1.4, data suggest that overweight or obese individuals are more likely to under-report food intake than normal weight individuals; third, comparing energy intake to relative weight status reflects only one side of the energy balance equation as it does not consider energy expenditure; and finally, relative weight at any point in time also reflects previous energy intake and expenditure.

2.2.7.2 Comparing Intake to the EER May Provide an Indication of Under-reporting. Although BMI likely provides a better estimate of energy adequacy than comparing energy intakes to the EER, comparing mean energy intake to the EER could provide an opportunity to estimate the extent to which under-reporting may have occurred in a group. (For more information on under-reporting, see Sections 2.3.1.3–2.3.1.5) One could compare the mean intake of a group (estimated from 24-hr recalls) with their mean EER (determined using individual values for height, weight age, sex, and estimated physical activity level). If mean intake was considerably below mean EER, it is likely that under-reporting occurred for the group. Conversely, if mean intake approximated the mean EER, substantial under-reporting is less probable.

For example, almost all studies done using doubly-labelled water indicate that the mean energy expenditure of groups exceeds what would be predicted for a sedentary physical activity level. In other words (on average) free-living populations are not sedentary. Thus, if a population's mean reported energy intake was at or below the intake expected for a sedentary physical activity level, under-reporting would almost certainly have occurred. As discussed in Sections 2.3.1.3–2.3.1.5, under-reporting has important implications for interpreting nutrient intakes.

2.3 Accuracy of 24-hr Intake Data

The above discussion on using DRIs to assess the prevalence of nutrient inadequacy and excess is based on the assumption that data obtained from 24-hr recalls provide accurate information on nutrient intake on the day of the recall. Two major sources of error affect the likelihood that this assumption is met: 1) the accuracy of the information provided by survey participants, and 2) the accuracy of the nutrient database used to analyze that information. Table 2.3 highlights some of the primary considerations related to these two sources of error, and additional information is provided in the text that follows. Overall, the available information indicates that errors related to the accuracy of the nutrient database are likely random and relatively modest, but that systematic error (average under-estimation of intake) is associated with the reporting of dietary intake by survey respondents. This needs to be considered by those interpreting and using the data from the 2015 CCHS-Nutrition (or any dietary survey).

Table 2.3 Accuracy of 24-hr recall nutrient intake data is affected by the accuracy of the 24-hr recall and the accuracy of the nutrient database

Accuracy of 24-hr Recalls

- The Automated Multiple-Pass Method for 24-hr recalls uses several methods to assist subjects to recall food and beverage intake.
- Proxy reporting for infants and young children may affect accuracy.
- Misreporting/under-reporting of food intake is not consistent among individuals or across foods—this has implications for interpreting nutrient intake data.
- Several methods exist to explore possible implications of under-reporting.

Accuracy of Nutrient Databases

- Databases may not be complete for all nutrients and may not contain all foods.
- Random error can occur because of differences in nutrient composition of different types of the same food, or the conditions in which the food was produced and/or processed.

2.3.1 ACCURACY OF 24-HR RECALLS

2.3.1.1 The Automated Multiple-Pass Method for 24-hr Recalls Uses Several Methods to Assist Subjects to Recall Food and Beverage Intake. The Automated Multiple-Pass Method for obtaining 24-hr recalls (described in Section 1.2.3.1) has been continuously refined in an effort to improve its accuracy. Features of the method that help participants recall their food intake accurately include permitting them to mention foods in any order they choose, specifically probing for foods that are commonly forgotten (which may help address differential under-reporting; see Section 2.3.1.3), and including tools to assist with portion size estimation.

Validation studies have evaluated the performance of the method under controlled conditions (Conway, Ingwersen, Vinyard, & Moshfegh, 2003; Conway, Ingwersen, & Moshfegh, 2004). In these studies, participants selected their meals and snacks for one day from a wide variety of foods offered in a cafeteria-style setting. Actual amounts consumed were measured, and the following day, the multiple-pass 24-hr recall was administered by telephone. The results showed that mean energy intake was estimated within 10% of actual intake in both women and men. It is important to note, however, that participants had been informed that the study was designed to assess food selection and recall. This may have resulted in greater attention to food selection and therefore better ability to recall than would occur in a field setting. Nevertheless, the results indicate that the method has the potential to perform well.

More recently, the AMPM was validated against the doubly-labelled water method, which assesses total energy expenditure (if body weight is stable over time, by definition energy intake from food and beverages is equal to energy expenditure; thus, in weight-stable individuals reported energy intake should equal total energy expenditure). In a comprehensive study (Moshfegh, Rhodes, Baer, et al., 2008), 524 healthy weight-stable adults aged 30 to 69 years and with BMI between 18 and 44 completed three multiple-pass method 24-hr recalls to estimate energy intake. The first recall was conducted in-person and the second and third recalls were conducted by telephone. In addition all participants had total energy expenditure measured over 14 days using doubly-labelled water. Overall, energy intake was under-reported by an average of 11%. However, the degree of under-reporting varied considerably by BMI: it averaged <3% among normal-weight individuals, and was about 15% and 20% in overweight and obese individuals, respectively. Individuals were also classified as under-reporters, acceptable reporters, or over-reporters if they were below, within, or above the 95% confidence limits of the log of the ratio of reported energy intake (from dietary recalls) to measured energy expenditure (from doubly-labelled water). The 95% confidence limits included ratios of energy intake to energy expenditure from 0.72 to 1.40 (for example, if energy expenditure was 2000 kcal/d, those with reported intakes ranging from 1440 kcal/d–2800 kcal/d would be considered acceptable reporters, while those below or above this range would be considered under-reporters and over-reporters, respectively). For the sample as a whole, about 76% were classified as acceptable reporters, while 20% were under-reporters and 4% were over-reporters. The proportion of under-reporters also varied with BMI, from 10.5% (normal-weight) to 22% (overweight) to 34.5% (obese). Women tended to be more likely to be under-reporters than men. Collectively, these results suggest that the AMPM has potential to provide reasonably accurate reports of energy intake in normal-weight subjects, but that more research is needed to improve its accuracy in overweight and obese individuals (Moshfegh et al., 2008). On average, however, energy intake is under-reported.

2.3.1.2 Proxy Reporting for Young Children May Affect Accuracy. When interpreting 24-hr recall data it is also important to consider who provided the recall data. Very young children do not have the cognitive skills to recall their intakes, but these capabilities develop as the child reaches school age. In the 2015 CCHS-Nutrition, the interview was conducted with a parent or guardian alone for children aged 1 to <6 years, with both the child and a parent or guardian of children aged 6 to 11 years, and with the child alone for those aged 12 years or above.

Including both the child and a parent or guardian for school-aged children is supported by data indicating that accuracy of reporting in dietary recalls is increased by the presence of one or both parents for children aged 4 to 10 years (Eck, Klesges, & Lanson, 1989).

When recall interviews are conducted with a parent or guardian alone, difficulties may arise if meals are provided to the child by other caregivers (e.g. in a daycare setting). In the 2015 CCHS-Nutrition, the interviewer asked the parent or guardian what the child ate at daycare. If the parent or guardian did not know, he or she was asked to call the daycare to obtain the missing information and then to call the interviewer back. However, recall of these meals may be less detailed and responses could be over- or under-estimates, because the daycare provider did not receive any of the usual prompts used by the CCHS interviewer. Furthermore, most daycare providers care for more than one child, and may not remember the amount of food consumed by a specific child. Instances in which this occurred (i.e. parents or guardians were not aware of foods consumed in a daycare setting and information was provided indirectly through the daycare provider) were not recorded in the data file. Thus, the impact on reported nutrient intakes cannot be assessed.

2.3.1.3 Misreporting/Under-reporting of Food Intake is Not Consistent Among Individuals or Across Foods—This Has Implications for Interpreting Nutrient Intake Data. As indicated previously, studies using the doubly-labelled water method to determine energy expenditure while simultaneously assessing reported dietary intakes have provided insight into errors associated with reported dietary intakes. While food intake may be either under-reported or over-reported (as well as accurately reported) by individuals, reviews of this work reveal that the average reported energy intake of a group systematically underestimates usual energy expenditure, indicating that food intake is under-reported at the group level (Trabulsi & Schoeller, 2001; Poslusna, Ruprich, de Vries, Jakubikova, & van't Veer, 2009). The issue is relevant because if energy intake is under-reported, it is likely that nutrient intakes will also be underestimated, which has the potential to lead to inflated estimates of the prevalence of inadequate nutrient intakes.

Research conducted to assess personal characteristics associated with under-reporting has revealed factors that are more common among those who under-report (Livingstone & Black, 2003; Murakami & Livingstone, 2015). One of the most consistent finding is an increased probability of low energy reporting among those with a high BMI. Other characteristics that may be more common among under-reporters include female sex, older age, body dissatisfaction, not smoking, high levels of physical activity, and social desirability (the tendency to behave in a way thought to be socially acceptable and desirable; for example, to report lower intakes of foods perceived as being less healthful). These findings have implications for comparing intakes of groups that differ with regard to these characteristics. For example, if one simply compared nutrient intakes of groups of normal-weight and overweight individuals, without considering that under-reporting is more common among those with high BMI, one might conclude (likely incorrectly) that the overweight group had lower intakes.

Reporting accuracy has also been examined among children. Although the available data are not completely consistent, several studies suggest that mean reported energy intakes of school-aged children are similar to mean energy expenditure as assessed by doubly-labelled water, but that reporting accuracy may decrease as children enter adolescence (Bandini et al., 2003; Johnson, Driscoll, & Goran, 1996; O'Connor et al., 2001). Conversely, among infants and young children (whose intakes are reported by parents or caregivers), there is even some evidence that energy intake may be over-reported (Devaney, Ziegler, Pac, Karwe & Barr, 2004; Murakami & Livingstone, 2016). Thus, differential under-reporting may need to be considered in interpreting intakes of children of different ages.

Studies also have been done to examine the nature of under-reporting, to determine whether it is primarily related to errors in portion size estimation (so that all foods are proportionally under-reported), or whether some types of foods are more likely to be under-reported. Most research suggests that the latter is true (Livingstone & Black, 2003). Those who under-report energy generally report a significantly higher percentage of energy from protein and starch, and a lower percentage of energy from fat and sugars. These observations are supported by studies comparing the types of foods reported by those who did and did not under-report energy. Low energy reporters are more likely to report foods generally perceived as healthy (such as fruit, vegetables, salad, meat and fish) and fewer foods generally perceived as less healthy (cakes, cookies, candies and fats). It is difficult to determine whether these patterns are seen because of social desirability, or more simply, because the less healthy foods are more likely to be forgotten. In any case, these differences in the types of foods reported, when combined with the lower energy intakes of under-reporters, lead to potentially misleading findings of higher micronutrient density (ratio of micronutrient intake to energy intake) among under-reporters.

2.3.1.4 Several Methods Exist to Explore Possible Implications of Under-reporting. Unfortunately, there is no completely accurate way to adjust for the effects of under-reporting. In the years since recognizing the under-reporting phenomenon, investigators have proposed a number of methods to address the issue; these depend to some extent on the purpose of the analysis (Livingstone & Black, 2003; Poslusna et al., 2009). In epidemiological studies exploring associations between nutrient intake and chronic disease, energy intake may be included in the multivariate model, or other approaches such as a nutrient-density model or the residuals model may be used. As discussed above, however, these methods cannot control for differences in the types of foods reported, and in some cases may further confound the bias.

In other cases (for example, comparing nutrient intakes of groups known to have different probabilities of under-reporting), invalid or 'implausible' reporters may be identified and excluded from the data set. Various cut-offs to identify energy under-reporters (and over-reporters) were initially proposed by Goldberg et al. (1991) and subsequently refined by Black (2000a, 2000b). These energy intake cut-offs were expressed as multiples of basal metabolic rate (BMR), and vary depending on the number of days of diet records or recalls, availability of information on the individual's physical activity level (PAL), and whether BMR was directly measured or was calculated. For example, the lower and upper energy intake cut-offs are 0.87 times BMR and 2.75 times BMR, respectively, for those who completed a single 24-hr recall and had a PAL of 1.55 (within the low active range) (Black, 2000a). Further work expressed the cut-offs relative to estimated total energy expenditure (estimated using the IOM equations for EER) rather than BMR (Huang et al., 2005).

Regardless of whether the cut-offs are expressed relative to BMR or EER, their application is similar: reported energy intake that falls below the lower cut-off is classified as under-reporting, reported intake that is above the upper cut-off is classified as over-reporting, and reported intake that falls between that lower and upper cut-offs is considered to represent plausible reporting. The importance of considering the plausibility of reported intakes is illustrated by comparing body weight to reported energy intake in population samples. Physiologically, we know that, on average, larger individuals have higher energy requirements than smaller individuals, and thus must have higher energy intakes (since in weight stable individuals, energy intake equals energy requirement). This theoretical relationship was clearly observed when the analysis was restricted to plausible reporters (larger people reported higher energy intakes), but not when all respondents were included (Huang et al., 2005).

The disadvantage of excluding those who misreport their intake is that large proportions of respondents may be deleted, thus compromising sample size and the ability to detect differences among groups. For this reason, other methods to try to adjust for misreporting are being explored (e.g., Lankester, Perry, & Parsonnet, 2014; Jessri, Lou, & L'Abbe, 2016). To date, however, no 'ideal' method has been identified and widely adopted.

2.3.1.5 Under-reporting in 2004 CCHS-Nutrition. The prevalence and potential implications of under-reporting of energy intake of individuals aged 12 years and above in the 2004 CCHS-Nutrition have been examined (Garriguet, 2008a; Garriguet, 2008b). Among all respondents, under-reporting of energy was found to average ~10% based on a comparison of reported energy intakes to estimated energy requirements. Similar to previous findings, under-reporting was more common among those who were overweight or obese, in women versus men, in adults versus teens, and in those with higher levels of physical activity (Garriguet, 2008a).

In a second analysis, the impact of identifying plausible respondents was examined (Garriguet, 2008b). Respondents were classified as plausible reporters (reported energy intake 70% to 142% of predicted energy expenditure), under-reporters (reported energy intake <70% of predicted energy expenditure) or over-reporters (reported energy intake >142% of predicted energy expenditure), and intakes of plausible respondents were compared to those of all respondents. Overall, 57% of respondents were considered plausible reporters, 33% were under-reporters, and 10% were over-reporters. The expected relationships between energy intake and body weight were observed among plausible respondents, while among all respondents, relationships were not observed or were much weaker. Moreover, plausible respondents had energy intakes that were ~8% higher than all respondents, and absolute intakes of most macronutrients, vitamins and minerals were higher by generally similar amounts (Garriguet, 2008b). Although not assessed in this report, it is possible that the prevalence of inadequate nutrient intakes (assessed as the % below the EAR) could also be lower among plausible respondents compared to all respondents.

Dietary intake methodology is continuously being refined in an effort to improve reporting accuracy and to limit the impact of misreporting. However, it is clear that those interpreting dietary intake data from 2015 CCHS-Nutrition, or any other dietary survey, must consider the implications of net under-reporting for conclusions that are drawn.

2.3.2 ACCURACY AND COMPLETENESS OF NUTRIENT DATABASES

The nutrient database used for the 2015 CCHS-Nutrition included foods and nutrients extracted from the 2015 Canadian Nutrient File (CNF), a recipe file, and survey foods (food items that were not in the CNF but reported in the survey and for which some nutritional information was available). The CNF is frequently updated, and the 2015 version contained 5690 foods with up to 152 food components (e.g. energy, macronutrients and micronutrients). (More information about the CNF is available in the CNF Users' Guide.) The CNF includes data from the USDA Nutrient Database for Standard Reference (up to and including SR27) for foods that correspond to the Canadian market. To form this standard Canadian resource, USDA nutrient values were modified to reflect Canadian levels of fortification and regulatory standards, 'Canadian only' foods or Canadian commodity data were added, and where appropriate, some Canadian brand name foods were added. As applicable, foods in the CNF have also been assigned to a food group and subgroup from 2007 Canada's Food Guide. For the four major food groups, it also classifies foods into four "Tiers" based on how closely they align with Food Guide guidance (see Section 2.4). Each food, when applicable, has been assigned a corresponding serving size, which is referred to as a "Food Guide Serving" for foods in the top three Tiers, and simply as a "serving" for foods in Tier 4.

Users should be aware that the CNF does not have complete values for all 152 food components for every food (the CNF Users' Guide provides information on the completeness of the database in the section on "nutrient code listing"). Accordingly, similar to the US National Health and Nutrition Examination Survey (NHANES) which has a survey nutrient database (Food and Nutrient Database for Dietary Studies [FNDDS]) that is as complete as possible, Health Canada and Statistics Canada experts decided to extract the most complete set of food and nutrient data from the CNF to ensure the best coverage and reporting of nutrient intakes for the CCHS nutrition survey. Although the CNF database is 100% complete for energy, carbohydrate, fat, and protein, and >95% complete for many vitamins and minerals, the rules for inclusion in the extracted database were set to incorporate nutrients for which ≥85% of foods have a value for the given nutrient, with the exception of eicosapentaenoic fatty acid (20:5n-3) with 77% coverage. For this reason, the 2015 CCHS-Nutrition data does not include nutrients from food sources for vitamin E, copper, selenium, vitamin K, pantothenic acid, biotin, choline, manganese, individual amino acids, total omega-3 fatty acids, total omega-6 fatty acids, and *trans* fatty acids. Furthermore, it should be noted that the 152 food components in the CNF do not include all known essential nutrients (e.g., chromium, fluoride, iodine and molybdenum). (See **Appendix 3** for a listing of nutrients with an EAR or AI that are reported for the 2015 CCHS-Nutrition).

Another issue related to completeness of the database is the degree to which it contains foods reported by respondents, such as mixed dishes, fast food, and ethnic foods that may be consumed by population subgroups. As also occurred in the 2004 CCHS-Nutrition, efforts were made to address this in the 2015 CCHS-Nutrition. For many mixed dishes, the recipe database was used. The recipe database is based on the Food and Nutrient Database for Dietary Studies (FNDDS) from the USDA. Recipes in the FNDDS were modified to reflect the Canadian food supply and Canadian recipes (e.g. poutine) were also added. For food items that were not in the CNF but have nutritional information available, a "survey food" containing the relevant nutrient information was added to the database. In a few cases, if nutritional information for a particular food was limited, the best option was to use a CNF food, a recipe, or a survey food having the closest nutritional profile.

In addition to the fact that nutrient databases are not complete for all nutrients or foods, other sources of error can contribute to the accuracy of nutrient analyses. There are differences in nutrient composition among similar foods based on the specific variety of the food. Because the CNF values for many foods represent a generic product, these subtle differences in nutrient composition are not always reflected in the CNF. For example, the CNF has nutrient values for raw apples, and these values would be applied regardless of whether a Macintosh or Gala apple was consumed. Similarly, for some nutrients the content in a food will vary depending on the composition of the soil the food was grown in, or the diet the animal was fed. For manufactured foods the composition included in the database may not be that found in the food (for example, fatty acid composition of crackers may vary over time depending on the source of fat used in manufacturing). Finally, the actual nutrient content of a given food will vary with how it has been processed and prepared, whether commercially or in the home.

Despite these potential concerns, nutrient database values generally provide reasonably accurate estimates of the nutrient content of foods, particularly at a population level. For example, in the Dietary Approaches to Stop Hypertension study, menus that were analyzed using nutrient database values were within 10% of the chemically determined values for all 13 nutrients that were assessed (McCullough et al., 1999). In contrast to under-reporting, which introduces systematic error, most errors associated with nutrient databases are random. Thus, assuming that the nutrient database is reasonably complete for a given nutrient, it is unlikely that database errors would substantively alter the conclusions drawn from a study at a population level. (Note that this might be different for groups consuming the same foods, such as could occur in institutional settings.)

2.4 Comparing Food Intakes to Eating Well with Canada's Food Guide

In addition to comparing nutrient intakes of Canadians to the DRIs (see Section 2.2), food intake data from the 2015 CCHS-Nutrition can be used to assess the food intakes of Canadians relative to guidance provided in Canada's Food Guide (CFG). Since its first release in 1942, the Food Guide has always been intended to guide the food selection and promote the nutritional health of Canadians. *Eating Well with Canada's Food Guide*, released in 2007, describes a dietary pattern developed to provide adequate amounts of essential nutrients and to be consistent with evidence linking diet to reduced risk of chronic diseases. The eating pattern includes recommendations (by age-sex group) for the number of servings per day of foods from four food groups (Vegetables and Fruit, Grain Products, Milk and Alternatives, and Meat and Alternatives), as well as a specific amount and type of Oils and Fats. (Note that, like nutrients, the recommended numbers of servings from the food groups in the CFG are expressed per day. However, again like nutrients, they are more appropriately considered as average intakes over a period of time, such as several days to a week.) The CFG also provides guidance on the types of foods to be emphasized. For example, recommendations include choosing foods prepared with little or no added fat, sugar or salt; having whole vegetables and fruit more often than juice; having at least one dark green and one orange vegetable each day; choosing whole grains for at least half of daily grain products servings; choosing lean meats and alternatives; choosing lower fat milk and milk alternatives; having meat alternatives often; and eating fish at least twice a week.

