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Canadian Community Health Survey Cycle 2.2, Nutrition (2004)

A Guide to Accessing and Interpreting the Data

Office of Nutrition Policy and Promotion
Health Products and Food Branch

Canada

Canadian Community Health Survey
Cycle 2.2, Nutrition (2004)

A Guide to Accessing and Interpreting the Data

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A Guide to Accessing and Interpreting the Data

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Foreword

The Canadian Community Health Survey (CCHS), Cycle 2.2, Nutrition (2004) provides the first national nutrition data since the Nutrition Canada survey was conducted nearly 35 years ago. The data provide reliable information about the food and nutrient intakes of Canadians and the relationship between diet and a wide range of health correlates.

This *Guide to Accessing and Interpreting the Data* is a concise reference for those wanting to use the CCHS 2.2 data. Its purpose is to increase understanding of the nature of the data and the considerations relevant to their analysis and interpretation. It is hoped that the guide will promote the appropriate use and interpretation of the data, and consistent reporting of the survey findings.

The intended audience is diverse and includes researchers and graduate students, policy makers, public health professionals, epidemiologists, educators, students, dietitians, the food industry, and the health media.

The guide describes:

- an overview of the CCHS and Cycle 2.2;
- how the Dietary Reference Intakes (DRIs) can be used in interpreting the dietary intake data;
- data tables that will be available from the CCHS 2.2 and how to access them; and
- how to compare the results with those of other surveys or data sources.

A variety of CCHS 2.2 resource documents from Statistics Canada are available for those planning to undertake their own data analyses.

We were most fortunate to have Dr. Susan Barr, Professor of Nutrition at the University of British Columbia, serve as lead writer. Health Canada staff guided the development of the technical content of the guide. We appreciate the valuable assistance from Statistics Canada, and other experts, including provincial partners, who gave their time, energy and insights.

This guide is designed to support users of the CCHS 2.2 data. It is the first in a series of reports Health Canada will release relating to the CCHS 2.2. Watch our Web site (www.hc-sc.gc.ca/fn-an/surveill/nutrition/index_e.html) to find out about learning opportunities and report releases.

We trust that this guide will contribute to the use of the CCHS 2.2 data.

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Health Canada

Notice to Readers

At the time of release of this guide, the information collected in the module on Vitamin and Mineral Supplement Details was still being validated. The wave 2 release of data only contains information on whether vitamin and mineral supplements were consumed.

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List of Abbreviations

Abbreviation	*Meaning*
AI	Adequate Intake
AMDR	Acceptable Macronutrient Distribution Range
AMPM	Automated Multiple-Pass Method
B.C.	British Columbia
BMI	Body Mass Index (kg/m^2)
BMR	Basal Metabolic Rate
BRFSS	Behavioral Risk Factor Surveillance System
CANSIM	Canadian Socio-economic Information Management System
CCHS	Canadian Community Health Survey
CDC	Centers for Disease Control and Prevention (US)
CFGHE	Canada's Food Guide to Healthy Eating
CHMS	Canadian Health Measures Survey
CI	Confidence Interval
CNF	Canadian Nutrient File
CSFII	Continuing Survey of Food Intake by Individuals (US)
CSV file	Comma-Separated Value file
CV	Coefficient of Variation
d	day
DIN	Drug Identification Number
DRI	Dietary Reference Intake
EAR	Estimated Average Requirement
EE	Energy Expenditure
EER	Estimated Energy Requirement
g	gram
HBSC	Health Behaviour in School-Aged Children
hr	hour
ht	height
HTML	Hypertext Mark-up Language

INMD	Institute of Nutrition, Metabolism, and Diabetes
kcal	kilocalories
kg	kilogram
LOAEL	Lowest-Observed-Adverse-Effect-Level
m	metre
MET	Metabolic Equivalent
µg	microgram
mg	milligram
ml	millilitre
NHANES	National Health and Nutrition Examination Survey (US)
NOAEL	No-Observed-Adverse-Effect-Level
PA	Physical Activity Coefficient
PAL	Physical Activity Level
PDF	Portable Document Format
P.E.I.	Prince Edward Island
PI	Ponderal Index
PUMF	Public Use Microdata Files
RAE	Retinol Activity Equivalents
RDA	Recommended Dietary Allowance
RDC	Research Data Centre
RMR	Resting Metabolic Rate
RNI	Recommended Nutrient Intake
SD	Standard Deviation
SEM	Standard Error of the Mean
SIDE	Software for Intake Distribution Estimation
SSHRC	Social Sciences and Humanities Research Council
TEE	Total Energy Expenditure
UF	Uncertainty Factor
UL	Tolerable Upper Intake Level
US	United States
USDA	United States Department of Agriculture
y	year

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 24-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 (95%) of containing a specified parameter estimate 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.