2.4.1 DEVELOPING A SURVEILLANCE TOOL TO ASSESS CANADIANS' FOOD INTAKES ACCORDING TO EATING WELL WITH CANADA'S FOOD GUIDE

Assessing Canadians' food intakes relative to the types and amounts of food recommended in the Food Guide requires that foods in the Canadian Nutrient File (CNF) be classified according to CFG. As such, a working group with representation from Health Canada and the Public Health Agency of Canada developed the CNF/CFG classification. Within this classification, foods are classified into "Tiers" based on how closely they align with CFG guidance, where Tier 1 reflects foods fully in line with CFG guidance, and Tier 4 reflects foods that are not in line with CFG guidance. The report of the working group (Health Canada, 2014) provides further details of the classification system, along with examples of the types of foods within each of the four tiers.

The classification system was validated using a similar modeling process to that used for the development of the 2007 CFG (described in Katamay, Esslinger, Vigneault, et al., 2007). Details of the validation process for the CNF-CFG classification are available (Elvidge Munene, Dumais, Esslinger, et al., 2015).

For those wishing to conduct primary analyses of the 2015 CCHS-Nutrition data in comparison to CFG guidance, the relevant data are contained in the 'CFG file' (one of the 2015 CCHS data files; see section 3.1). This file includes a list of foods and recipes reported in the 24-hr recall of the 2015 CCHS-Nutrition, along with their respective Tiers.

2.4.2 USING THE CNF/CFG CLASSIFICATION SYSTEM TO ASSESS CANADIANS' FOOD INTAKE

Health Canada provides the following summary (see Table 2.4) of the Tiers and how to use them to report on food group intakes (Health Canada, 2014). A key consideration is that for foods in Tier 4, which are not in line with CFG guidance, quantities that are equivalent to Food Guide Servings were established but are simply called "servings". The term "servings" is used to distinguish these foods from "Food Guide Servings" so as to avoid the suggestion that Tier 4 foods are in line or partially in line with CFG recommendations. Thus, it is possible to derive the total number of "servings" for each of the food groups in the CFG (Tiers 1–4) as well as the number of "Food Guide Servings" (Tiers 1–3; foods that are in line or partially in line with CFG guidance).

Table 2.4 Description of Tiers of the CNF/CFG Classification

Tiers	Description	General Explanation	When reporting food group intakes	Example (from milk & alternatives group)
1 and 2	"Foods in line with CFG guidance"	Generally lower in fats, sugars or salt. **Most** choices should come from this category.	Count toward total number of Food Guide Servings	Skim, 1% and 2% milk, fortified soy beverage
3	"Foods partially in line with CFG guidance"	Foods that are higher in fats, sugars or salt. On average, **few** choices should come from this category.	Count toward total number of Food Guide Servings	Whole milk, most cheese (e.g., cheddar, mozzarella)
4	"Foods not in line with CFG guidance"	Generally high in at least two of the following: fats, sugars or salt. Foods to **limit**.	**Do not count** toward total number of Food Guide Servings	Some cheeses and milk-based desserts.

Modified from Health Canada, 2014

2.4.2.1 Comparing Quantities of Food Intakes to Amounts Recommended in Canada's Food Guide. Similar to the situation for nutrients, when assessing quantities of food intakes relative to amounts recommended in CFG it is important to examine usual intake distributions (adjusted to remove within-person variability) rather than 1-day distributions (see section 2.2.1.1). The most relevant metric is the proportion of the group who are below (or at/above the recommendation), rather than the mean number of servings. This should be accompanied by information on the distribution of intakes so one can see where the population falls along the distribution.

As an example of the types of analyses that will be conducted for the 2015 CCHS-Nutrition, Table 2.5 shows the usual intake distribution of children's vegetable and fruit intake, using data from the 2004 CCHS-Nutrition. In this case, total servings from all 4 Tiers are shown. The data indicate that close to half of 2–3 year old girls and boys were below the CFG recommendation, and that this proportion increased with age to about two-thirds of 4–8 year olds and ~80% of 9–13 year olds, reflecting the age-associated increases in the recommended number of servings.

Table 2.5 The usual number of vegetable and fruit servings consumed per day by Canadian children 2–13 years of age: CCHS 2004

			Percentile of Usual Intake Distribution (SE)*								
Sex	Age (yrs)	n	5th	10th	25th	Median	75th	90th	95th	CFG recommended intake (servings)	% Below recommended intake (% SE)*
MF	2–3	1430	1.9 (0.16)	2.3 (0.15)	3.1 (0.12)	4.1 (0.11)	5.4 (0.15)	6.9 (0.25)	7.8 (0.33)	4	46.9 (2.50)
MF	4–8	3235	2.0 (0.17)	2.4 (0.15)	3.2 (0.12)	4.2 (0.09)	5.4 (0.13)	6.8 (0.22)	7.7 (0.29)	5	67.7 (2.03)
M	9–13	2080	2.2 (0.18)	2.5 (0.16)	3.3 (0.13)	4.4 (0.13)	5.7 (0.18)	7.2 (0.27)	8.3 (0.34)	6	79.2 (2.46)
F	9–13	1980	2.2 (0.18)	2.6 (0.16)	3.4 (0.14)	4.4 (0.13)	5.7 (0.18)	7.0 (0.28)	8.0 (0.36)	6	80.0 (2.59)

DATA SOURCE: Canadian Community Health Survey, Cycle 2.2., Nutrition (2004)

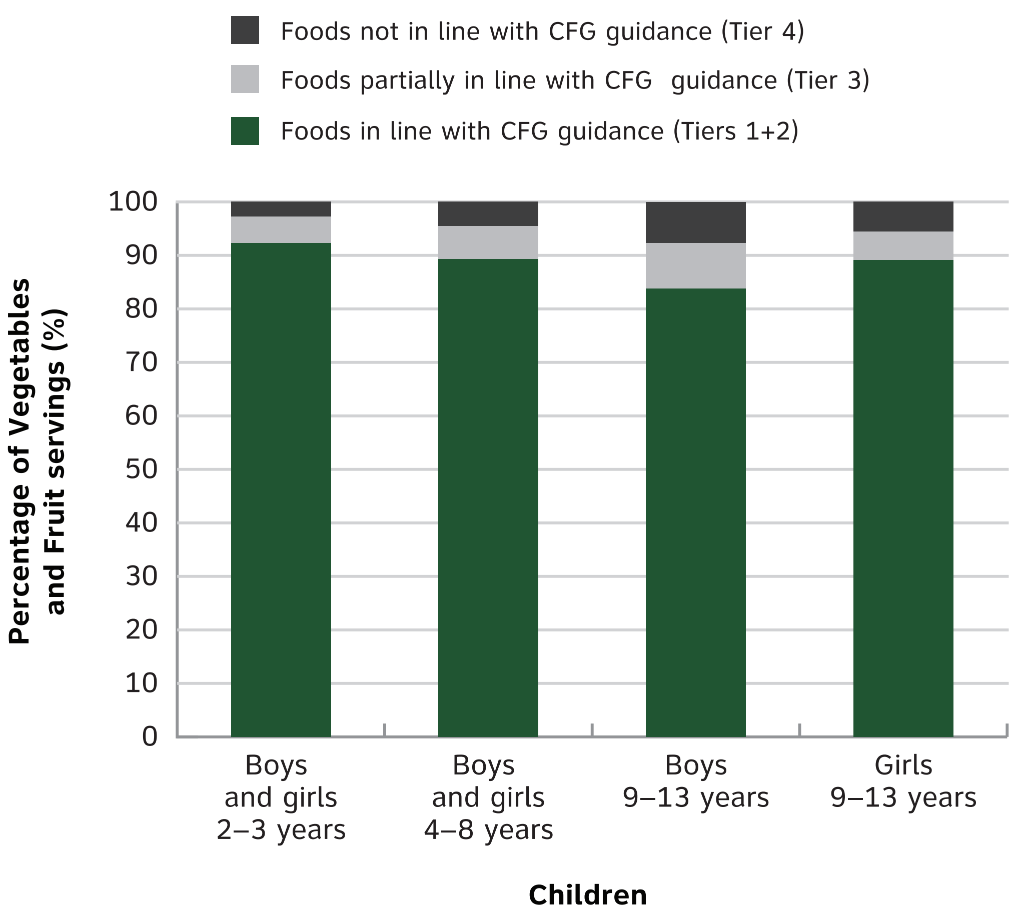
CFG: Eating Well with Canada's Food Guide (2007); MF: Male and female combined; M: Male; F: Female; E: Standard error

* The usual intake and % below recommended intake were calculated using the National Cancer Institute (NCI) method, with sex, age and total fruits and vegetable consumption as covariates.

It is important to emphasize that, in contrast to nutrients, there are no biological "requirements" for servings from the CFG food groups. Thus, the proportion below the recommended numbers cannot be interpreted as having "inadequate" intakes (as can be inferred for the proportions with nutrient intakes below the EAR). However, it could indicate increased potential for inadequate intakes of some of the nutrients provided by a particular food group. Moreover, the data could also be useful to help identify priorities for nutrition education.

2.4.2.2 Assessing the Quality of Food Choices within a Food Group. In addition to assessing the quantity of foods consumed from a food group, the 'quality' of food choices in a food group will be assessed in 2015 CCHS-Nutrition by determining the proportions of servings that are "in line with CFG guidance" (Tiers 1 and 2), "partially in line with CFG guidance" (Tier 3), and "not in line with CFG guidance" (Tier 4). Figure 2.4 shows an example of this, again using data for children's vegetable and fruit intake from the 2004 CCHS-Nutrition. Although substantial proportions of children did not consume the recommended amounts from this food group (see Table 2.5), the Figure indicates the majority (>80%) of children's choices were in line with CFG guidance, and that <10% of choices were not in line with CFG guidance.

Figure 2.4 Percentage of children's Vegetables and Fruit servings from "Foods in line with CFG guidance", "Foods partially in line with CFG guidance" and "Foods not in line with CFG guidance", based on one 24h recall, CCHS 2004



SOURCE: Health Canada, 2014 (data from Canadian Community Health Survey, Cycle 2.2, Nutrition [2004]).

2.4.2.3 Limitations of the Classification System. Nutrient values in the CNF are constantly being updated, reflecting changes in the food supply (e.g., manufacturers may reduce the amount of sodium in a food product, or change the fat source and in turn affect the saturated fat content). This has potential implications for the Tier in which a food is classified, and in some cases, whether it is 'counted' as a Food Guide Serving (Tiers 1–3) or not. Thus, the classification system reflects the data that were available in the CNF version 2015 at the time the 2015 CCHS-Nutrition was conducted.

It is also important to recognize that some foods could not be classified as falling in Tiers 1 through 4 because of missing values in the CNF. Where possible, foods with missing values were filled in using data from similar foods, allowing them to be classified. Occasionally, however, this was not possible. In total, less than 1% of the reported foods from 2015 CCHS-Nutrition could not be classified using the CNF/CFG classification system, which means that the numbers of servings may be underestimated to a small extent. However, it is not anticipated that this would have a major impact on the general findings related to assessing Canadians' intakes against the Food Guide.

2.4.3 THE HEALTHY EATING INDEX PROVIDES AN INTEGRATED MEASURE OF ADHERENCE TO THE FOOD GUIDE

The Healthy Eating Index (HEI) was originally developed in the US to provide a single measure of dietary quality as assessed against the Dietary Guidelines for Americans and the US Food Guide Pyramid (Kennedy, Ohls, Carlson, & Fleming, 1995). In its original iteration, it assessed 10 components of the diet, each of which could be scored from zero to 10. Five components were related to the extent to which the serving recommendations for the five U.S. food groups were met; four components reflected adherence to guidelines for total fat, saturated fat, cholesterol, and sodium; and one component was based on dietary variety. Possible scores could thus range between 0 and 100. The US HEI is updated periodically to reflect changes in the Dietary Guidelines for Americans; the most recent version is the HEI-2010 (Guenther, Casavale, Reedy, et al., 2013).

A Canadian adaptation of the HEI, based on the US HEI-2005 (Guenther, Reedy, & Krebs-Smith, 2008) was developed and used to assess diet quality of Canadians as reported in the 2004 CCHS-Nutrition (Garriguet, 2009). The Canadian adaptation reflects guidance provided in the 2007 Canada's Food Guide, and includes eight components that reflect dietary adequacy (total vegetables and fruit, whole fruit, dark green and orange vegetables, total grain products, whole grains, milk and alternatives, meat and alternatives, and unsaturated fats) and three components that reflect moderation (saturated fats, sodium, and percentage of energy from 'other foods' that are not part of the Food Guide).

Health Canada and Statistics Canada are planning to update the Canadian adaptation of the US HEI. Once complete, the Canadian HEI adaptation will be available for the 2015 CCHS-Nutrition data as a derived variable in the Research Data Centres (see Section 3.1.1).


3. THE 2015 CCHS-NUTRITION DATA

This section describes the raw data files that contain the 2015 CCHS-Nutrition data, which can be accessed and used by researchers who wish to conduct their own analyses of the data. It provides examples of the types of analyses being considered by Health Canada, Statistics Canada and the Public Health Agency of Canada to address the 2015 CCHS-Nutrition objectives. It also presents an overview of the mechanisms that may be used to disseminate the survey findings, including examples from the 2004 CCHS-Nutrition.

3.1 2015 CCHS-Nutrition Data Files

The raw data collected in the 2015 CCHS-Nutrition, released in June 2017, are contained in three sets of different files: the Master Files, the Share Files, and the Public Use Microdata Files (PUMF). All three sets of files include data (or some aggregated data in the PUMF) from the first and second 24-hr recalls, the vitamin and mineral supplements recalls, the general health questionnaire, food and ingredient details, and Canada's Food Guide servings and "Tiers". The overall structure of the files is very similar to the files released from the 2004 CCHS-Nutrition. As described below, the three sets of files have some differences that are related to confidentiality issues, and their results may differ slightly.

3.1.1 MASTER FILES

The Master Files include all data collected from every respondent. These data files are maintained by Statistics Canada, and for confidentiality reasons, only Statistics Canada employees or deemed employees can access these files. It is possible for researchers to submit applications to access the Master Files through Research Data Centres at some Canadian universities.

3.1.2 SHARE FILES

These files contain all variables only for the respondents who agreed to have their information shared with the survey share partners. Share partners include the provincial Ministries of Health, L'institut de la Statistique du Québec, Health Canada, and the Public Health Agency of Canada. The share files contain all of the variables available on the Master Files and about 96% of the respondents. Appropriate survey weights are provided within each file so that comparable estimates (e.g.., of food/nutrient intakes, BMI) are obtained from the Master and Share files.

3.1.3 PUBLIC USE MICRODATA FILES (PUMF)

The PUMF include all records (100% of respondents) contained on the Master Files but not all of the variables. Variables may be removed, capped or regrouped to protect confidentiality of respondents. For example, levels of geography may be restricted to the province where a respondent lives, whereas the Master file and Share file would include the postal code. Similarly, age may be reported in broad categories, rather than as the specific age in years. The PUMF are available through 80 universities/post-secondary institutions participating in the Data Liberation Initiative (DLI; a list of the institutions and their contact information is available on the DLI website), and may also be available upon request from Statistics Canada.

For the 2004 CCHS-Nutrition, the PUMF contained only data from the general health questionnaire, and did not include any data from the 24-hr recall. The PUMF for 2015 CCHS-Nutrition will include data on nutrients from foods, a summary of vitamin/mineral supplement use, and the health questionnaire data. Additional data at more detailed levels such as food, ingredient, and recipes along with Canada Food Guide tiers may be included depending upon the file structure and the results from a mandatory confidentiality review. It is expected to be released 6 to 8 months following the June 2017 data release.

3.1.4 REAL TIME REMOTE ACCESS (RTRA)

In addition to accessing the data at a university (through an RDC or a university participating in the DLI), it is possible to researchers to apply to access the data remotely, through the Real Time Remote Access (RTRA) system. This online remote access facility allows users (researchers associated with a government department, non-profit organization, or an academic institution) to submit and run SAS programs (SAS is a statistical analysis software program) in real time from their own computers. Results are extracted in the form of frequency tables.

3.2 Use of the Data by Health Canada, Statistics Canada and the Public Health Agency of Canada

3.2.1 POTENTIAL ANALYSES FOCUSED ON SURVEY OBJECTIVES

Statistics Canada, Health Canada and the Public Health Agency of Canada are planning to analyze the data from 2015 CCHS-Nutrition to explore a number of questions related to the survey's overall objectives and that are relevant to policy and program priorities. These objectives, and some examples of the types of analyses being considered for completion in the next several years, are shown below.

Objective 1: Collect detailed data on the consumption of foods and dietary supplements among a representative sample of Canadians at national and provincial levels. Proposed analyses include:

- Determine the percentage of the population consuming different vitamin and mineral supplements by age and sex, and assess if Canadians are following life-stage guidance related to supplementation
- Assess the food intake of Canadians relative to advice provided in Canada's Food Guide (e.g., the number of servings consumed; the proportions of servings in each food group that are "in line", "partially in line", or "not in line" with Food Guide guidance; the extent to which directional statements in the Food Guide are being followed)
- Determine the percentage of energy coming from beverages and various categories of beverages, "other foods" (i.e., foods that are not included in the Food Guide), various meals and snacks, foods consumed at home versus other locations, etc.

Objective 2: Estimate the distribution of usual dietary intake in terms of nutrients from foods, food groups, dietary supplements and eating patterns. Proposed analyses include:

- Determine the distribution of usual nutrient intakes from food alone, and the proportions below the EAR, above the UL, and within the AMDR, by DRI age/sex group
- Determine the distribution of total usual nutrient intakes (from food plus supplements), and the proportions below the EAR and above the UL, by DRI age/sex group

Objective 3: Gather anthropometric (physical) measurements for accurate body weight and height assessment to interpret dietary intake. Proposed analyses include:

- Describe the distribution of BMI (and associated BMI categories of normal weight, overweight and obesity) by age/sex group, and by other socio-demographic variables such as income, education, physical activity, self-reported health, chronic disease and smoking status

Objective 4: Support the interpretation and analysis of dietary intake data by collecting data on selected health conditions and socio-economic and demographic characteristics. Proposed analyses include:

- Assess intakes relative to food security status

Objective 5: Evaluate changes in dietary intake from the 2004 CCHS-Nutrition. Proposed analyses include:

- Compare the prevalence of usual intakes below the EAR and above the UL to estimates from 2004
- Compare the percentages of energy coming from “other foods”, beverages, various meals and snacks, etc. to estimates from 2004

For more information or questions: email: nutritionsurveillancenutritionelle@hc-sc.gc.ca

3.2.2 OTHER POTENTIAL ANALYSES

3.2.2.1 Geospatial Information Systems (GIS). Statistics Canada is currently assessing whether it would be feasible to use respondents’ postal codes to add geo-spatial variables to survey data files, such as the neighbourhood walkability score, proximity to parks and green spaces, population density, the material and social deprivation index (Pampalon, Hamel, Gamache, & Raymond, 2009), and proximity to food outlets (grocery stores, fast-food restaurants, etc.). While the specific variables that could be added have not been determined, it may be possible to add some variables to the 2015 CCHS-Nutrition data file, at some point after the initial data release, permitting analysis of whether nutrient intakes or body weight status are associated with these variables.

3.2.2.2 Data Linkages. The potential to link data from the 2015 CCHS-Nutrition to other surveys (e.g. the census) and administrative databases (e.g. vital statistics, the Canadian Institute for Health Information), provides additional opportunities to explore relevant research questions. As part of the survey, respondents were asked to provide their provincial health number. With that information, data can be linked from the 2015 CCHS-Nutrition to other data, such as past and continuing use of health services, or to information from other surveys or administrative data sources. This would permit relationships between nutritional variables and various health outcomes to be explored. It should be noted that Health Canada and the Public Health Agency of Canada would not be able to do the linking themselves because Statistics Canada removes any identifying information that would be used to do the linkage. The actual linkage has to be done by Statistics Canada, on a cost-recovery basis, and the same applies to researchers at RDCs. Further information on Statistics Canada’s policies on record linkage are available on-line.

3.3 Dissemination of CCHS-Nutrition Findings

Health Canada, Statistics Canada and the Public Health Agency of Canada will disseminate findings from the 2015 CCHS-Nutrition in a number of different ways, as was done following the 2004 CCHS-Nutrition. These are described below, and where appropriate, examples are provided of dissemination products from the 2004 CCHS-Nutrition.

3.3.1 THE DAILY

The Daily is Statistics Canada's official online release vehicle. It includes announcements of the release of new datasets (e.g. 2015 CCHS-Nutrition), analytical products (e.g. Health-at-a-Glance articles, Health Reports articles, Fact Sheets), and information products (e.g. PUMF, CANSIM tables, graphs, maps, text).

3.3.2 CANSIM SUMMARY TABLES

Statistics Canada's Canadian Socio-Economic Information System (CANSIM) is an online database for Canadian socioeconomic statistics on labour, health, income, trade, education, manufacturing, investment and other factors. New data are uploaded frequently, and the tool provides fast and easy access to a range of the latest Canadian statistics. CANSIM will not provide all of the data available from the 2015 CCHS-Nutrition, but selected tables were produced at the time of the data release and include: BMI of adults and children, physical activity and screen time for those aged 6 to 17 years, past-month vitamin and mineral supplement consumption, and percentage of total energy intake from carbohydrate, protein and fat. From the main page of the CANSIM site, these tables can be accessed by selecting "Health" and then "Lifestyle and social conditions". (It should be noted that Statistics Canada plans to replace CANSIM with the "Common Output Data Repository" [CODR] in April 2018. The summary data from 2015 CCHS-Nutrition that were previously available through CANSIM will be accessible through the CODR.)

3.3.3 NUTRIENT INTAKES FROM FOOD

In 2009, Health Canada produced a DVD that provided provincial, regional and national summary data tables on nutrient intakes from food as assessed in the 2004 CCHS-Nutrition, which will continue to be available as a zip file by sending an email to Health Canada Publications—publications@hc-sc.gc.ca. The tables show data by DRI age/sex group, as well as for all adult males and all adult females. The data presented include the mean intake, percentiles (and standard errors) of the usual intake distribution (5th, 10th, 25th, 50th, 75th, 90th and 95th), and where applicable, the proportions of the usual intake distribution below the EAR, above the AI, above the UL, or below, within and above the AMDR.

Table 3.1 is an example of one of these summary tables, and shows usual vitamin C intakes from food for Canadians (excluding the territories, which were not included in the CCHS-Nutrition). Although the table includes information on the proportions of the population with intakes below the EAR and above the UL, it should be noted that because the intakes in this table are based on intake from food alone (they do not include supplements), they may overestimate that proportions with total intakes below the EAR and underestimate the proportions above the UL. Similarly, the data in the tables do not adjust for misreporting, which could further add to these potential errors.

Although a DVD will not be produced to disseminate summaries of nutrient intake data from the 2015 CCHS-Nutrition, summary data on nutrient intakes from food (and in some cases, from the combined intake of food and supplements) will be publicly released when they become available.

Table 3.1 Example of Summary Table of Usual Nutrient Intake from Food

Table 3.1 Vitamin C (mg/d): Usual intakes from food, by DRI age–sex group, household population, Canada excluding territories, 2004[1]

					Percentiles *(and SE)* of usual intake																			
Sex	**Age (years)**	**n**	**Mean**	*(SE)*	5th *(SE)*		10th *(SE)*		25th *(SE)*		50th *(SE)*		75th *(SE)*		90th *(SE)*		95th *(SE)*		**EAR[2]**	**% <EAR**	*(SE)*	**UL[3]**	**% >UL**	*(SE)*
Both	1–3	**2117**	**135**	*(3)*	**45**	*(3)*	**58**	*(4)*	**86**	*(4)*	**128**	*(4)*	**180**	*(5)*	**237**	*(8)*	**276**	*(10)*	**13**	**<3**		**400**	**0.6**	*(0.2)[E]*
	4–8	**3235**	**145**	*(3)*	**57**	*(6)*	**71**	*(6)*	**100**	*(5)*	**137**	*(4)*	**180**	*(5)*	**227**	*(9)*	**260**	*(13)*	**22**	**<3**		**650**	**0.0**	*(0.0)*
Male	9–13	**2080**	**157**	*(5)*	**58**	*(5)*	**73**	*(5)*	**104**	*(5)*	**147**	*(6)*	**201**	*(9)*	**262**	*(14)*	**306**	*(19)*	**39**	**<3**		**1200**	**0.0**	*(0.0)*
	14–18	**2288**	**163**	*(6)*	**56**	*(5)*	**71**	*(5)*	**102**	*(6)*	**151**	*(7)*	**214**	*(10)*	**283**	*(14)*	**330**	*(17)*	**63**	**7.1**	*(1.6)[E]*	**1800**	**0.0**	*(0.0)*
	19–30	**1804**	**158**	*(7)*	**54**	*(6)*	**67**	*(7)*	**97**	*(7)*	**144**	*(8)*	**207**	*(11)*	**277**	*(16)*	**325**	*(20)*	**75**	**13.7**	*(3.2)[E]*	**2000**	**0.0**	*(0.0)*
	31–50	**2596**	**127**	*(4)*	**40**	*(4)*	**51**	*(4)*	**76**	*(5)*	**116**	*(5)*	**169**	*(6)*	**226**	*(10)*	**266**	*(14)*	**75**	**24.4**	*(3.0)*	**2000**	**0.0**	*(0.0)*
	51–70	**2550**	**131**	*(5)*	**38**	*(3)*	**50**	*(3)*	**77**	*(4)*	**118**	*(5)*	**173**	*(8)*	**237**	*(12)*	**284**	*(16)*	**75**	**24.0**	*(2.4)*	**2000**	**0.0**	*(0.0)*
	>70	**1520**	**111**	*(4)*	**32**	*(3)*	**43**	*(3)*	**66**	*(4)*	**101**	*(5)*	**148**	*(6)*	**201**	*(9)*	**238**	*(11)*	**75**	**31.5**	*(2.9)*	**2000**	**0.0**	*(0.0)*
	19+	**8470**	**133**	*(3)*	**41**	*(2)*	**52**	*(2)*	**79**	*(3)*	**120**	*(3)*	**177**	*(4)*	**243**	*(6)*	**289**	*(9)*	**75**	**22.5**	*(1.5)*	**2000**	**0.0**	*(0.0)*
Female	9–13	**1980**	**146**	*(4)*	**59**	*(5)*	**72**	*(5)*	**99**	*(5)*	**136**	*(5)*	**180**	*(7)*	**225**	*(9)*	**255**	*(12)*	**39**	**<3**		**1200**	**0.0**	*(0.0)*
	14–18	**2256**	**147**	*(4)*	**53**	*(4)*	**67**	*(5)*	**96**	*(5)*	**138**	*(5)*	**190**	*(7)*	**247**	*(10)*	**286**	*(13)*	**56**	**6.0**	*(1.5)[E]*	**1800**	**0.0**	*(0.0)*
	19–30	**1854**	**133**	*(5)*	**47**	*(5)*	**58**	*(5)*	**83**	*(5)*	**121**	*(6)*	**171**	*(8)*	**225**	*(12)*	**260**	*(14)*	**60**	**10.8**	*(2.5)[E]*	**2000**	**0.0**	*(0.0)*
	31–50	**2686**	**117**	*(4)*	**34**	*(3)*	**44**	*(3)*	**67**	*(3)*	**104**	*(4)*	**153**	*(5)*	**210**	*(8)*	**252**	*(10)*	**60**	**19.9**	*(2.2)*	**2000**	**0.0**	*(0.0)*
	51–70	**3200**	**122**	*(3)*	**41**	*(3)*	**52**	*(3)*	**77**	*(3)*	**111**	*(4)*	**156**	*(5)*	**206**	*(7)*	**240**	*(9)*	**60**	**14.2**	*(1.8)*	**2000**	**0.0**	*(0.0)*
	>70	**2610**	**106**	*(3)*	**34**	*(2)*	**44**	*(2)*	**66**	*(3)*	**98**	*(3)*	**137**	*(4)*	**180**	*(6)*	**210**	*(8)*	**60**	**20.8**	*(1.9)*	**2000**	**0.0**	*(0.0)*
	19+	**10350**	**120**	*(2)*	**38**	*(2)*	**49**	*(2)*	**73**	*(2)*	**109**	*(2)*	**157**	*(3)*	**210**	*(5)*	**247**	*(6)*	**60**	**16.7**	*(1.2)*	**2000**	**0.0**	*(0.0)*

DATA SOURCE: Statistics Canada, Canadian Community Health Survey, Cycle 2.2, Nutrition (2004)–Share File

Symbol Legend

E Data with a coefficient of variation (CV) from 16.6% to 33.3%; interpret with caution.

<3 Data with a coefficient of variation (CV) greater than 33.3% with a 95% confidence interval entirely between 0 and 3%; interpret with caution.

F Data with a coefficient of variation (CV) greater than 33.3% with a 95% confidence interval not entirely between 0 and 3%; suppressed due to extreme sampling variability.

Footnotes

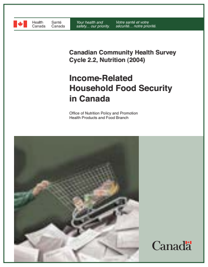
1 Intakes are based on food consumption only. For additional detail, see footnote 4 in Appendix A.

2 EAR is the Estimated Average Requirement. For additional detail, see footnote 9 in Appendix A. The EAR for vitamin C used in this table is that for non-smokers.

3 UL is the Tolerable Upper Intake Level. For additional detail, see footnote 11 in Appendix A.

For additional footnotes common to all tables, see Appendix A.

3.3.4 REPORT ON INCOME-RELATED HOUSEHOLD FOOD SECURITY IN CANADA AND SUPPLEMENTARY DATA TABLES


Health Canada / Santé Canada — Your health and safety... our priority. / Votre santé et votre sécurité... notre priorité.

Canadian Community Health Survey Cycle 2.2, Nutrition (2004)

Income-Related Household Food Security in Canada

Office of Nutrition Policy and Promotion
Health Products and Food Branch

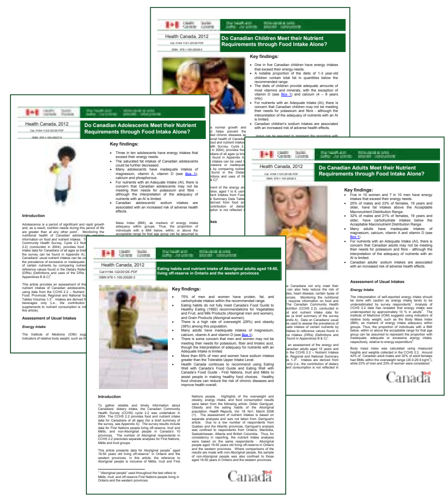
Canada

A key objective of the 2004 CCHS-Nutrition was to measure the prevalence of food insecurity in Canada. Accordingly, Health Canada published a report that provided national, provincial, regional and Aboriginal off-reserve estimates of income-related food insecurity at the household, adult and child level, and assessed food security status by selected socio-demographic characteristics. Supplementary data tables are also available.

Health Canada will not be producing another report on prevalence of food insecurity, as the CCHS-Annual Component is the reporting vehicle for prevalence estimates. The appropriate focus for the 2015 CCHS-Nutrition analyses will be related to nutritional vulnerability (i.e., the extent to which food security/insecurity status is associated with food and nutrient intakes).

3.3.5 HEALTH CANADA ARTICLES ON CANADIANS' FOOD AND NUTRIENT INTAKES

Following the 2004 CCHS-Nutrition, Health Canada produced a series of articles that summarized the intakes of energy and nutrients from food alone for children aged 1–8, adolescents aged 9–18, and adults aged 19 years and older. An additional article described the eating habits and nutrient intakes of off-reserve Aboriginal people aged 19–50 living in Ontario and the four western provinces. (Note that because off-reserve Aboriginal people were not oversampled in the 2015 CCHS-Nutrition, a report on their intakes will not be produced; however, articles summarizing other key findings may be produced.)


Health Canada, 2012
Do Canadian Children Meet their Nutrient Requirements through Food Intake Alone?

Health Canada, 2012
Do Canadian Adolescents Meet their Nutrient Requirements through Food Intake Alone?

Health Canada, 2012
Do Canadian Adults Meet their Nutrient Requirements through Food Intake Alone?

Health Canada, 2012
Eating habits and nutrient intakes of Aboriginal adults aged 19-50, living off-reserve in Ontario and the western provinces

3.3.6 PUBLICATIONS FROM STATISTICS CANADA AND OTHER RESEARCHERS

Researchers at Statistics Canada, as well as other researchers in universities and elsewhere, used data from the 2004 CCHS-Nutrition to develop articles that were published in *Health Reports* (Statistics Canada's peer-reviewed journal) and in other scientific publications. A list of articles is provided in **Appendix 5**.

3.3.7 CIHR-FUNDED RESEARCH

To promote the use and analysis of these data, the Canadian Institutes of Health Research (CIHR) Institute of Nutrition and Diabetes Metabolism, funded researchers to contribute further to the body of evidence using data from the 2004 CCHS-Nutrition. Some of the publications included in **Appendix 5** were supported by this funding opportunity. A similar funding initiative from CIHR supports analysis of the 2015 CCHS-Nutrition. As part of these grants, knowledge translation sessions and published articles will be vehicles used to disseminate results.

4. USING THE DATA TO MAKE COMPARISONS

As stated in Chapter 1, the over-arching goal of the 2015 CCHS-Nutrition is to provide reliable, timely information about Canadians' dietary intake, nutritional wellbeing and their key determinants, with the purpose of informing and guiding programs, policies and activities of federal and provincial governments. This goal, and many of the specific objectives, can be met to a considerable extent using data from the 2015 CCHS-Nutrition alone. For example, one of the specific objectives is to estimate the distribution of usual dietary intake in terms of nutrients from foods, food groups, dietary supplements and eating patterns. Because the distributions of usual dietary intake are specific to DRI age/sex groups (since nutrient requirements and food group recommendations vary by age and sex), fully meeting this objective may involve comparing age/sex groups within the 2015 CCHS-Nutrition to assess if they differ. However, the fifth specific objective is to evaluate changes in dietary intake since the 2004 CCHS-Nutrition, which requires comparing data between the two surveys. In addition, it may also be of interest to compare the findings to other surveys (e.g., nutrition surveys in the United States). The sections that follow describe issues to be aware of when making comparisons within the 2015 CCHS-Nutrition, between the 2004 and the 2015 CCHS-Nutrition, or between the 2015 CCHS-Nutrition and other surveys.

4.1 Making Comparisons Within the 2015 CCHS-Nutrition

Data summaries from the 2015 CCHS-Nutrition will be available by age group and sex. Users of these data summaries may want to know whether differences exist between certain groups, such as older and younger individuals, or men and women. The ability to assess the statistical significance of observed differences in tabulated data is limited; however, some information is available by using the Confidence Intervals (CIs) or Standard Errors (SEs) that are provided in the tables. These variables reflect uncertainty that arises due to extrapolating from the sample that was measured to the Canadian population.

For example, the 2004 CCHS-Nutrition reported that the average vitamin C intake from food alone was 133 mg/d for Canadian men aged 19 years and above. However, because the survey did not measure every adult Canadian male, the mean vitamin C intake for the adult male population could be slightly higher or lower than the mean value for the 8470 men who took part in the 2004 CCHS-Nutrition. If one repeated the survey thousands of times, selecting a different representative sample each time and assessing mean vitamin C intake in each sample, that set of thousands of mean vitamin C intakes would have its own mean and standard deviation. The standard error (SE) is the standard deviation of all the possible sample means drawn from the population, and plus or minus twice the SE estimates the 95% confidence interval (CI), which would include 95% of the individual sample means. A CI is a range within which there is a specified degree of confidence (commonly 95%) that the variable's true value could lie. In this example, where mean daily vitamin C intake of Canadian adult men in the 2004 CCHS was 133 mg, the SE was 3 mg. Thus, subtracting and adding twice the SE to the mean of 133 mg/d leads to a 95% CI of 127 mg to 139 mg (133 mg – [2*3 mg] = 127 mg; 133 mg + [2*3 mg] = 139 mg).

When looking at tabulated data summaries that are not presented in conjunction with results of statistical analysis, knowledge of the 95% CI can assist those without access to the raw data in assessing whether apparent differences between two groups are true differences, or simply reflect sampling variability. In general, if the 95% CIs for the two groups do not overlap, they are significantly different, while if there is extensive overlap between the 95% CIs, they do not differ significantly (Cumming, 2009). Table 4.1 below shows data on the prevalence of inadequate (<EAR) vitamin C intakes from food sources among adult men from the 2004 CCHS-Nutrition (these data are shown for all age/sex groups in Table 3.1; to simplify interpretation, information on the 95% CI has been added). If one wanted to know whether the apparent difference in the prevalence of inadequacy for men aged 19 to 30 years and those aged >70 years was significant, the 95% CIs could be examined. It is clear that the 95% CI of 37.3% to 51.7% for men aged >70 years does not overlap with the 95% CI of 39.2% to 48.4% for men aged 19 to 30 years. Thus, men over the age of 70 are more likely than young adult men to have inadequate vitamin C intakes from food. However, there is no difference between men aged 31 to 50 years and those aged 51 to 70 years: the 95% CIs overlap almost completely.

Table 4.1 Prevalence of inadequate vitamin C intake from food sources in Canadian men aged 19 to >70 years, 2004

Age group (y)	% (SE) with intake <EAR	95% CI
19–30	13.7 (3.2)	7.3–20.1
31–50	24.4 (3.0)	18.4–30.4
51–70	24.0 (2.4)	19.2–28.8
>70	31.5 (2.9)	25.7–37.3

DATA SOURCE: Statistics Canada, CCHS, Cycle 2.2, Nutrition (2004). The 95% CI was calculated by subtracting and adding 2 SE from the point estimate of prevalence.

It should be emphasized that use of CIs to assess significant differences is a coarse tool that is sometimes useful but is not perfect. The method works well in cases such as the prevalence of inadequate vitamin C intakes between older and younger men, or between men in the two intermediate age groups, where there is either no overlap or extensive overlap between the two age groups. When partial overlap exists, differences may or may not be significant. A second key point is that this method is most suited to making a single comparison between two groups. When making multiple comparisons, such as comparing all possible age groups in Table 4.1 to each other, there is an increased likelihood of Type I error (concluding that a difference is significant when it is due to chance).

A final consideration regarding differences between groups relates to the question “So what?” It is important to note that not all statistically significant differences will have major implications for policies or programs. For example, in the 2004 CCHS-Nutrition, the prevalence of obesity among adult women was significantly higher in the middle and upper-middle income groups than in the highest income group, while prevalence in the lowest and lower-middle income groups did not differ from the highest income group (Tjepkema, 2006). However, prevalence in all income groups ranged from 20% to 28%; accordingly, despite their significantly higher prevalence rates, targeting an intervention to women in middle and upper-middle income groups would likely not be the most efficient use of resources.

4.2 Comparisons Between 2004 CCHS-Nutrition[3] and 2015 CCHS-Nutrition

One of the objectives of the 2015 CCHS-Nutrition was to assess whether changes have occurred since the 2004 CCHS-Nutrition. For example, in the 2004 CCHS-Nutrition, key findings for adults were: 1) there was a high prevalence of overweight and obesity; 2) 25% of men and 23% of women had fat intakes above the AMDR; 3) 32% of men and 21% of women had carbohydrate intakes below the AMDR; 4) many adults had inadequate intakes of magnesium, calcium, vitamin A and vitamin D (based on intake from food alone); 5) potassium and fibre intakes may have been low; and 6) sodium intakes were high (Health Canada, 2012). Have these findings changed over time?

The two surveys were designed to be similar to facilitate comparing the data. Nevertheless, there were some differences in some of the survey modules (e.g., which specific questions were asked), as well as in the overall execution of the survey (e.g., sample size and response rate) and the databases used for analyses. Table 4.2 summarizes key features of the two surveys, and points out (using bold font) where differences occurred.

Table 4.2 Comparison of Key Features of 2004 and 2015 CCHS-Nutrition

	2004	2015
Survey Characteristics		
Sample universe	All ages 0 and above; individuals living in private households in 10 provinces	**Age ≥1yr**; individuals living in private households in 10 provinces
Stratification	15 DRI age-sex groups (sexes combined: 0–1 yr, 1–3 yr, 4–8 yr; males and females separately: 9–13 yr, 14–18 yr, 19–30 yr, 31–50 yr, 51–70 yr, ≥71 yr)	**12 DRI age-sex groups** (sexes combined: 1–3 yr, 4–8 yr; males and females separately: 9–13 yr, 14–18 yr, **19–50** yr, 51–70 yr, ≥71 yr)
Sample size	1st interview: 35,107 2nd interview: 10,786 (30.7%)	1st interview: **20,487** 2nd interview: **7,623 (~37%)**
Oversampled groups	Aboriginal Canadians aged 19 to 50 yr living off-reserve were over-sampled, and the provincial governments of Ontario, Manitoba and PEI paid for larger samples for their provinces.	**No oversampling**
Survey administration	Voluntary interviews: conducted by proxy (parent or caregiver) for children <6 yr; joint interview (respondent and parent/caregiver) for children aged 6–11 yr; respondent alone for individuals age ≥12 yr	
Survey mode	1st interview: Face-to-face (computer-assisted personal interview) 2nd interview: Telephone (computer-assisted telephone interview)	
Response rate	76%	**61.6%**

[3] Full documentation (questionnaires, user guide, data dictionary, derived variables, response rates, etc.) for the 2004 CCHS-Nutrition is available from the Statistics Canada survey page for the 2004 CCHS-Nutrition. See the sections on "Questionnaires" and "Documentation".

	2004	2015
Interview kit/tools	Food model booklet Weigh scale Tape measure Triangle	Food model booklet (all colour) Weigh scale (same as in 2004) Tape measure (metric only) Triangle
24-hr Recall		
Interview duration	~30 minutes	
Methodology used	Modification of US Automated Multiple-Pass Method (AMPM). Information obtained on where meals or snacks were *prepared*.	The same AMPM was used, but updated (see Section 1.2.3.1). Information was obtained on where meals or snacks were **eaten** (rather than where they were prepared).
Database used to analyze nutrient intake	Foods and nutrients extracted from the Canadian Nutrition File (CNF) Version 2001b based on USDA Standard Release (SR) 13–14 (folic acid) Recipe database based on the Food and Nutrient Database for Dietary Studies (FNDDS) 1.0	Foods and nutrients extracted from the **CNF Version 2015** based on USDA SR 23–27 Recipe database based on **FNDDS 5.0** and some **FNDDS 2011–12**.
Supplemented Foods	N/A	Use of some **supplemented foods** with a Temporary Marketing Authorization (e.g., energy drinks, vitamin waters) noted
Categories used for food units	Based on usage (e.g., whatever respondents reported for a given food)	**Standardized units**, with options appropriate for each food
Soft 'edits' for units or amounts of food (e.g., minimum and maximum values)	Few edits	**Extensive edits** (see section 1.2.3.1) leading to a reduced likelihood of recording implausible amounts)
"Trailing questions"	Frequency of adding salt to food at the table, and use of table salt.	Use of table salt (**type of salt used now includes sea salt and gourmet salt**, addition to foods at the table **or in cooking/food preparation); Foods completely excluded from the diet (meat, fish, poultry, eggs, dairy, gluten)**
Dietary Supplement Recall		
Supplements queried	Primarily vitamins and minerals	Vitamins, minerals, **fibre supplements, antacids, fish oils and other oils**
Reference period for intake	Frequency and dosage of intake over the past month	Frequency and dosage of intake over the past month; **in addition, the amount of the supplement used during the period of the 24-hr recall ('yesterday')**

	2004	2015
Second 24-hr recall	Supplement use not assessed	**Use of supplements reported in the first 24-hr recall was assessed during the second 24-hr recall**
Database used	Drug Products Database	**Licensed Natural Health Products Database**
Nutrients Reported		
Energy and macronutrients from food	Energy (kcal), alcohol (g), carbohydrate (g), total sugars (g), total dietary fibre (g), total fat (g), cholesterol (mg), total saturates (g), total monounsaturates (g), total polyunsaturates (g), protein (g)	
Energy and macronutrients from supplements	Carbohydrates (g), fibre (g)	
Fatty acids from food	Linoleic (C18:2 n-6; g), linolenic (C18:3 n-3; g)	Linoleic, linolenic, **octadecanoic (stearic; C18:0; g), DHA (C22:6 n-3; g), EPA (C20: 5n-3; g), DPA (C22:5n-3; g)**
Fatty acids from supplements	Linoleic (g), linolenic (g)	Linoleic (g), linolenic (g), **DHA (g), EPA (g)**
Vitamins from food	Vitamin A (mcg RAE), thiamin (mg), riboflavin (mg), niacin (mg NE), vitamin B_6 (mg), vitamin B_{12} (mg), folic acid (mcg), dietary folate equivalents (mcg DFE), folacin (mcg), naturally occurring folate (mcg), vitamin C (mg), vitamin D (mcg)	
Vitamins from supplements	Vitamin A (mcg RAE), thiamin (mg), riboflavin (mg), niacin (mg NE), vitamin B_6 (mg), vitamin B_{12} (mg), folic acid (mcg and DFE), vitamin C (mg), vitamin D (mcg), vitamin E (mg alpha-tocopherol)	
Minerals from food (and from supplements)	Calcium (mg), iron (mg), magnesium (mg), phosphorus (mg), potassium (mg), sodium (mg), zinc (mg)	
Other	Moisture (g), caffeine (mg)	
Health and Socio-demographic Data		
Interview duration	~30 minutes	**~15 minutes**
Survey modules included in 2004 that were deleted in 2015	Fruit and vegetable consumption, 12-month alcohol consumption, self-reported height and weight on a subset	
Survey modules shortened in 2015	• General health (5 questions) • Chronic conditions (9 questions, all ages) • Adult physical activity (age 12+; for leisure only; frequency and duration of each of up to 24 types of physical activity in the past 3 months) • Smoking (10 questions) • Labour force (17 questions) • Income (household & personal)	• General health (**1** question) • Chronic conditions (**6** questions, **age 19+**) • Adult physical activity (**age 18+;** for **leisure, work, housework, or transportation (combined)**; frequency and average duration in the past **7 days**) • Smoking (**2** questions) • Labour force (**3** questions) • Income (household)

	2004	2015
Survey modules generally similar in 2015	• Children and youth physical and sedentary activity (however, note that in 2015, children (age 6–11) and youth (age 12–17) were asked similar questions, whereas in 2004, youth were asked the 'adult' questions about leisure physical activity) • Socio-demographics • Women's health • Measured height and weight (self-reported values from those who refused/were not able to be measured). • Food security	
Measured height and weight	Measured height and weight; self-report data for those unwilling/unable to be measured AND on a subsample of those with measured values. International Obesity Task Force (IOTF) standards used to classify BMI of children <17 yr.	Measured height and weight; self-report data for those unwilling/unable to be measured. **BMI of children <17 yr classified using both IOTF and World Health Organization (WHO) standards**
Data linkage	Respondents' permission was sought to link CCHS data with provincial health care utilization (through the provincial health care number).	Respondents were **informed** that their CCHS responses could be linked with their provincial health care utilization (unless they specifically objected to the statement).

Modified from a presentation by Leslie Geran (Statistics Canada) at the Canadian Nutrition Society Annual Conference, Gatineau, May 6 2016.

4.2.1 POTENTIAL IMPLICATIONS OF DIFFERENCES IN SURVEY METHODS AND DATA

Overall, the differences in the methods used and data collected between the surveys were modest, and should not have major implications for the primary comparisons between 2004 and 2015 (e.g., nutrient intakes from food alone). Although many of the health and socio-demographic modules were shortened, these modules were not intended to provide key survey outcomes, but instead, were designed to be used to examine associations with key outcomes (e.g., whether dietary intakes vary by smoking status, education level, household income, etc.). Using the shorter modules still permits these associations to be examined. However, there are a few differences that should be noted, as there is potential that they may affect the comparisons between 2004 and 2015. These relate to assessment of supplement intake, the sample size and response rate, differences in DRI age-sex groups, new standards for interpreting BMI in children, methods used to generate usual intake distributions, and changes in the nutrient database used to analyze 24-hr recalls.

4.2.1.1 Nutritional Supplements. In 2015 questions about supplement use were broadened to include use of antacids, fibre supplements, and fish oils and other oils. Many over-the-counter antacids contain substantial amounts of calcium and some also contain magnesium. If intakes of supplemental calcium and magnesium are higher in 2015 than in 2004, the change may be due, at least in part, to the fact that the contribution of intake from antacids has been included. Similarly, use of fibre supplements was not specifically assessed in 2004, so if supplemental fibre intakes are higher in 2015, this may be due in part to asking about fibre supplements. Finally, use of fish oils was not queried in 2004. However, the nutrient intake data from 2004 were not analyzed for docosahexaenoic acid (DHA) or eicosapentaenoic acid (EPA), two of the key fatty acids found in fish oils.

Thus, it will not be possible to compare supplemental DHA or EPA intakes between the two surveys. (Similarly, comparing intakes of these fatty acids from food sources will also not be possible, as they were not included in the data from 2004 CCHS-Nutrition. This is also true for stearic acid [C18:0].)

In 2015, the Natural Product Numbers (NPN) of nutrition supplements used by survey participants were recorded during the interview process, and used to access data on the supplement's nutrient content from the Licensed Natural Health Products Database. For supplements without a NPN, information on nutrient content was recorded directly from the label. A similar process was used in 2004, although at that time supplements were labeled with a Drug Identification Number (DIN) and information on the nutrient content was obtained from the Drug Products Database. This difference is not expected to affect the interpretation of data on nutrient intake from supplements.

4.2.1.2 Sample Size and Response Rate. In 2004, the sample size was 35,107, compared to 20,487 in 2015. A smaller sample size generally results in larger standard errors and 95% confidence intervals, which in turn means that differences between groups must be larger to be statistically significant. So it is possible that in some cases, intakes may 'appear' to have changed over time, but the difference does not attain statistical significance.

Secondly, the response rate in 2015 was 61.6%, compared to 76% in 2004. This increases the potential for non-response bias (see section 2.3.1.3). In this case, it could be speculated that individuals with an interest in nutrition (who could have higher nutrient intakes and/or be more likely to use supplements) were more likely to take part in the survey. That in turn could make intakes appear 'better' in 2015 than in 2004. However, use of non-response adjustments in the survey weights should reduce the potential impact of non-response bias.

4.2.1.3 DRI Age-Sex Groups. In 2015, the number of DRI age-sex groups was reduced from 15 to 12. For several reasons, the 0 to1 year age group was eliminated from the survey in 2015. First, in 2004 the target number for children under the age of 1 year was not reached, and there is no Statistics Canada sampling frame to identify households with a child under the age of 1year, since in most cases the child would not have been born when the sampling was developed. Second, during the 24-hr recall it was not possible to quantify the volume of breastmilk consumed by breastfed infants, so data on their total nutrient intake was not available. Furthermore, height and weight measurements were not conducted in this age group.

The other change was that the 19 to 30 year and 31 to 50 year age groups were combined to a single age group aged 19 to 50 years. Combining these age groups was reasonable, as the DRIs are identical for all nutrients except magnesium (where the EARs are 330 mg/d and 350 mg/d for men aged 19 to 30 and 31 to 50 years, respectively, and 255 mg/d and 265 mg/d for the same two age groups of women). Comparing mean intakes and the prevalence of inadequacy between 2004 and 2015 will require subdividing the 2015 CCHS-Nutrition data for the 19 to 50 year age group into the DRI age groups of 19 to 30 years and 31 to 50 years.

4.2.1.4 Interpretive Standards for BMI in Children. As noted elsewhere (Section 1.2.4.3), the WHO standards for classifying children's BMI by sex and age were not available when the 2004 CCHS-Nutrition data were analyzed, and children's BMI was assessed using the IOTF cu-offs (Cole et al., 2000). The overall prevalence of overweight/obesity for children aged 2 to 17 years in the 2004 CCHS-Nutrition was 26% using the IOTF cut-offs, but was 35% when the data were re-analyzed using the WHO cut-offs (Shields & Tremblay, 2010). Thus, when comparing data on the weight status of children between 2004 and 2015 CCHS-Nutrition, it is essential to make comparisons using the same reference standards. To support this, Statistics Canada will provide prevalence estimates for the 2015 CCHS-Nutrition using both the WHO and the IOTF (Cole et al., 2000) cut-offs, and include derived variables for both on the data files, and will also report both sets of values for the data from the 2004 CCHS-Nutrition. It should be noted that the IOTF classification system uses the same terminology for children aged 2 to <5 years and for those aged 5 years and above: for both groups, the categories are 'overweight', 'obese', and 'neither overweight nor obese'. In contrast, the WHO classification system uses 'at risk of overweight' and 'overweight' in those aged 2 to <5 years to describe the 'overweight' and 'obese' categories used in children aged ≥5 years (see Section 1.2.4.3 and Table 1.3).

4.2.1.5 Generating Usual Intake Distributions. As noted in Section 2.2.1.2, the ISU method was used by Health Canada and Statistics Canada to generate usual nutrient intake distributions from food for the 2004 CCHS-Nutrition, while the NCI method will be used for the 2015 CCHS-Nutrition. As described earlier (Section 2.2.1.2), both methods effectively remove within-person variation and generate comparable usual intake distributions for nutrients that are consumed on a daily basis (Souverein, Dekkers, Geelen et al., 2011). It should be noted that small differences will likely exist in the usual nutrient intake distributions generated by the two methods, particularly in the "tails" of the distributions (e.g., the 5^{th} and 95^{th} percentiles). However, it is unlikely that these would affect broad conclusions about the adequacy or the potential risk of excessive nutrient intakes.

4.2.1.6 Nutrient Intake Database. All nutrient databases have certain limitations, although as described in Section 2.3.2, nutrient databases that are relatively complete (such as those used in both the 2004 and the 2015 CCHS-Nutrition) provide reasonably accurate estimates of the nutrient content of foods, particularly at a population level. However, nutrient databases change over time, due to changes in the formulation of food products by manufacturers, addition of new food products and/or new nutrients, and constant updating of nutrient values in the database, including nutrient filling in values that were 'missing'. These changes have the potential to contribute to differences in apparent nutrient intake between the 2004 and 2015 surveys, and should be considered when interpreting apparent changes in nutrient intake over time.

4.3 Canadian Community Health Survey Annual Component

For the most part, few comparisons can be made between data from the 2015 CCHS-Nutrition and data from the CCHS-Annual Component surveys, as the surveys have different objectives, sample sizes, and collect different data. Even in the few cases where the data are similar, comparisons may not be appropriate. For example, the CCHS-Annual Component obtains information on height and weight, but the values are self-reported, while measured values were obtained in the 2015 CCHS-Nutrition. Because of bias in self-reports of height and weight, average BMI values are lower when self-reported versus measured heights and weights are used to calculate BMI. For example, in the 2004 CCHS-Nutrition, 1131 participants provided self-reported values for height and weight, and measured values were also obtained. The overall prevalence of obesity was 23.0% based on measured BMI, compared to 15.6% based on self-reported BMI (Akhtar-Danesh, Dehghan, Merchant, & Rainey, 2008). Thus, comparing measured BMI values from 2015 CCHS-Nutrition to self-reported BMI values from the CCHS-Annual surveys is not appropriate. (That said, however, correction factors have been developed, using Canadian data, that can be applied to self-reported estimates of height and weight so they more closely approximate measured BMI values [Connor Gorber, Shields, Tremblay, & McDowell, 2008].) Another example is related to the assessment of food insecurity. Although the 2015 CCHS-Nutrition and the CCHS-Annual Component use the same module to assess food insecurity, the CCHS-Annual Component is the most appropriate source of data to monitor the prevalence of food insecurity in Canada over time.

4.4 Canadian Health Measures Survey

The Canadian Health Measures Survey (CHMS) is a nationally representative ongoing survey that collects information relevant to Canadians' health by conducting household interviews and direct physical measures at a mobile examination centre. The household questionnaire collects data on socio-demographic variables and health status, as well as health behaviours that are specifically related to the direct measures obtained during the survey. Some of the direct measures relevant to nutrition include physical measures (e.g., anthropometry, cardiovascular health and musculoskeletal fitness, physical activity) and biochemical assessments (e.g., vitamin and mineral status assessed using blood or urine samples, blood lipids, glycated hemoglobin). The nutrition questions included in the household questionnaire are intended to provide data to support the interpretation of the direct measures, and are not designed to obtain quantitative data on overall nutrient or dietary intake. Respondents are asked to indicate their frequency of consumption of selected foods (which they can express per day, week, month, or year, as appropriate) but no information is obtained on the amounts consumed. In addition, the specific foods queried will vary from one cycle of the survey to the next (the survey is conducted over two-year cycles), depending on which nutrients are being assessed biochemically. For these reasons, it is generally not possible to compare nutrient intakes between the CCHS-Nutrition and the CHMS. However, the CHMS provides information that complements interpretation of CCHS-Nutrition data for key nutrients.

The CHMS also provides information on measured BMI, using methods similar to those in the CCHS-Nutrition. However, because of the differences in the surveys (e.g., sample size and method of obtaining the sample), it is possible that estimates would differ to some extent, even for the same time period.

4.5 Nutrition Canada Survey

Before the 2004 CCHS-Nutrition, the Nutrition Canada national survey was the only previous national survey of Canadians' nutrient intakes. It was conducted between October 1970 and October 1972, and at that time, was the most comprehensive national survey ever conducted of the population's nutritional status (Nutrition Canada, 1973). It included three separate sample designs for 1) residents of the 10 provinces (excluding those living on reserves, in institutions, and on military bases), 2) First Nations people living on reserves and crown lands in the provinces and territories, and 3) Inuit living in four communities in the territories.[4]

The survey procedures included clinical, dental, and anthropometric examinations, dietary interviews, and blood and urine collections. The clinical exam was designed to detect past or present malnutrition, including signs and symptoms of nutrient deficiency. Fourteen physical measurements were taken, including height, weight, skinfolds, and chest and shoulder widths. The dietary interview was a single 24-hr recall of the previous day's intake, and included intake of vitamin and mineral supplements. Blood and urine samples were analyzed for a variety of indicators of vitamin, mineral, and protein status.

Although the survey is of historical interest, it is generally not possible to compare the CCHS-Nutrition data to the Nutrition Canada findings, as the primary (raw) data are not available for analysis. Moreover, differences in the survey methodology, response rates, and completeness and accuracy of nutrient databases would render most comparisons unreliable.

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[4] In Nutrition Canada's documentation, First Nations people and Inuit were referred to as Indians and Eskimos, respectively (Nutrition Canada, 1973)

4.6 Surveys from the United States

In the past, two major dietary surveys were periodically conducted in the United States. The Continuing Survey of Food Intakes by Individuals (CSFII) was conducted by the USDA's Agricultural Research Service, and the National Health and Nutrition Examination Survey (NHANES) was conducted by the U.S. Department of Health and Human Services. NHANES also included a comprehensive health assessment (e.g. physical and dental exams, assessment of body composition including bone density, physical fitness, lab tests of nutritional status parameters, environmental contaminants or toxins, sexually transmitted diseases, and a variety of questionnaires; a summary of the NHANES survey content for 1999 to 2016 is available. Information about the CSFII surveys (e.g. questionnaires, reports, datasets) is also available.

Beginning in 2002, the dietary components of the CSFII and NHANES were integrated into *What We Eat in America*, which is now administered as part of an ongoing NHANES. Two days of dietary intake data are obtained from all participants using the AMPM (which was also used in the 2004 and 2015 CCHS-Nutrition). The first 24-hr recall is conducted in person, whereas the second is conducted by telephone. For those wishing to conduct their own analysis, datasets, questionnaires, and related documentation are available. The dietary data are also available in tabular form. Two different types of data tables can be accessed: The first present data (typically, mean and SE) for two-year survey cycles (e.g., 2009–2010, 2011–2012) for a large number of dietary intake variables by gender and age, race/ethnicity and age, and income and age. For nutrients, information includes: the percent reporting use of the nutrient as a supplement; mean intake of all individuals from each of food, supplements and food plus supplements; mean intake of supplement users from food, supplements and food plus supplements; and mean intake of supplement non-users from food. It should be noted that the age groups used in these data tables do not correspond to the DRI age groups. Instead, the age groups are ages 2 to 5, 6 to 11, 12 to 19, 20 to 29, 30 to 39, 40 to 49, 50 to 59, 60 to 69, and 70 years and above. Summaries of the usual intake distributions compared to the Dietary Reference Intakes (and using the DRI age groups) are available for a more limited group of nutrients. These tables are formatted in a similar manner to the Health Canada/Statistics Canada summary table shown in section 3.3.3.


5. CONCLUSIONS AND NEXT STEPS

The 2015 CCHS-Nutrition presents an opportunity to examine the food and nutrient intakes of Canadians, the extent to which intakes have changed since the 2004 CCHS-Nutrition, and the relationship between diet and a wide range of health and socio-demographic correlates. This Reference Guide brings together information needed to understand data summaries (such as tables) and provides broad information about the survey for those planning to perform analyses. It is complemented by a variety of Statistics Canada's 2015 CCHS-Nutrition resource documents that are directed more specifically to those conducting statistical analyses of the data, and that focus on the data collection and the organization and accessibility of the various 2015 CCHS-Nutrition data files.

As occurred after the data from 2004 CCHS-Nutrition were released, learning and research opportunities are being organized to support the users of the 2015 CCHS-Nutrition, and to build additional capacity for future research. Health Canada is working closely with Statistics Canada and the Canadian Institutes of Health Research's Institute of Nutrition, Metabolism and Diabetes (INMD) to identify events such as conference presentations, customized workshops, and other training activities. The need to support development of the capacity to use statistical programming to provide estimates of usual intake, such as that necessary for the 2015 CCHS-Nutrition, is recognised and will be addressed. The INMD is promoting research through a special Request for Applications initiative launched in September 2016. The opportunity for informal learning and sharing will be possible through Health Canada's Nutrition Data Users' Group, which was formed to address the ongoing research and data analysis issues of interested parties.

Reports based on 2015 CCHS-Nutrition data will be released by Health Canada, Statistics Canada and the Public Health Agency of Canada, jointly and individually, as was done following the 2004 CCHS-Nutrition. These three organizations are collaborating to leverage analysis capacity and avoid duplication of effort.

In conclusion, it is hoped that this Reference Guide will facilitate the awareness, understanding and use of the 2015 CCHS-Nutrition data, which in turn will further advance research opportunities, identify and address potential gaps and needs, and enhance and support Canadian food and nutrition policy, with the ultimate goal of improving the nutritional health of Canadians.

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APPENDIX 1: GLOSSARY

24-hr Recall

A means of obtaining dietary intake whereby subjects, or a proxy, are asked by a trained interviewer to recall their exact food intake during the previous twenty-four hour period or preceding day. The interviewer records detailed descriptions of all food and beverages consumed in combination with associated preparation and cooking methods, if possible.

95% Confidence Interval

A 95% Confidence Interval (CI) is a range of values, calculated from a sample of the population, which has a high probability of containing a specified parameter estimate of the population. More specifically, if repeated samples were taken and the mean and 95% CI was calculated for each sample, 95% of the CIs would contain the true mean of the population.

Acceptable Macronutrient Distribution Range

The Acceptable Macronutrient Distribution Range (AMDR) is a range of intakes for a particular energy source (protein, fat, or carbohydrate), expressed as a percentage of total energy (kcal), that is associated with reduced risk of chronic disease while providing adequate intakes of essential nutrients.

Adequate Intake

The Adequate Intake (AI) is the recommended average daily nutrient intake level based on observed or experimentally determined approximations or estimates of nutrient intakes by a group (or groups) of apparently healthy people who are assumed to be maintaining an adequate nutritional status. The AI is used when a Recommended Dietary Allowance (RDA) cannot be determined.

Automated Multiple-Pass Method

The Automated Multiple-Pass Method (AMPM) is an approach that utilizes five steps intended to enhance the comprehensiveness and accuracy of food recall by collecting a list of all food and beverages consumed in a 24-hour period; probing for foods forgotten during the enumeration of foods and beverages; collecting the time and eating occasion for each food; collecting detailed descriptions of amounts and additions for each food which includes a review of the 24-hour day (eating occasions and between eating occasions); and finally probing for anything else that was consumed.

Basal Metabolic Rate

Basal metabolic rate (BMR) is the rate of energy expenditure that occurs when someone has not consumed food for 12–14 hours, is lying down, resting comfortably, awake but not moving, and in a thermoneutral environment. It is typically expressed in kcal/kg/hr. Thus, it reflects the energy needed to sustain the bodily function, under conditions when food and physical activity have a minimal influence on metabolism.

Between-Person Variability (Inter-Individual Variability)

Between-person or inter-individual variability is defined as the variation that occurs between individuals across a population.

Body Mass Index

Body Mass Index (BMI) is a ratio of a person's weight relative to their height and is calculated by dividing their weight in kilograms by their height in meters squared (**BMI = weight [kg]/height [m]^2**). There are four categories of BMI ranges in the Canadian (and international) weight classification system: underweight (<18.5), normal weight (18.5 to < 25), overweight (25 to < 30) and obese (≥ 30). For children and youth, age- and sex-specific cut-offs are used to classify BMI.

Eating Well with Canada's Food Guide
Eating Well with Canada's Food Guide is a tool designed to help Canadians make healthy food choices. The Food Guide translates the science of healthy eating into a practical pattern of food choices that meets nutrient needs, promotes health and minimizes the risk of nutrition-related chronic diseases.

Canadian Community Health Survey
The Canadian Community Health Survey (CCHS) program consists of cross-sectional surveys that collect information related to health status, health care utilization and health determinants for the Canadian population. The CCHS includes two types of surveys. The CCHS-Annual Component is a large sample, general population health survey, designed to provide reliable estimates at the health region level. In addition, surveys that focus on a specific subject matter or population (e.g., nutrition, mental health, and aging) are conducted on an occasional basis, and provide estimates that are reliable at the provincial level.

Canadian Health Measures Survey
The Canadian Health Measures Survey (CHMS) is a nationally representative survey that collects key information about the health of Canadians through direct physical measurements such as blood pressure, height, weight and physical fitness. It also collects blood and urine samples, and tests for chronic and infectious diseases, nutritional status, and environmental exposures. Household interviews are also conducted to obtain information about nutrition and lifestyle factors, health status, as well as demographic and socioeconomic variables.

Canadian Nutrient File
The Canadian Nutrient File (CNF) is the standard reference food composition database reporting the amount of nutrients in foods commonly consumed in Canada. The database used to analyze 24-hr recalls conducted as part of CCHS-Nutrition is extracted from the CNF by selecting foods and nutrients that have a high proportion of complete information.

Coefficient of Variation
The coefficient of variation (CV) represents the ratio of the standard error to the estimate of a specified parameter and is expressed as a percentage. The CV can also be used to assess the degree of variation.

Cross-Sectional Survey
A cross-sectional survey is used to measure the relationship between health-related characteristics or other variables in a defined population at a single point in time.

Data Dictionary
A data dictionary is a description of the information contained in a database. It can be consulted to understand what files are in the database, what records or values they may contain and generally what the data item(s) mean in everyday language.

Derived Variables
A derived variable is created from one or more variables in the original data set. For example, Body Mass Index (BMI) is derived from the variables weight and height (BMI = weight [kg]/height [m]^2).

Dietary Reference Intakes
The Dietary Reference Intakes (DRIs) are a set of scientifically based nutrient reference values for healthy populations. DRIs include four types of reference values: Estimated Average Requirement (EAR), Recommended Dietary Allowance (RDA), Adequate Intake (AI) and Tolerable Upper Intake Level (UL).

Doubly-Labelled Water Method

The doubly-labelled water technique, regarded as the "gold standard" for measuring total energy expenditure in humans, also reflects energy intake in those who are in energy balance (neither gaining nor losing weight). This technique involves calculating the difference between the turnover rates of ingested oxygen and hydrogen isotopes in order to determine how much carbon dioxide was produced, a measure of metabolic rate (and thus energy expenditure).

Drug Identification Number

The Drug Identification Number (DIN) is the number located on the label of prescription and over-the-counter drug products that have been evaluated by the Therapeutic Products Directorate of Health Canada and approved for sale in Canada. In 2004 CCHS-Nutrition, vitamin and mineral supplements were labeled with a DIN.

EAR Cut-Point Method

The EAR cut-point method is a simpler version of the probability approach whereby the number of individuals with intakes below the Estimated Average Requirement (EAR) is counted in order to estimate the proportion of individuals in the group with inadequate intakes. For this method to provide a reliable estimate certain assumptions must be met: group intake and requirements must be independent; the distribution of requirements must be symmetrical about the EAR; and the variance of intakes in the population group must be greater than its requirements.

Estimated Average Requirement

The Estimated Average Requirement (EAR) is the median daily nutrient intake level that is estimated to meet the requirement of half of the apparently healthy individuals in a particular life-stage and gender group. At this level of intake, the other half of the individuals would not have its needs met.

Estimated Energy Requirements

The Estimated Energy Requirement (EER) is defined as the average dietary energy intake that is predicted to maintain energy balance in healthy, normal-weight individuals of a defined age, gender, weight, height, and level of physical activity consistent with good health. In children and in pregnant or lactating women, the EER includes the needs associated with growth or secretion of milk, at rates consistent with good health.

Food Security/Insecurity

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. Conversely, food insecurity is the inability to acquire or consume an adequate diet quality or sufficient quantity of food in socially acceptable ways, or the uncertainty that one will be able to do so. The presence of household food insecurity is assessed in the Canadian Community Health Survey using the Household Food Security Survey Module., which focuses primarily on characteristics of food security that relate to household's financial ability to access adequate food.

Median

The median is the middle of a distribution, the point on the scale that divides the sample into two parts, the lower and the upper half, whereby each half has an equal number of observations (for a sample) or equal probability (for a distribution).

Natural Product Number
The Natural Product Number (NPN) is the number located on the natural health products (including vitamin and mineral supplements) that have been assessed by Health Canada and found to be safe, effective and of high quality under their recommended conditions of use. The NPN can be used to search the Licensed Natural Health Products Database, which contains detailed information on the product (e.g., specific amounts of vitamins or minerals included in a supplement).

Non-Response Bias
Non-response bias is a bias that may occur when the data are limited to only those that respond to a survey and do not include the responses of individuals who refuse to take part in the survey or who drop out. This lack of response, or poor compliance, can result in a significant nonresponse bias if non-respondents have characteristics that differ from those who responded.

Physical Activity Level
The Physical Activity level (PAL) is the ratio of total energy expenditure to basal energy expenditure, estimated as *sedentary* (PAL 1.0 to < 1.4), *low active* (PAL 1.4 to < 1.6), *active* (PAL 1.6 to < 1.9), or *very active* (PAL 1.9 to 2.5). The estimated PAL is used in calculating EER.

Probability Approach
The probability approach is a statistical method that estimates the proportion of individuals at risk for nutrient inadequacy by comparing the distributions of requirements and intakes for the group and summing the probabilities. It must be used when the assumptions required for use of the EAR cut-point method are not satisfied.

Recommended Dietary Allowance
The Recommended Dietary Allowance (RDA) is the average daily nutrient intake level that is sufficient to meet the nutrient requirement of nearly all (97–98%) apparently healthy individuals in a particular life-stage and gender group.

Requirement
A nutritional requirement is the level of a dietary factor (e.g. calcium), based on scientific criteria, the human body needs to achieve a specified state of physiological health (e.g. strong bones). The level of dietary factor required varies among individuals.

Sampling Frame
A sampling frame is a list of sample units or sources within a population such as individuals, households or institutions, from which a statistical sample can be taken.

Standard Deviation
The standard deviation (SD), a measure of variation or dispersion, is equal to the square root of the variance and represents the average distance a set of values is from the mean.

Standard Error of the Mean
The standard error of the mean (SEM) or Standard Error (SE) is defined as the standard deviation of the observations divided by the square root of the sample size. It gives an estimate of how close the mean or other parameter estimates of the sample are to true population parameters.

Tolerable Upper Intake Level

The Tolerable Upper Intake Level (UL) is the highest average daily nutrient intake level that is likely to pose no risk of adverse health effects to almost all individuals in a given life-stage and gender group. As intake increases above the UL, the potential risk of adverse effects may increase.

Uncertainly Factor

An Uncertainty Factor (UF) is used when determining the Tolerable Upper Intake Level (UL) from a no-observed-adverse-effect level (NOAEL; the highest intake at which no adverse effects have been observed) or a lowest-observed-adverse-effect level (LOAEL; the lowest intake at which adverse effects have been observed). In either case, the UL is estimated by dividing the NOAEL or LOAEL by a UF. The magnitude of the UF (which is always >1) varies among nutrients and reflects a number of sources of uncertainty, including the degree of inter-individual variation in sensitivity to the adverse effect, whether extrapolation from animal data occurred, whether a LOAEL was used instead of a NOAEL, whether data on subchronic instead of chronic exposures were used, as well as the severity of the adverse effect and whether or not it is reversible.

Usual Intake Distribution

A usual intake distribution is a distribution of observed intakes, collected as a daily average over a long period of time, for a food or nutrient among a group of individuals that removes within-person variability.

Within-Person Variability (Intra-Individual Variability)

Within-person or intra-individual variability is defined as the variation that occurs within a given individual over different periods of time.

APPENDIX 2: DIETARY REFERENCE INTAKES

Equations to Estimate Energy Requirement

Infants and young children Estimated Energy Requirement (kcal/day) = Total Energy Expenditure + Energy Deposition	
0–3 months	EER = (89 X weight [kg] – 100) + 175
4–6 months	EER = (89 X weight [kg] – 100) + 56
7–12 months	EER = (89 X weight [kg] – 100) + 22
13–35 months	EER = (89 X weight [kg] – 100) + 20
Children and Adolescents 3–18 years Estimated Energy Requirement (kcal/day) = Total Energy Expenditure + Energy Deposition	
Boys	
3–8 years	EER = 88.5 – 61.9 X age [y] + PA X (26.7 X weight [kg] + 903 X height [m]) + 20
9–18 years	EER = 88.5 – 61.9 X age [y] + PA X (26.7 X weight [kg] + 903 X height [m]) + 25
Girls	
3–8 years	EER = 135.3 – 30.8 X age [y] + PA X (10.0 X weight [kg] + 934 X height [m]) + 20
9–18 years	EER = 135.3 – 30.8 X age [y] + PA X (10.0 X weight [kg] + 934 X height [m]) + 25
Adults 19 years and older Estimated Energy Requirement (kcal/day) = Total Energy Expenditure	
Men	EER = 662 – 9.53 X age [y] + PA X (15.91 X weight [kg] + 539.6 X height [m])
Women	EER = 354 – 6.91 X age [y] + PA X (9.36 X weight [kg] + 726 X height [m])
Pregnancy Estimated Energy Requirement (kcal/day) = Non-pregnant EER + Pregnancy Energy Deposition	
1st trimester	EER = Non-pregnant EER + 0
2nd trimester	EER = Non-pregnant EER + 340
3rd trimester	EER = Non-pregnant EER + 452
Lactation Estimated Energy Requirement (kcal/day) = Non-pregnant EER + Milk Energy Output – Weight Loss	
0–6 months postpartum	EER = Non-pregnant EER + 500 – 170
7–12 months postpartum	EER = Non-pregnant EER + 400 – 0

SOURCE: IOM, 2005a

These equations provide an estimate of energy requirement. Relative body weight (i.e. loss, stable, gain) is the preferred indicator of energy adequacy.

Physical Activity Coefficients (PA values) for Use in EER Equations

	Sedentary (PAL 1.0–1.39)	Low Active (PAL 1.4–1.59)	Active (PAL 1.6–1.89)	Very Active (PAL 1.9–2.5)
	Typical daily living activities (e.g. household tasks, walking to the bus)	Typical daily living activities PLUS 30–60 minutes of daily moderate activity (ex. walking at 5–7 km/h)	Typical daily living activities PLUS At least 60 minutes of daily moderate activity	Typical daily living activities PLUS At least 60 minutes of daily moderate activity PLUS An additional 60 minutes of vigorous activity or 120 minutes of moderate activity
Boys 3–18 y	1.00	1.13	1.26	1.42
Girls 3–18 y	1.00	1.16	1.31	1.56
Men 19 y +	1.00	1.11	1.25	1.48
Women 19 y +	1.00	1.12	1.27	1.45

SOURCE: IOM, 2005a

Dietary Reference Intakes

Reference Values for Vitamins (part 1)

	Vitamin A[1,2]						Vitamin D**						Vitamin E[5]			Vitamin K	
Unit	**µg/day (RAE)**			**IU/day (RAE)**			**µg/day[4]**			**IU/day[4]**			**mg/day**			**µg/day**	
	EAR	RDA/AI	UL[3]	*EAR*	RDA/AI	UL[3]	*EAR*	RDA/AI	UL	*EAR*	RDA/AI	UL	*EAR*	RDA/AI	UL[6]	AI	UL[7]
Infants																	
0–6 mo	*ND*	400*	600	*ND*	1333*	2000	*ND*	10*	25	*ND*	400*	1000	*ND*	4*	ND	2.0*	ND
7–12 mo	*ND*	500*	600	*ND*	1667*	2000	*ND*	10*	38	*ND*	400*	1500	*ND*	5*	ND	2.5*	ND
Children																	
1–3 y	*210*	**300**	600	*700*	**1000**	2000	*10*	15	63	*400*	**600**	2500	*5*	**6**	200	30*	ND
4–8 y	*275*	**400**	900	*917*	**1333**	3000	*10*	15	75	*400*	**600**	3000	*6*	**7**	300	55*	ND
Males																	
9–13 y	*445*	**600**	1700	*1483*	**2000**	5667	*10*	15	100	*400*	**600**	4000	*9*	**11**	600	60*	ND
14–18 y	*630*	**900**	2800	*2100*	**3000**	9333	*10*	15	100	*400*	**600**	4000	*12*	**15**	800	75*	ND
19–30 y	*625*	**900**	3000	*2083*	**3000**	10000	*10*	15	100	*400*	**600**	4000	*12*	**15**	1000	120*	ND
31–50 y	*625*	**900**	3000	*2083*	**3000**	10000	*10*	15	100	*400*	**600**	4000	*12*	**15**	1000	120*	ND
51–70 y	*625*	**900**	3000	*2083*	**3000**	10000	*10*	15	100	*400*	**600**	4000	*12*	**15**	1000	120*	ND
>70 y	*625*	**900**	3000	*2083*	**3000**	10000	*10*	20	100	*400*	**800**	4000	*12*	**15**	1000	120*	ND
Females																	
9–13 y	*420*	**600**	1700	*1400*	**2000**	5667	*10*	15	100	*400*	**600**	4000	*9*	**11**	600	60*	ND
14–18 y	*485*	**700**	2800	*1617*	**2333**	9333	*10*	15	100	*400*	**600**	4000	*12*	**15**	800	75*	ND
19–30 y	*500*	**700**	3000	*1667*	**2333**	10000	*10*	15	100	*400*	**600**	4000	*12*	**15**	1000	90*	ND
31–50 y	*500*	**700**	3000	*1667*	**2333**	10000	*10*	15	100	*400*	**600**	4000	*12*	**15**	1000	90*	ND
51–70 y	*500*	**700**	3000	*1667*	**2333**	10000	*10*	15	100	*400*	**600**	4000	*12*	**15**	1000	90*	ND
>70 y	*500*	**700**	3000	*1667*	**2333**	10000	*10*	20	100	*400*	**800**	4000	*12*	**15**	1000	90*	ND
Pregnancy																	
≤18 y	*530*	**750**	2800	*1767*	**2500**	9333	*10*	15	100	*400*	**600**	4000	*12*	**15**	800	75*	ND
19–30 y	*550*	**770**	3000	*1833*	**2567**	10000	*10*	15	100	*400*	**600**	4000	*12*	**15**	1000	90*	ND
31–50 y	*550*	**770**	3000	*1833*	**2567**	10000	*10*	15	100	*400*	**600**	4000	*12*	**15**	1000	90*	ND
Lactation																	
≤18 y	*880*	**1200**	1800	*2933*	**4000**	6000	*10*	15	100	*400*	**600**	4000	*16*	**19**	800	75*	ND
19–30 y	*900*	**1300**	2000	*3000*	**4333**	6667	*10*	15	100	*400*	**600**	4000	*16*	**19**	1000	90*	ND
31–50 y	*900*	**1300**	2000	*3000*	**4333**	6667	*10*	15	100	*400*	**600**	4000	*16*	**19**	1000	90*	ND

SOURCE: IOM, 2000a, 2001, 2011

This table presents *Estimated Average Requirements (EARs) in italics*, **Recommended Dietary Allowances (RDAs) in bold type**, Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). Tolerable Upper Intake Levels (ULs) are in shaded columns. ND = Not Determinable

** New 2010 values have replaced 1997 values.

1 As Retinol Activity Equivalents (RAE). See conversion factors for more details.

2 No DRIs are established for beta-carotene or other carotenoids. However, existing recommendations for consumption of carotenoid-rich fruits and vegetables are supported.

3 UL as preformed vitamin A only. Beta-carotene supplements are advised only to serve as a provitamin A source for individuals at risk of vitamin A deficiency.

4 These reference values assume minimal sun exposure.

5 EAR and RDA/AI as alpha-tocopherol (*2R*-stereoisomeric forms) only. See conversion factors for more details.

6 The UL for vitamin E applies only to synthetic vitamin E (all isomeric forms) obtained from supplements, fortified foods, or a combination of the two.

7 Due to lack of suitable data, a UL could not be established for vitamin K. This does not mean that there is no potential for adverse effects resulting from high intakes.

NOTE: These are reference values for normal, apparently healthy individuals eating a typical mixed North American diet. An individual may have physiological, health, or lifestyle characteristics that may require tailoring of specific nutrient values

Dietary Reference Intakes

Reference Values for Vitamins (part 2)

	Vitamin C[8]			**Thiamin**			**Riboflavin**			**Niacin[10]**			**Vitamin B_6**		
Unit	**mg/day**			**mg/day**			**mg/day**			**mg/day**			**mg/day**		
	EAR	RDA/AI	UL	*EAR*	RDA/AI	UL	*EAR*	RDA/AI	UL	*EAR*	RDA/AI	UL	*EAR*	RDA/AI	UL
Infants															
0–6 mo	*ND*	40*	ND	*ND*	0.2*	ND	*ND*	0.3*	ND	*ND*	2*[a]	ND	*ND*	0.1*	ND
7–12 mo	*ND*	50*	ND	*ND*	0.3*	ND	*ND*	0.4*	ND	*ND*	4*	ND	*ND*	0.3*	ND
Children															
1–3 y	*13*	**15**	400	*0.4*	**0.5**	ND	*0.4*	**0.5**	ND	*5*	**6**	10	*0.4*	**0.5**	30
4–8 y	*22*	**25**	650	*0.5*	**0.6**	ND	*0.5*	**0.6**	ND	*6*	**8**	15	*0.5*	**0.6**	40
Males															
9–13 y	*39*	**45**	1200	*0.7*	**0.9**	ND	*0.8*	**0.9**	ND	*9*	**12**	20	*0.8*	**1.0**	60
14–18 y	*63*	**75**	1800	*1.0*	**1.2**	ND	*1.1*	**1.3**	ND	*12*	**16**	30	*1.1*	**1.3**	80
19–30 y	*75*	**90**	2000	*1.0*	**1.2**	ND	*1.1*	**1.3**	ND	*12*	**16**	35	*1.1*	**1.3**	100
31–50 y	*75*	**90**	2000	*1.0*	**1.2**	ND	*1.1*	**1.3**	ND	*12*	**16**	35	*1.1*	**1.3**	100
51–70 y	*75*	**90**	2000	*1.0*	**1.2**	ND	*1.1*	**1.3**	ND	*12*	**16**	35	*1.4*	**1.7**	100
>70 y	*75*	**90**	2000	*1.0*	**1.2**	ND	*1.1*	**1.3**	ND	*12*	**16**	35	*1.4*	**1.7**	100
Females															
9–13 y	*39*	**45**	1200	*0.7*	**0.9**	ND	*0.8*	**0.9**	ND	*9*	**12**	20	*0.8*	**1.0**	60
14–18 y	*56*	**65**	1800	*0.9*	**1.0**	ND	*0.9*	**1.0**	ND	*11*	**14**	30	*1.0*	**1.2**	80
19–30 y	*60*	**75**	2000	*0.9*	**1.1**	ND	*0.9*	**1.1**	ND	*11*	**14**	35	*1.1*	**1.3**	100
31–50 y	*60*	**75**	2000	*0.9*	**1.1**	ND	*0.9*	**1.1**	ND	*11*	**14**	35	*1.1*	**1.3**	100
51–70 y	*60*	**75**	2000	*0.9*	**1.1**	ND	*0.9*	**1.1**	ND	*11*	**14**	35	*1.3*	**1.5**	100
>70 y	*60*	**75**	2000	*0.9*	**1.1**	ND	*0.9*	**1.1**	ND	*11*	**14**	35	*1.3*	**1.5**	100
Pregnancy															
≤18 y	*66*	**80**	1800	*1.2*	**1.4**	ND	*1.2*	**1.4**	ND	*14*	**18**	30	*1.6*	**1.9**	80
19–30 y	*70*	**85**	2000	*1.2*	**1.4**	ND	*1.2*	**1.4**	ND	*14*	**18**	35	*1.6*	**1.9**	100
31–50 y	*70*	**85**	2000	*1.2*	**1.4**	ND	*1.2*	**1.4**	ND	*14*	**18**	35	*1.6*	**1.9**	100
Lactation															
≤18 y	*96*	**115**	1800	*1.2*	**1.4**	ND	*1.3*	**1.6**	ND	*13*	**17**	30	*1.7*	**2.0**	80
19–30 y	*100*	**120**	2000	*1.2*	**1.4**	ND	*1.3*	**1.6**	ND	*13*	**17**	35	*1.7*	**2.0**	100
31–50 y	*100*	**120**	2000	*1.2*	**1.4**	ND	*1.3*	**1.6**	ND	*13*	**17**	35	*1.7*	**2.0**	100

SOURCE: IOM 1998a, 2000a

This table presents *Estimated Average Requirements (EARs) in italics*, **Recommended Dietary Allowances (RDAs) in bold type**, Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). Tolerable Upper Intake Levels (ULs) are in shaded columns. ND = Not Determinable

[8] Because smoking increases oxidative stress and metabolic turnover of vitamin C, the requirement for smokers is increased by 35 mg/day.

[9] Due to lack of suitable data, ULs could not be established for thiamin and riboflavin. This does not mean that there is no potential for adverse effects resulting from high intakes.

[10] As Niacin Equivalents (NE). See conversion factors for more details.

[11] The UL for niacin applies only to synthetic forms obtained from supplements, fortified foods, or a combination of the two.

[a] As preformed niacin, not NE, for this age group.

NOTE: These are reference values for normal, apparently healthy individuals eating a typical mixed North American diet. An individual may have physiological, health, or lifestyle characteristics that may require tailoring of specific nutrient values.

Dietary Reference Intakes

Reference Values for Vitamins (part 3)

	Folate[12]			Vitamin B_{12}			Pantothenic Acid		Biotin		Choline[15]	
Unit	**µg/day (DFE)**			**µg/day**			**mg/day**		**µg/day**		**mg/day**	
	EAR	RDA/AI	UL[13]	*EAR*	RDA/AI	UL[14]	AI	UL[14]	AI	UL[14]	AI	UL
Infants												
0–6 mo	*ND*	65*	ND	*ND*	0.4*	ND	1.7*	ND	5*	ND	125*	ND
7–12 mo	*ND*	80*	ND	*ND*	0.5*	ND	1.8*	ND	6*	ND	150*	ND
Children												
1–3 y	*120*	**150**	300	*0.7*	**0.9**	ND	2*	ND	8*	ND	200*	1000
4–8 y	*160*	**200**	400	*1.0*	**1.2**	ND	3*	ND	12*	ND	250*	1000
Males												
9–13 y	*250*	**300**	600	*1.5*	**1.8**	ND	4*	ND	20*	ND	375*	2000
14–18 y	*330*	**400**	800	*2.0*	**2.4**	ND	5*	ND	25*	ND	550*	3000
19–30 y	*320*	**400**	1000	*2.0*	**2.4**	ND	5*	ND	30*	ND	550*	3500
31–50 y	*320*	**400**	1000	*2.0*	**2.4**	ND	5*	ND	30*	ND	550*	3500
51–70 y	*320*	**400**	1000	*2.0*	**2.4**[d]	ND	5*	ND	30*	ND	550*	3500
>70 y	*320*	**400**	1000	*2.0*	**2.4**[d]	ND	5*	ND	30*	ND	550*	3500
Females												
9–13 y	*250*	**300**	600	*1.5*	**1.8**	ND	4*	ND	20*	ND	375*	2000
14–18 y	*330*	**400**[b]	800	*2.0*	**2.4**	ND	5*	ND	25*	ND	400*	3000
19–30 y	*320*	**400**[b]	1000	*2.0*	**2.4**	ND	5*	ND	30*	ND	425*	3500
31–50 y	*320*	**400**[b]	1000	*2.0*	**2.4**	ND	5*	ND	30*	ND	425*	3500
51–70 y	*320*	**400**	1000	*2.0*	**2.4**[d]	ND	5*	ND	30*	ND	425*	3500
>70 y	*320*	**400**	1000	*2.0*	**2.4**[d]	ND	5*	ND	30*	ND	425*	3500
Pregnancy												
≤18 y	*520*	**600**[c]	800	*2.2*	**2.6**	ND	6*	ND	30*	ND	450*	3000
19–30 y	*520*	**600**[c]	1000	*2.2*	**2.6**	ND	6*	ND	30*	ND	450*	3500
31–50 y	*520*	**600**[c]	1000	*2.2*	**2.6**	ND	6*	ND	30*	ND	450*	3500
Lactation												
≤18 y	*450*	**500**	800	*2.4*	**2.8**	ND	7*	ND	35*	ND	550*	3000
19–30 y	*450*	**500**	1000	*2.4*	**2.8**	ND	7*	ND	35*	ND	550*	3500
31–50 y	*450*	**500**	1000	*2.4*	**2.8**	ND	7*	ND	35*	ND	550*	3500

SOURCE: IOM, 1998a

This table presents *Estimated Average Requirements (EARs) in italics*, **Recommended Dietary Allowances (RDAs) in bold type**, Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). Tolerable Upper Intake Levels (ULs) are in shaded columns. ND = Not Determinable

[12] As Dietary Folate Equivalents (DFE). See conversion factors for more details.

[13] The UL for folate applies only to synthetic forms obtained from supplements, fortified foods, or a combination of the two.

[14] Due to lack of suitable data, ULs could not be established for vitamin B_{12}, pantothenic acid or biotin. This does not mean that there is no potential for adverse effects resulting from high intakes.

[15] Although AIs have been set for choline, there are few data to assess whether a dietary supply of choline is needed at all stages of the life cycle, and it may be that the choline requirement can be met by endogenous synthesis at some of these stages.

[b] In view of evidence linking the use of supplements containing folic acid before conception and during early pregnancy with reduced risk of neural tube defects in the fetus, it is recommended that all women capable of becoming pregnant take a supplement containing 400µg of folic acid every day, in addition to the amount of folate found in a healthy diet.

[c] It is assumed that women will continue consuming 400 µg folic acid from supplements until their pregnancy is confirmed and they enter prenatal care. The critical time for formation of the neural tube is shortly after conception.

[d] Because 10 to 30 percent of older people may malabsorb food-bound vitamin B_{12}, it is advisable for those older than 50 years to meet the RDA mainly by consuming foods fortified with vitamin B_{12} or a supplement containing vitamin B_{12}.

NOTE: These are reference values for normal, apparently healthy individuals eating a typical mixed North American diet. An individual may have physiological, health, or lifestyle characteristics that may require tailoring of specific nutrient values.

Dietary Reference Intakes

Reference Values for Elements (part 1)

	Arsenic[16]		Boron		Calcium**			Chromium		Copper			Fluoride		Iodine		
Unit	**N/A**		**mg/day**		**mg/day**			**µg/day**		**µg/day**			**mg/day**		**µg/day**		
	AI	UL[17]	AI	UL	*EAR*	RDA/AI	UL	AI	UL[17]	*EAR*	RDA/AI	UL	AI	UL	*EAR*	RDA/AI	UL
Infants																	
0–6 mo	ND	ND	ND	ND	*ND*	260*	1000	0.2*	ND	*ND*	200*	ND	0.01*	0.7	*ND*	110*	ND
7–12 mo	ND	ND	ND	ND	*ND*	260*	1500	5.5*	ND	*ND*	220*	ND	0.5*	0.9	*ND*	130*	ND
Children																	
1–3 y	ND	ND	ND	3	*500*	**700**	2500	11*	ND	*260*	**340**	1000	0.7*	1.3	*65*	**90**	200
4–8 y	ND	ND	ND	6	*800*	**1000**	2500	15*	ND	*340*	**440**	3000	1*	2.2	*65*	**90**	300
Males																	
9–13 y	ND	ND	ND	11	*1100*	**1300**	3000	25*	ND	*540*	**700**	5000	2*	10	*73*	**120**	600
14–18 y	ND	ND	ND	17	*1100*	**1300**	3000	35*	ND	*685*	**890**	8000	3*	10	*95*	**150**	900
19–30 y	ND	ND	ND	20	*800*	**1000**	2500	35*	ND	*700*	**900**	10000	4*	10	*95*	**150**	1100
31–50 y	ND	ND	ND	20	*800*	**1000**	2500	35*	ND	*700*	**900**	10000	4*	10	*95*	**150**	1100
51–70 y	ND	ND	ND	20	*800*	**1000**	2000	30*	ND	*700*	**900**	10000	4*	10	*95*	**150**	1100
>70 y	ND	ND	ND	20	*1000*	**1200**	2000	30*	ND	*700*	**900**	10000	4*	10	*95*	**150**	1100
Females																	
9–13 y	ND	ND	ND	11	*1100*	**1300**	3000	21*	ND	*540*	**700**	5000	2*	10	*73*	**120**	600
14–18 y	ND	ND	ND	17	*1100*	**1300**	3000	24*	ND	*685*	**890**	8000	3*	10	*95*	**150**	900
19–30 y	ND	ND	ND	20	*800*	**1000**	2500	25*	ND	*700*	**900**	10000	3*	10	*95*	**150**	1100
31–50 y	ND	ND	ND	20	*800*	**1000**	2500	25*	ND	*700*	**900**	10000	3*	10	*95*	**150**	1100
51–70 y	ND	ND	ND	20	*1000*	**1200**	2000	20*	ND	*700*	**900**	10000	3*	10	*95*	**150**	1100
>70 y	ND	ND	ND	20	*1000*	**1200**	2000	20*	ND	*700*	**900**	10000	3*	10	*95*	**150**	1100
Pregnancy																	
≤18 y	ND	ND	ND	17	*1100*	**1300**	3500	29*	ND	*785*	**1000**	8000	3*	10	*160*	**220**	900
19–30 y	ND	ND	ND	20	*800*	**1000**	2500	30*	ND	*800*	**1000**	10000	3*	10	*160*	**220**	1100
31–50 y	ND	ND	ND	20	*800*	**1000**	2500	30*	ND	*800*	**1000**	10000	3*	10	*160*	**220**	1100
Lactation																	
≤18 y	ND	ND	ND	17	*1100*	**1300**	3500	44*	ND	*985*	**1300**	8000	3*	10	*209*	**290**	900
19–30 y	ND	ND	ND	20	*800*	**1000**	2500	45*	ND	*1000*	**1300**	10000	3*	10	*209*	**290**	1100
31–50 y	ND	ND	ND	20	*800*	**1000**	2500	45*	ND	*1000*	**1300**	10000	3*	10	*209*	**290**	1100

SOURCE: IOM, 1997, 2001, 2011

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** New 2010 values have replaced 1997 values.

16 Although a UL was not determined for arsenic, there is no justification for adding arsenic to food or supplements.

17 Due to lack of suitable data, ULs could not be established for arsenic and chromium. This does not mean that there is no potential for adverse effects resulting from high intakes.

NOTE: These are reference values for normal, apparently healthy individuals eating a typical mixed North American diet. An individual may have physiological, health, or lifestyle characteristics that may require tailoring of specific nutrient values.

Dietary Reference Intakes

Reference Values for Elements (part 2)

	Iron[18]			Magnesium			Manganese		Molybdenum			Nickel		Phosphorus		
Unit	**mg/day**			**mg/day**			**mg/day**		**µg/day**			**mg/day**		**mg/day**		
	EAR	RDA/AI	UL	*EAR*	RDA/AI	UL[19]	AI	UL	*EAR*	RDA/AI	UL	AI	UL	*EAR*	RDA/AI	UL
Infants																
0–6 mo	*ND*	**0.27***	40	*ND*	30*	ND	0.003*	ND	*ND*	2*	ND	ND	ND	*ND*	100*	ND
7–12 mo	*6.9*	**11**	40	*ND*	75*	ND	0.6*	ND	*ND*	3*	ND	ND	ND	*ND*	275*	ND
Children																
1–3 y	*3.0*	**7**	40	*65*	**80**	65	1.2*	2	*13*	**17**	300	ND	0.2	*380*	**460**	3000
4–8 y	*4.1*	**10**	40	*110*	**130**	110	1.5*	3	*17*	**22**	600	ND	0.3	*405*	**500**	3000
Males																
9–13 y	*5.9*	**8**	40	*200*	**240**	350	1.9*	6	*26*	**34**	1100	ND	0.6	*1055*	**1250**	4000
14–18 y	*7.7*	**11**	45	*340*	**410**	350	2.2*	9	*33*	**43**	1700	ND	1.0	*1055*	**1250**	4000
19–30 y	*6*	**8**	45	*330*	**400**	350	2.3*	11	*34*	**45**	2000	ND	1.0	*580*	**700**	4000
31–50 y	*6*	**8**	45	*350*	**420**	350	2.3*	11	*34*	**45**	2000	ND	1.0	*580*	**700**	4000
51–70 y	*6*	**8**	45	*350*	**420**	350	2.3*	11	*34*	**45**	2000	ND	1.0	*580*	**700**	4000
>70 y	*6*	**8**	45	*350*	**420**	350	2.3*	11	*34*	**45**	2000	ND	1.0	*580*	**700**	3000
Females																
9–13 y	*5.7*[e]	**8**[e]	40	*200*	**240**	350	1.6*	6	*26*	**34**	1100	ND	0.6	*1055*	**1250**	4000
14–18 y	*7.9*[e]	**15**[e]	45	*300*	**360**	350	1.6*	9	*33*	**43**	1700	ND	1.0	*1055*	**1250**	4000
19–30 y	*8.1*[e]	**18**[e]	45	*255*	**310**	350	1.8*	11	*34*	**45**	2000	ND	1.0	*580*	**700**	4000
31–50 y	*8.1*[e]	**18**[e]	45	*265*	**320**	350	1.8*	11	*34*	**45**	2000	ND	1.0	*580*	**700**	4000
51–70 y	*5*[e]	**8**[e]	45	*265*	**320**	350	1.8*	11	*34*	**45**	2000	ND	1.0	*580*	**700**	4000
>70 y	*5*[e]	**8**[e]	45	*265*	**320**	350	1.8*	11	*34*	**45**	2000	ND	1.0	*580*	**700**	3000
Pregnancy																
≤18 y	*23*	**27**	45	*335*	**400**	350	2.0*	9	*40*	**50**	1700	ND	1.0	*1055*	**1250**	3500
19–30 y	*22*	**27**	45	*290*	**350**	350	2.0*	11	*40*	**50**	2000	ND	1.0	*580*	**700**	3500
31–50 y	*22*	**27**	45	*300*	**360**	350	2.0*	11	*40*	**50**	2000	ND	1.0	*580*	**700**	3500
Lactation																
≤18 y	*7*	**10**	45	*300*	**360**	350	2.6*	9	*35*	**50**	1700	ND	1.0	*1055*	**1250**	4000
19–30 y	*6.5*	**9**	45	*255*	**310**	350	2.6*	11	*36*	**50**	2000	ND	1.0	*580*	**700**	4000
31–50 y	*6.5*	**9**	45	*265*	**320**	350	2.6*	11	*36*	**50**	2000	ND	1.0	*580*	**700**	4000

SOURCE: IOM, 1997, 2001

This table presents *Estimated Average Requirements (EARs) in italics*, **Recommended Dietary Allowances (RDAs) in bold type**, Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). Tolerable Upper Intake Levels (ULs) are in shaded columns. ND = Not Determinable

[18] The requirement for iron is 1.8 times higher for vegetarians due to the lower bioavailability of iron from a vegetarian diet.

[19] The UL for magnesium represents intake from a pharmacological agent only and does not include intake from food and water.

[e] For the EAR and RDA, it is assumed that girls younger than 14 years do not menstruate and that girls 14 years and older do menstruate. It is assumed that women 51 years and older are post-menopausal.

NOTE: These are reference values for normal, apparently healthy individuals eating a typical mixed North American diet. An individual may have physiological, health, or lifestyle characteristics that may require tailoring of specific nutrient values.

Dietary Reference Intakes

Reference Values for Elements (part 3)

	Selenium			Silicon[20]		Vanadium[22]		Zinc[23]			Potassium[24]		Sodium[25]		Chloride[26]		Sulfate[27]	
Unit	**μg/day**			**N/A**		**mg/day**		**mg/day**			**mg/day**		**mg/day**		**mg/day**		**N/A**	
	EAR	RDA/AI	UL	AI	UL[21]	AI	UL	*EAR*	RDA/AI	UL	AI	UL[21]	AI	UL	AI	UL	AI	UL[21]
Infants																		
0–6 mo	*ND*	15*	45	ND	ND	ND	ND	*ND*	2*	4	400*	ND	120*	ND	180*	ND	ND	ND
7–12 mo	*ND*	20*	60	ND	ND	ND	ND	*2.5*	**3**	5	700*	ND	370*	ND	570*	ND	ND	ND
Children																		
1–3 y	*17*	**20**	90	ND	ND	ND	ND	*2.5*	**3**	7	3000*	ND	1000*	1500	1500*	2300	ND	ND
4–8 y	*23*	**30**	150	ND	ND	ND	ND	*4.0*	**5**	12	3800*	ND	1200*	1900	1900*	2900	ND	ND
Males																		
9–13 y	*35*	**40**	280	ND	ND	ND	ND	*7.0*	**8**	23	4500*	ND	1500*	2200	2300*	3400	ND	ND
14–18 y	*45*	**55**	400	ND	ND	ND	ND	*8.5*	**11**	34	4700*	ND	1500*	2300	2300*	3600	ND	ND
19–30 y	*45*	**55**	400	ND	ND	ND	1.8	*9.4*	**11**	40	4700*	ND	1500*	2300	2300*	3600	ND	ND
31–50 y	*45*	**55**	400	ND	ND	ND	1.8	*9.4*	**11**	40	4700*	ND	1500*	2300	2300*	3600	ND	ND
51–70 y	*45*	**55**	400	ND	ND	ND	1.8	*9.4*	**11**	40	4700*	ND	1300*	2300	2000*	3600	ND	ND
>70 y	*45*	**55**	400	ND	ND	ND	1.8	*9.4*	**11**	40	4700*	ND	1200*	2300	1800*	3600	ND	ND
Females																		
9–13 y	*35*	**40**	280	ND	ND	ND	ND	*7.0*	**8**	23	4500*	ND	1500*	2200	2300*	3400	ND	ND
14–18 y	*45*	**55**	400	ND	ND	ND	ND	*7.3*	**9**	34	4700*	ND	1500*	2300	2300*	3600	ND	ND
19–30 y	*45*	**55**	400	ND	ND	ND	1.8	*6.8*	**8**	40	4700*	ND	1500*	2300	2300*	3600	ND	ND
31–50 y	*45*	**55**	400	ND	ND	ND	1.8	*6.8*	**8**	40	4700*	ND	1500*	2300	2300*	3600	ND	ND
51–70 y	*45*	**55**	400	ND	ND	ND	1.8	*6.8*	**8**	40	4700*	ND	1300*	2300	2000*	3600	ND	ND
>70 y	*45*	**55**	400	ND	ND	ND	1.8	*6.8*	**8**	40	4700*	ND	1200*	2300	1800*	3600	ND	ND
Pregnancy																		
≤18 y	*49*	**60**	400	ND	ND	ND	ND	*10.5*	**12**	34	4700*	ND	1500*	2300	2300*	3600	ND	ND
19–30 y	*49*	**60**	400	ND	ND	ND	ND	*9.5*	**11**	40	4700*	ND	1500*	2300	2300*	3600	ND	ND
31–50 y	*49*	**60**	400	ND	ND	ND	ND	*9.5*	**11**	40	4700*	ND	1500*	2300	2300*	3600	ND	ND
Lactation																		
≤18 y	*59*	**70**	400	ND	ND	ND	ND	*10.9*	**13**	34	5100*	ND	1500*	2300	2300*	3600	ND	ND
19–30 y	*59*	**70**	400	ND	ND	ND	ND	*10.4*	**12**	40	5100*	ND	1500*	2300	2300*	3600	ND	ND
31–50 y	*59*	**70**	400	ND	ND	ND	ND	*10.4*	**12**	40	5100*	ND	1500*	2300	2300*	3600	ND	ND

SOURCE: IOM, 2000a, 2001, 2005b

This table presents *Estimated Average Requirements (EARs) in italics*, **Recommended Dietary Allowances (RDAs) in bold type**, Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). Tolerable Upper Intake Levels (ULs) are in shaded columns. ND = Not Determinable

[20] Although silicon has not been shown to cause adverse effects in humans, there is no justification for adding silicon to supplements.

[21] Due to lack of suitable data, ULs could not be established for silicon, potassium, and sulfate. This does not mean that there is no potential for adverse effects resulting from high intakes.

[22] Although vanadium in food has not been shown to cause adverse effects in humans, there is no justification for adding vanadium to food and vanadium supplements should be used with caution. The UL is based on adverse effects in laboratory animals and this data could be used to set a UL for adults but not children and adolescents.

[23] The requirement for zinc may be as much as 50 percent greater for vegetarians, particularly for strict vegetarians whose major food staples are grains and legumes, due to the lower bioavailability of zinc from a vegetarian diet.

[24] The beneficial effects of potassium appear to be mainly from the forms of potassium found naturally in foods such as fruits and vegetables. Supplemental potassium should only be provided under medical supervision because of the well-documented potential for toxicity.

[25] Grams of sodium x 2.53 = grams of salt.

[26] Sodium and chloride are normally found in foods together as sodium chloride (table salt). For this reason, the AI and UL for chloride are set at a level equivalent on a molar basis to those for sodium, since almost all dietary chloride comes with sodium added during processing or consumption of foods.

[27] An AI for sulfate was not established because sulfate requirements are met when dietary intakes contain recommended levels of sulfur amino acids (protein).

NOTE: These are reference values for normal, apparently healthy individuals eating a typical mixed North American diet. An individual may have physiological, health, or lifestyle characteristics that may require tailoring of specific nutrient values.

Dietary Reference Intakes

Reference Values for Macronutrients (part 1)

	Carbohydrate (Digestible)			Total Protein[29]				Total Fat		Linoleic Acid (n-6)		α-linolenic Acid (n-3)		Total Fibre[31]		Total Water[33]	
Unit	**g/day**			**g/kg/day**		**g/day[30]**		**g/day**		**g/day**		**g/day**		**g/day**		**Litres/day**	
	EAR	RDA/AI	UL[28]	*EAR*	RDA/AI	RDA/AI	UL[28]	AI	UL[28]	AI	UL[28]	AI	UL[28]	AI[32]	UL[28]	AI	UL[28]
Infants																	
0–6 mo	*ND*	60*	ND	*ND*	1.52*	9.1*	ND	31*	ND	4.4*	ND	0.5*	ND	ND	ND	0.7*	ND
7–12 mo	*ND*	95*	ND	*1.0*	**1.2**	**11.0**	ND	30*	ND	4.6*	ND	0.5*	ND	ND	ND	0.8*	ND
Children																	
1–3 y	*100*	**130**	ND	*0.87*	**1.05**	**13**	ND	ND	ND	7*	ND	0.7*	ND	19*	ND	1.3*	ND
4–8 y	*100*	**130**	ND	*0.76*	**0.95**	**19**	ND	ND	ND	10*	ND	0.9*	ND	25*	ND	1.7*	ND
Males																	
9–13 y	*100*	**130**	ND	*0.76*	**0.95**	**34**	ND	ND	ND	12*	ND	1.2*	ND	31*	ND	2.4*	ND
14–18 y	*100*	**130**	ND	*0.73*	**0.85**	**52**	ND	ND	ND	16*	ND	1.6*	ND	38*	ND	3.3*	ND
19–30 y	*100*	**130**	ND	*0.66*	**0.80**	**56**	ND	ND	ND	17*	ND	1.6*	ND	38*	ND	3.7*	ND
31–50 y	*100*	**130**	ND	*0.66*	**0.80**	**56**	ND	ND	ND	17*	ND	1.6*	ND	38*	ND	3.7*	ND
51–70 y	*100*	**130**	ND	*0.66*	**0.80**	**56**	ND	ND	ND	14*	ND	1.6*	ND	30*	ND	3.7*	ND
>70 y	*100*	**130**	ND	*0.66*	**0.80**	**56**	ND	ND	ND	14*	ND	1.6*	ND	30*	ND	3.7*	ND
Females																	
9–13 y	*100*	**130**	ND	*0.76*	**0.95**	**34**	ND	ND	ND	10*	ND	1.0*	ND	26*	ND	2.1*	ND
14–18 y	*100*	**130**	ND	*0.71*	**0.85**	**46**	ND	ND	ND	11*	ND	1.1*	ND	26*	ND	2.3*	ND
19–30 y	*100*	**130**	ND	*0.66*	**0.80**	**46**	ND	ND	ND	12*	ND	1.1*	ND	25*	ND	2.7*	ND
31–50 y	*100*	**130**	ND	*0.66*	**0.80**	**46**	ND	ND	ND	12*	ND	1.1*	ND	25*	ND	2.7*	ND
51–70 y	*100*	**130**	ND	*0.66*	**0.80**	**46**	ND	ND	ND	11*	ND	1.1*	ND	21*	ND	2.7*	ND
>70 y	*100*	**130**	ND	*0.66*	**0.80**	**46**	ND	ND	ND	11*	ND	1.1*	ND	21*	ND	2.7*	ND
Pregnancy																	
≤18 y	*135*	**175**	ND	*0.88*[f]	**1.1**[f]	**71**[f]	ND	ND	ND	13*	ND	1.4*	ND	28*	ND	3.0*	ND
19–30 y	*135*	**175**	ND	*0.88*[f]	**1.1**[f]	**71**[f]	ND	ND	ND	13*	ND	1.4*	ND	28*	ND	3.0*	ND
31–50 y	*135*	**175**	ND	*0.88*[f]	**1.1**[f]	**71**[f]	ND	ND	ND	13*	ND	1.4*	ND	28*	ND	3.0*	ND
Lactation																	
≤18 y	*160*	**210**	ND	*1.05*	**1.3**	**71**	ND	ND	ND	13*	ND	1.3*	ND	29*	ND	3.8*	ND
19–30 y	*160*	**210**	ND	*1.05*	**1.3**	**71**	ND	ND	ND	13*	ND	1.3*	ND	29*	ND	3.8*	ND
31–50 y	*160*	**210**	ND	*1.05*	**1.3**	**71**	ND	ND	ND	13*	ND	1.3*	ND	29*	ND	3.8*	ND

SOURCE: IOM, 2005a

This table presents *Estimated Average Requirements (EARs) in italics*, **Recommended Dietary Allowances (RDAs) in bold type**, Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). Tolerable Upper Intake Levels (ULs) are in shaded columns. ND = Not Determinable

[28] Although a UL was not set for any of the macronutrients, the absence of definitive data does not signify that people can tolerate chronic intakes of these substances at high levels.

[29] Available evidence does not support recommending a separate protein requirement for vegetarians who consume complimentary mixtures of plant proteins, as these can provide the same quality of protein as that from animal proteins.

[30] Recommendations for total protein are determined as the amount needed per kg body weight multiplied by the reference weight.

[31] Total fibre is defined as the sum of dietary fibre and functional fibre. See definitions for further details.

[32] The AI for total fibre is based on 14 g/1000 kcal multiplied by the median usual daily energy intake from the Continuing Survey of Food Intakes by Individuals (CSFII 1994–1996, 1998).

[33] Total water includes drinking water, water in beverages, and water that is part of food.

[f] The EAR and RDA for pregnancy are only for the second half of pregnancy. For the first half of pregnancy, protein requirements are the same as those of the nonpregnant woman.

NOTE: These are reference values for normal, apparently healthy individuals eating a typical mixed North American diet. An individual may have physiological, health, or lifestyle characteristics that may require tailoring of specific nutrient values.

Dietary Reference Intakes

Reference Values for Macronutrients (part 2)

Acceptable Macronutrient Distribution Ranges (AMDR)

Males & Females[34]	Total Carbohydrate	Total Protein	Total Fat	n-6 polyunsaturated fatty acids (linoleic acid)	n-3 polyunsaturated fatty acids (α-linolenic acid)
	Percent of Energy	Percent of Energy	Percent of Energy	Percent of Energy	Percent of Energy[35]
1–3 years	45–65 %	5–20 %	30–40 %	5–10 %	0.6–1.2 %
4–18 years	45–65 %	10–30 %	25–35 %	5–10 %	0.6–1.2 %
19 years and over	45–65 %	10–35 %	20–35 %	5–10 %	0.6–1.2 %

[34] Includes pregnant and lactating women.

[35] Up to 10% of the AMDR can be consumed as eicosapentaenoic acid (EPA) and/or docosahexaenoic acid (DHA).

Additional Macronutrient Recommendations

Saturated fatty acids	As low as possible while consuming a nutritionally adequate diet
Trans fatty acids	
Dietary cholesterol	
Added sugars[g]	Limit to no more than 25% of total energy

SOURCE: IOM, 2005a

A UL was not set for saturated fatty acids, trans fatty acids, dietary cholesterol, or added sugars.

[g] Added sugars are defined as sugars and syrups that are added to foods during processing or preparation. Although there were insufficient data to set a UL for added sugars, this maximal intake level is suggested to prevent the displacement of foods that are major sources of essential micronutrients.

APPENDIX 3: CRITERIA USED TO SET EERs, EARs, AIs AND ULs, AND AVAILABILITY OF DATA IN 2015 CCHS-NUTRITION

Table A3.1 Criteria used to set Estimated Energy Requirements (EERs), Estimated Average Requirements (EARs), Adequate Intakes (AIs) and Tolerable Upper Intake Levels (ULs), and Availability of Data in 2015 CCHS-Nutrition

Nutrient	Reference Standard	Criterion used to set EER, EAR or AI in adults[1]	Adverse effect used to set UL[2] in adults	Data availability in 2015 CCHS-Nutrition[3]
Energy	EER	Energy expenditure (and in certain age groups, energy needed for growth or secretion of milk)	N/A[4]	Yes
Carbohydrate	EAR	Brain glucose utilization	N/A	Yes
Total fibre	AI	Intake level associated with greatest protection against coronary heart disease risk (14 g/1000 kcal) x median energy intake (kcal/d)	N/A	Yes
n-6 Polyunsaturates (linoleic acid)	AI	Median intake of linoleic acid from the US Continuing Survey of Food Intake by Individuals	N/A	Yes (for linoleic acid, but not for total n-6 PUFA)
n-3 Polyunsaturates (α-linolenic acid)	AI	Median intake of α-linolenic acid from the US Continuing Survey of Food Intake by Individuals	N/A	Yes (for linolenic acid, EPA, DPA, and DHA, but not for total n-3 PUFA)
Protein	EAR	Nitrogen equilibrium (and in certain age groups, protein required for growth or milk production)	N/A	Yes
Water	AI	Median total water intakes (plain water, water in beverages and water in food) from the US National Health and Nutrition Examination III, 1988–1994	N/A	Yes
Vitamin A	EAR	Adequate liver vitamin A stores	For women of reproductive age, the UL is based on teratogenicity; for other adults, it is based on liver abnormalities. (UL applies only to preformed vitamin A [retinol].)	Yes (for EAR, assessed as µg retinol activity equivalents) No (for UL; CCHS data do not include information on retinol)

Nutrient	Reference Standard	Criterion used to set EER, EAR or AI in adults[1]	Adverse effect used to set UL[2] in adults	Data availability in 2015 CCHS-Nutrition[3]
Thiamin	EAR	Erythrocyte transketolase activity, urinary thiamine excretion	N/A	Yes
Riboflavin	EAR	Erythrocyte glutathione reductase activity coefficient, blood riboflavin, and urinary riboflavin excretion	N/A	Yes
Niacin	EAR	Urinary excretion of niacin metabolites	Flushing (UL applies only to supplemental or synthetic forms)	Yes (for EAR, assessed as mg niacin equivalents) No (for UL, CCHS data do not include information on only synthetic forms)
Vitamin B_6	EAR	Plasma 5′-pyridoxal phosphate value of at least 20 nmol/L.	Sensory neuropathy	Yes
Folate	EAR	Erythrocyte folate in conjunction with plasma homocysteine and folate concentrations	Precipitation or exacerbation of neuropathy in vitamin B_{12}-deficient individuals (UL applies only to supplemental or synthetic folic acid).	Yes (CCHS data include information on dietary folate equivalents [for EAR] and synthetic folic acid [for UL]).
Pantothenic Acid	AI	Pantothenic acid intake sufficient to replace urinary excretion.	N/A	No
Vitamin B_{12}	EAR	Maintenance of hematological status and normal serum vitamin B_{12} values	N/A	Yes
Choline	AI	Intake required to maintain liver function as assessed by measuring serum alanine aminotransferase levels.	Hypotension, with corroborative evidence on cholinergic side effects (e.g. sweating and diarrhea) and fishy body odor	No
Biotin	AI	Extrapolation from the biotin content of human milk	N/A	No
Vitamin C	EAR	Near-maximal neutrophil ascorbate concentration with minimal urinary ascorbate excretion (to provide antioxidant protection)	Osmotic diarrhea and gastrointestinal disturbances	Yes

Nutrient	Reference Standard	Criterion used to set EER, EAR or AI in adults[1]	Adverse effect used to set UL[2] in adults	Data availability in 2015 CCHS-Nutrition[3]
Vitamin D	EAR	Bone health (Serum 25(OH)D levels)	Hypercalcemia	Yes
Vitamin E	EAR	Plasma α-tocopherol concentration that minimizes hydrogen peroxide-induced hemolysis to 12% or less	Increased tendency to hemorrhage. (UL applies to any form of alpha-tocopherol obtained from supplements and/ or fortified foods.)	Yes (for UL, assessed as intake from supplements) No (for EAR)
Vitamin K	AI	Dietary intake of healthy individuals	N/A	No
Calcium	EAR	Bone health (desirable calcium retention/ calcium balance/ fracture risk reduction)	Risk of kidney stones; Urinary calcium excretion (infants)	Yes
Chromium	AI	Estimated mean intakes based on chromium content of 'balanced diets'/1000 kcal, and average energy intake	N/A	No
Copper	EAR	Plasma copper, serum ceruloplasmin, platelet copper, and red cell superoxide dismutase activity	Liver damage	No
Fluoride	AI	Caries prevention	Skeletal fluorosis	No
Iodine	EAR	Thyroid iodine accumulation and turnover	Elevated serum TSH (thyroid stimulating hormone) concentrations	No
Iron	EAR	Factorial modelling to replace losses and to allow for growth	Gastrointestinal distress	Yes
Magnesium	EAR	Magnesium balance	Diarrhea (UL applies only to supplemental magnesium)	Yes
Manganese	AI	Median intakes from the US Food and Drug Administration Total Diet Study	Manganese neurotoxicity and elevated blood manganese concentrations	No
Molybdenum	EAR	Molybdenum balance	Impaired reproduction and growth in animals	No
Phosphorus	EAR	Serum inorganic phosphorus concentration	Elevated serum inorganic phosphorus concentration	Yes

Nutrient	Reference Standard	Criterion used to set EER, EAR or AI in adults[1]	Adverse effect used to set UL[2] in adults	Data availability in 2015 CCHS-Nutrition[3]
Potassium	AI	Maintenance of lower blood pressure, reduced risk of kidney stones, possible reduction of bone loss, reduction of adverse effects of sodium chloride on blood pressure	N/A	Yes
Selenium	EAR	Amount needed to maximize synthesis of glutathione peroxidase (a selenium-containing antioxidant enzyme)	Selenosis (includes hair and nail brittleness and loss, gastrointestinal disturbances, rash, and other symptoms)	No
Sodium	AI	Amount associated with a diet that provides adequate intakes of other essential nutrients; amount needed for moderate sweat sodium losses	Effect of sodium on blood pressure	Yes
Zinc	EAR	Factorial analysis of zinc losses and needs for growth	Reduced copper status (reduced red blood cell copper-zinc superoxide dismutase activity)	Yes

1. In some cases, different criteria were used for children.

2. Unless otherwise specified, the UL represents total intake from food, water, and supplements.

3. This column indicates whether the 2015 CCHS-Nutrition data file contains nutrient intake variables that permit the assessment of intakes in relation to the EAR or AI, and/or in relation to the UL.

4. Due to the lack of suitable data, ULs could not be established for several nutrients. In the absence of a UL, extra caution may be warranted in consuming intakes above recommended levels.

SOURCES: Institute of Medicine, 1997, 1998a, 2000a, 2000b, 2002, 2004, 2005, 2011

APPENDIX 4: THE PROBABILITY METHOD FOR ASSESSING GROUP PREVALENCE OF INADEQUACY

In population nutrition surveys such as the 2015 CCHS-Nutrition, an important objective is to determine the prevalence of inadequate nutrient intakes in the population and its subgroups. This can be done using the probability method, which is described below, or a shortcut to the full probability method, known as the EAR cut-point method (described in Section 2.2.2). This appendix provides a brief overview of the probability method, shows a simple example of how it is used, and lays the foundation for use of the EAR cut-point method. Readers interested in a more complete explanation should consult the IOM report (IOM, 2000c).

DESCRIPTION AND ILLUSTRATION OF THE PROBABILITY METHOD

The probability method of estimating the group prevalence of nutrient inadequacy involves: 1) determining the probability of inadequacy for each usual intake level in the group; and 2) calculating the average of those individual probabilities. To use the probability method, the requirement distribution must be known (so the probability of inadequacy associated with each intake level can be determined), and nutrient requirements and intakes must be independent. This is thought to be true for most nutrients, although it is known not to be true for energy.

To illustrate the probability method, an example will be used of a group of 650 adult men aged 19 to 30 years, and a hypothetical nutrient with an EAR of 7 mg/d for this age-sex group. Individuals in this group, even though they are similar in age and sex, differ both in their requirements for the nutrient and their usual intakes of the nutrient. At a conceptual level, determining the prevalence of inadequate nutrient intakes in the group would simply involve comparing each individual's usual nutrient intake to his individual requirement, and totalling the number of men with usual intakes below their individual requirements. For example, a man with a usual nutrient intake of 9 mg/d and a requirement of 10 mg/d would not meet his requirement and would be classified as inadequate, whereas another man with a usual nutrient intake of 9 mg/d and a requirement of 5 mg/d would exceed his requirement. In practice, however, we almost never know individuals' nutrient requirements. Instead, we may have information on the distribution of requirements for a small group of individuals who are similar in age and sex, and who took part in studies to determine nutrient requirements. From that information, we can determine the probability, or risk, that a given intake will be adequate or inadequate.

Knowledge of the distribution of requirements allows one to construct a risk curve that defines the probability that any given intake is inadequate, whether the requirement distribution is statistically normal or not. Figure A4.1 shows a risk curve for the example nutrient with an EAR of 7 mg/d. The requirement distribution for this nutrient is statistically normal, and the SD is ~1.5 mg/d. As described in Section 2.1.2, for nutrients with normal requirement distributions, 95% of individuals have requirements within ± 2 SD of the EAR. In this example, 95% of men aged 19 to 30 years would have requirements between 4 mg/d (7 mg/d minus twice the SD of 1.5 mg/d) and 10 mg/d (7 mg/d plus twice the SD of 1.5 mg/d). The probability of inadequacy associated with any intake can be determined by assessing where the intake level intersects the risk curve.

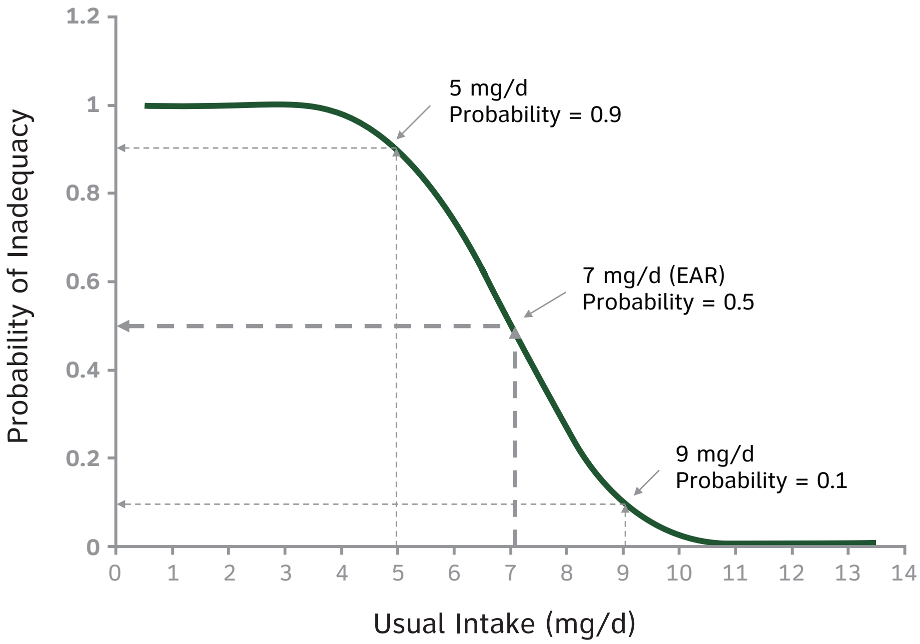

Figure A4.1 Risk curve

The risk curve is from a normal requirement distribution with a mean of 7 mg/d and a SD of 1.5 mg/d. Usual intakes below ~3 mg/d have a 100% (1.0) probability of inadequacy, while intakes at or above ~11 mg/d have a 0% probability of inadequacy. By definition, the probability of inadequacy is 0.5 at the EAR. The probability of inadequacy for any given usual intake can be determined by assessing where the usual intake intersects the risk curve. In this example, intakes of 5 mg/d and 9 mg/d are associated with probabilities of inadequacy of ~0.9 and ~0.1, respectively.
Modified from IOM, 2000c.

- As can be seen in the Figure, the probability of inadequacy at a usual intake at or below about 3 mg/d is associated with a probability of inadequacy of essentially 1.0 (100%), meaning that virtually everyone with a usual intake in this range does not meet their own requirement. When usual intakes are at or above about 11 mg/d, the probability of inadequacy is essentially 0, meaning that virtually everyone with a usual intake in this range would meet their own requirement.
- When usual intake is between 4 mg/d and 10 mg/d, the probability of inadequacy varies, and can be estimated by determining where the usual intake level intersects the risk curve:
  - It is relatively high at intakes that are just above the lower end of the distribution of requirements (about 0.9 or 90% at a usual intake of 5 mg/d in this example)
  - By definition, the probability of inadequacy at the EAR is 0.5 or 50% (7 mg/d in this example)
  - It is relatively low at intakes that are closer to the upper end of the distribution of requirements (about 0.1 or 10% at a usual intake of 9 mg/d in this example).

The information on the probability of inadequacy of different usual intake levels is used to estimate the prevalence of inadequate intakes in the group. This is done by determining the probability of inadequacy for each usual intake level in the group, and then computing the average for the group as a whole. Figure A4.2 and Table A4.1 illustrate this approach. Figure A4.2 shows the risk curve from Figure A4.1, as well as a usual intake distribution for the group of 650 men in the example (each 'box' in the Figure represents 10 men and there are 65 boxes). The Table shows the usual intake levels from the distribution shown in Figure A4.2, the associated probability of inadequacy, and the number of men at that intake level. To illustrate how the Figure and Table work to determine the prevalence of inadequacy, consider men with intakes of 5 mg/d and 9 mg/d. Twenty men have usual intakes of 5 mg/d, and an intake of 5 mg/d intersects the risk curve at a probability of inadequacy of 0.90. Because each individual with a usual intake of 5 mg/d has a 90% (0.9) probability of being inadequate, one would expect 18 of 20 men (90% of 20) to be inadequate. In contrast, 80 men have usual intakes of 9 mg/d, and an intake of 9 mg/d intersects the risk curve at a probability of inadequacy of 10%. One would thus expect 8 men (10% of the 80 men with usual intakes of 9 mg/d) to be inadequate. The average probability of inadequacy is calculated by totalling the number of individuals likely to have inadequate intakes, and then dividing by the total number of men. (This is mathematically identical to adding up all the individual probabilities of inadequacy—i.e. 1.0 + 1.0 + 1.0 +...0 + 0 + 0—and dividing by the total number of men). In this example, the group prevalence of inadequacy is approximately 20%.

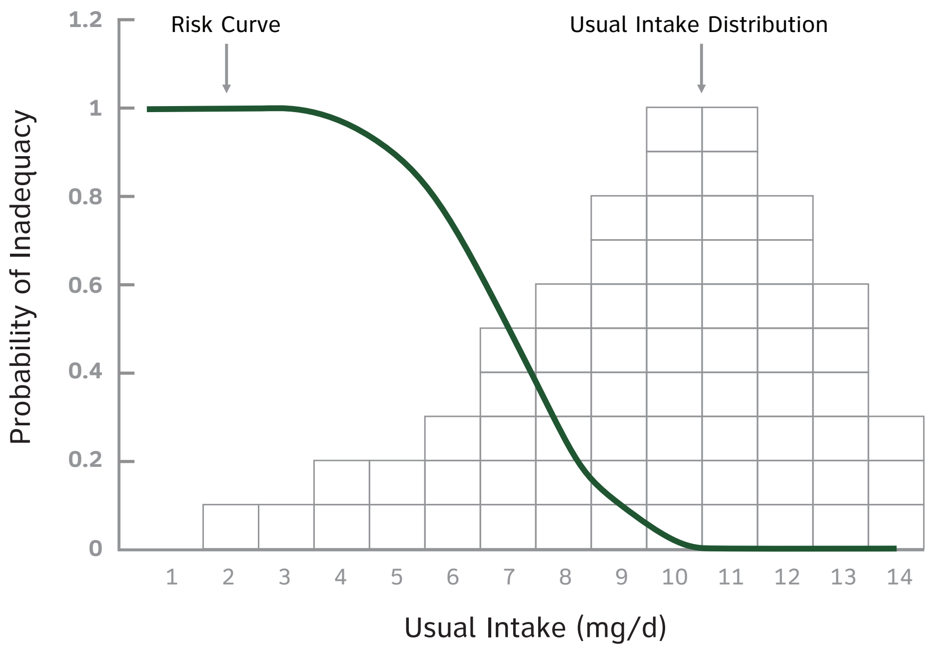

Figure A4.2 Comparison of the risk curve to a usual intake distribution.

In this simplified usual intake distribution, each 'box' represents 10 men aged 19 to 30 years. The prevalence of inadequate intakes in the group is estimated by determining the probability of inadequacy associated with each individual usual intake level, and then calculating the average probability for the group.

Table A4.1 Example of estimating group prevalence of inadequacy using the probability method

Usual Intake Level (mg/d)	Probability of Inadequacy	Number of people	Probability x Number*
2	1.0	10	10
3	1.0	10	10
4	0.97	20	19.4
5	0.90	20	18.0
6	0.73	30	21.9
7	0.50	50	25.0
8	0.27	60	16.2
9	0.10	80	8.0
10	0.03	100	3.0
11	0	100	0
12	0	80	0
13	0	60	0
14	0	30	0
Total		**650**	**131.5**

Average Probability = probability x number/total
= 131.5/650 = 0.20 (20%)

* This represents the number of men expected to have inadequate intakes at each intake level.

RELATIONSHIP OF THE EAR CUT-POINT METHOD TO THE PROBABILITY METHOD

The EAR cut-point method is a shortcut derived from the full probability method. It does not require knowledge of the complete distribution of requirements, although the EAR must be known and the requirement distribution must be approximately symmetrical. Like the full probability method, intakes and requirements must be independent, and an additional requirement is that the distribution of usual intakes must be more variable than the requirement distribution.

When the conditions outlined above are satisfied, the proportion of the group with intakes below the EAR will approximate the prevalence of inadequacy in the group as determined by the full probability method. The reason this occurs can be described as follows:

1. Although the probability of inadequacy exceeds 50% when usual intakes are below the EAR, not everyone with an intake below the EAR fails to meet their own requirement: Some individuals with lower-than-average requirements will have adequate intakes (their usual intake, although below the EAR, exceeds their own requirement).
2. Similarly, although the probability of inadequacy is less than 50% when usual intakes are above the EAR, not everyone with intakes above the EAR meets their own requirement: Some individuals with higher-than-average requirements will have inadequate intakes (their usual intake, although above the EAR, is below their own requirement).

3. When the requirement distribution is symmetrical, when intakes are more variable than requirements, and when intakes and requirements are independent, the proportion of the group described in (1) above cancels out the proportion described in (2) above. The prevalence of inadequacy in the group can thus be approximated by the proportion with usual intakes below the EAR.

The EAR cut-point method is illustrated in Figure A4.3. The Figure shows a hypothetical joint distribution of usual intakes and individual requirements for a group of 60 individuals. This example is hypothetical because in practice we almost never have access to accurate data on either usual intakes of individuals or their individual requirements. The Figure includes a 45° dashed line labelled *Intake = Requirement*. Individuals who fall to the right of and below this line have usual intakes that exceed their individual requirements (i.e. they have adequate intakes), whereas individuals who fall to the left of and above the line have usual intakes that do not meet their requirements (i.e. they have inadequate intakes). Determining the prevalence of inadequacy in this hypothetical situation is easy: one simply counts the number of individuals with usual intakes below their individual requirements. In this example, 13 individuals have intakes to the left of and above the Intake = Requirement line, so the group prevalence of inadequacy is 13/60, or 21.7%.

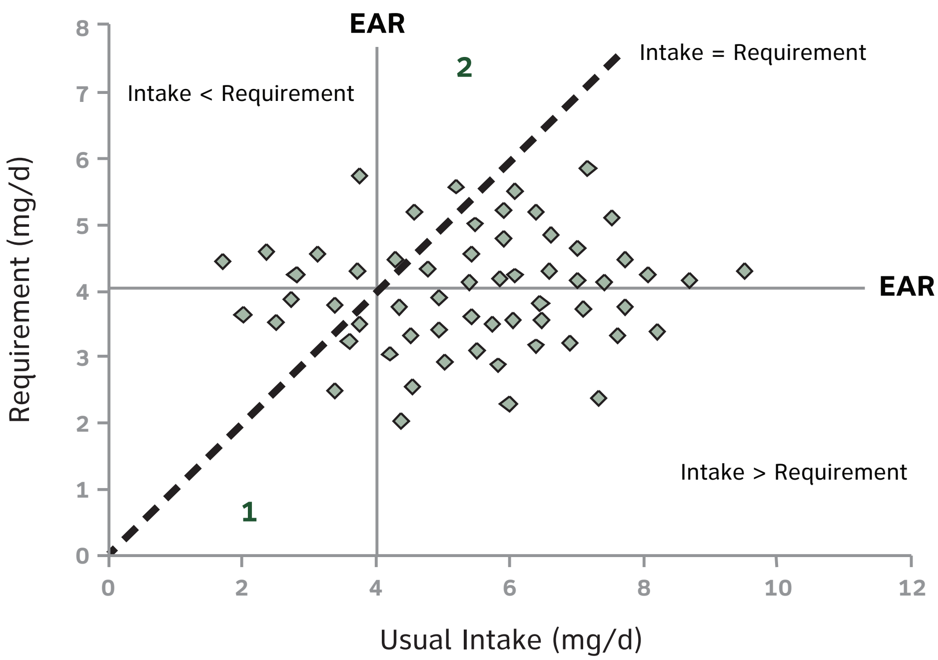

Figure A4.3 Joint distribution of requirements and usual intakes

Individuals with usual intakes below their individual requirements are found to the left of and above the dashed 45° line labelled *Intake = Requirement*. When assumptions for the EAR cut-point method are satisfied, this proportion of the group is mathematically similar to the proportion to the left of the vertical EAR line (i.e., there are similar numbers of individuals in triangles 1 and 2). Modified from IOM, 2000c.

The Figure also shows the EAR (in this example, it is 4 mg/d) on both the requirement axis (the Y axis) and on the usual intake axis (X axis). Focusing on the X axis, note that most individuals with usual intakes below the EAR have inadequate intakes (they are to the left of and above the Intake = Requirement line), but that some (who appear in the triangle labelled *1*) have usual intakes that exceed their individual requirements. Similarly, although most individuals with usual intakes above the EAR meet their requirements (they are to the right of and below the Intake = Requirement line), some (who appear in the triangle labelled *2*) do not.

The assumptions required for use of the EAR cut-point method are satisfied in this example, as described below:

1. Requirement distribution is approximately symmetrical. In the Figure, it can be seen that similar proportions of the group have requirements above and below the EAR of 4 mg/d (the number of individuals above the horizontal EAR line is similar to the number of individuals below).
2. Intakes and requirements are independent. The Figure shows that individuals with low requirements are just as likely as individuals with high requirements to have high (or low) usual intakes.
3. The usual intake distribution is more variable than the requirement distribution. In the Figure, it can be seen that there is more variability in the intake distribution (it ranges from less than 2 mg/d to almost 10 mg/d) than in the requirement distribution (which ranges from about 2 mg/d to about 6 mg/d).

When the above conditions are met, the individuals in triangle 1 (with intakes below the EAR but above their own requirements) are similar in number to the individuals in triangle 2 (with intakes above the EAR and below their own requirements). These two triangles cancel one another out, and the number of individuals that do not meet their requirements (those found to the left of the 45° Intake = Requirement line) is thus mathematically similar to the number with usual intakes below the EAR.

The EAR cut-point method can also be applied to the example of 650 men described earlier, as the requirement distribution is symmetrical, intakes and requirements are independent, and the usual intake distribution is more variable than the requirement distribution. In this case, one would simply determine the number of men with intakes at or below the EAR of 7 mg/d. From Table A4.1, this would be 10 (2 mg/d) + 10 (3 mg/d) + 20 (4 mg/d) + 20 (5 mg/d) + 30 (6 mg/d) + 50 (7 mg/d), for a total of 140 men. Dividing this by the total group size of 650 yields the estimated prevalence of inadequacy of 21.5%, which is very similar to the estimate of 20% obtained using the full probability method.

In summary, the full probability method and a shortcut, known as the EAR cut-point method, can be used to estimate the prevalence of nutrient inadequacy in a group. Both methods require knowledge of the distribution of usual intakes for the group, and that intakes and requirements are independent. The EAR cut-point method has two additional requirements; namely, that the requirement distribution is symmetrical, and that the distribution of usual intakes is more variable than the distribution of requirements. If either of these two additional requirements is not met, the full probability method can be used instead, provided the requirement distribution is known.

APPENDIX 5: PUBLICATIONS FROM 2004 CCHS-NUTRITION

A PubMed search was conducted (November 2016), with the search terms "CCHS" OR "Canadian Community Health Survey" AND "2004" OR "2.2". 344 articles were identified, and abstracts were reviewed to identify articles in which primary analyses of the 2004 CCHS-Nutrition data had been conducted. In addition, some Statistics Canada reports, which are not accessible through PubMed, are included.

1 Akhtar-Danesh, N., Dehghan, M., Merchant, A. T., & Rainey, J. A. (2008). Validity of self-reported height and weight for measuring prevalence of obesity. *Open Medicine: A Peer-Reviewed, Independent, Open-Access Journal, 2*(3), e83–8. PMID: 21602953

2 Arcand, J., Abdulaziz, K., Bennett, C., L'Abbé, M. R., & Manuel, D. G. (2014). Developing a web-based dietary sodium screening tool for personalized assessment and feedback. *Applied Physiology, Nutrition, and Metabolism,39*(3), 413–414. doi:10.1139/apnm-2013-0322

3 Azagba, S., & Sharaf, M. F. (2012). Fruit and vegetable consumption and body mass index: A quantile regression approach. *Journal of Primary Care & Community Health, 3*(3), 210–220. doi:10.1177/2150131911434206

4 Barr, S. I., DiFrancesco, L., & Fulgoni, V. L.,3rd. (2013). Consumption of breakfast and the type of breakfast consumed are positively associated with nutrient intakes and adequacy of Canadian adults. *The Journal of Nutrition, 143*(1), 86–92. doi:10.3945/jn.112.167098

5 Barr, S. I., DiFrancesco, L., & Fulgoni, V. L., 3rd. (2014). Breakfast consumption is positively associated with nutrient adequacy in Canadian children and adolescents. *The British Journal of Nutrition, 112*(8), 1373–1383. doi:10.1017/S0007114514002190

6 Barr, S. I., DiFrancesco, L., & Fulgoni, V. L., 3rd. (2016). Association of breakfast consumption with body mass index and prevalence of overweight/obesity in a nationally-representative survey of Canadian adults. *Nutrition Journal, 15*, 33-016-0151-3. doi:10.1186/s12937-016-0151-3

7 Batal, M., Makvandi, E., Imbeault, P., Gagnon-Arpin, I., Grenier, J., Chomienne, M. H., & Bouchard, L. (2013). Comparison of dietary intake between francophones and anglophones in Canada: Data from CCHS 2.2. *Canadian Journal of Public Health, 104*(6 Suppl 1), S31–8. PMID: 24300318

8 Black, J. L., & Billette, J. M. (2013). Do Canadians meet Canada's food guide's recommendations for fruits and vegetables? *Applied Physiology, Nutrition, and Metabolism, 38*(3), 234–242. doi:10.1139/apnm-201-0166

9 Black, J. L., & Billette, J. M. (2015). Fast food intake in Canada: Differences among Canadians with diverse demographic, socio-economic and lifestyle characteristics. *Canadian Journal of Public Health, 106*(2), e52–8. doi:10.17269/cjph.106.4658

10 Brown, K., Nevitte, A., Szeto, B., & Nandi, A. (2015). Growing social inequality in the prevalence of type 2 diabetes in Canada, 2004–2012. *Canadian Journal of Public Health, 106*(3), e132–9. doi:10.17269/cjph.106.4769

11 Chan, Y. M., MacFarlane, A. J., & O'Connor, D. L. (2015). Modeling demonstrates that folic acid fortification of whole-wheat flour could reduce the prevalence of folate inadequacy in Canadian whole-wheat consumers. *The Journal of Nutrition, 145*(11), 2622–2629. doi:10.3945/jn.115.217851

12 Cockell, K. A., Miller, D. C., & Lowell, H. (2009). Application of the dietary reference intakes in developing a recommendation for pregnancy iron supplements in Canada. *The American Journal of Clinical Nutrition, 90*(4), 1023–1028. doi:10.3945/ajcn.2009.27561

13 Csizmadi, I., Boucher, B. A., Lo Siou, G., Massarelli, I., Rondeau, I., Garriguet, D., . . . Subar, A. F. (2016). Using national dietary intake data to evaluate and adapt the US diet history questionnaire: The stepwise tailoring of an FFQ for Canadian use. *Public Health Nutrition,* Jun 28,1–9. doi: 10.1017/S1368980016001506

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