Average

The average is equal to the arithmetic mean and is the value obtained by dividing the sum of a set of quantities by the number of quantities in the set.

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 his or her height and is calculated by dividing the weight in kilograms by the height in meters squared (BMI = weight [kg]/height $[m]^2$). There are four categories of BMI ranges in the Canadian weight classification system: *underweight* (<18.5), *normal weight* (18.5 to 24.9), *overweight* (25 to 29.9) and *obese* (≥30).

Canada's Food Guide to Healthy Eating

Canada's Food Guide to Healthy Eating (CFGHE) 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) is a cross-sectional survey that collects information related to health status, health care utilization and health determinants for the Canadian population. The CCHS operates on a two-year collection cycle. The first year of the survey cycle "X.1" is a large sample, general population health survey, designed to provide reliable estimates at the health region level. The second year of the survey cycle "X.2" is a smaller survey designed to provide provincial-level results on specific focused health topics.

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.

CANSIM

CANSIM (Canadian Socio-economic Information Management System) is an online socioeconomic database that provides quick and easy access to a large range of the latest and most up-to-date statistics available in Canada such as labour, health, income, trade, education, manufacturing and investment.

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.

Common Content Modules in the Canadian Community Health Survey

Common content modules are modules, or a series of questions, that are asked of all survey respondents. For example, some questions (e.g. fruit and vegetable consumption) were included in the common content section of the Canadian Community Health Survey (CCHS) 1.1 and 2.1 (which were included in surveys in all health regions), and were identical to those included in the CCHS 2.2.

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 it may contain and generally what the data item(s) mean in everyday language.

Data Liberation Initiative

The Data Liberation Initiative is a program offered by Statistics Canada, whereby Canadian universities and colleges pay an annual fee that allows their faculty and students unlimited, affordable and equitable access to various Statistics Canada public use microdata files (PUMF), databases and geographic files.

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, is the only method available designed to assess food energy expenditure. This technique involves calculating the difference between the turnover of ingested oxygen and hydrogen isotopes in order to determine how much carbon dioxide was produced, a measure of metabolic rate.

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.

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.

Essential Fatty Acid

An essential fatty acid is a fatty acid that the human body needs but cannot synthesize; the primary essential fatty acids are linoleic and alpha-linolenic acids.

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 Frequency Questionnaire

A food frequency questionnaire (FFQ) aims to assess the frequency with which food items or food groups are consumed during a specified time period. Respondents, or a proxy, are asked to indicate on a well-defined checklist of food and food categories, the associated frequency with which they consume a particular food item (daily, weekly, monthly or yearly). The food list may be extensive or may focus on specific groups of foods that may or may not be associated with specific events or seasons. The inclusion of portion sizes in the FFQ in addition to improved computerized methods permits researchers to obtain energy and nutrient intakes for the respondent or group being studied.

Food Record

There are two types of food records: estimated and weighed. In both records the respondent, or a proxy, is asked to record detailed descriptions of all foods, beverages and snacks consumed, including preparation and cooking methods, for a specified period of time. For an estimated food record, food portion sizes are estimated using household measures; for a weighed record, respondents or a proxy are asked to weigh all foods and beverages consumed. In both methods mixed dishes are documented by recording the amount of each raw ingredient used in the recipe, the final weight of the mixed dish and the amount consumed by the subject.

Food Security (Access)

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. The food security module in the Canadian Community Health Survey (CCHS) 2.2 focuses primarily on characteristics of food security that relate to household "food access" in the context of financial resource constraint.

Macronutrients

Macronutrients are macromolecules in plant and animal structures that can be digested, absorbed, and used as energy sources and substrates for synthesis of the carbohydrates, fats, and proteins required to maintain cell and system integrity.

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).

Metabolic Equivalent

The Metabolic Equivalent (MET) is a physiological concept that reflects the intensity of an activity. MET is expressed as multiples of the resting metabolic rate, which is approximated as 1 kcal/kg/hr.

Non-Response Bias

Non-response bias is a bias that results 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 as these subjects may have characteristics that differ from those who responded.

Optional Content Modules in the Canadian Community Health Survey

Optional content modules are modules, or a series of questions, that are asked of only some survey respondents. Certain geographical regions, provinces or health regions would decide whether or not to include these modules or series of questions in their survey. For example, some questions differed among the Canadian Community Health Survey (CCHS) 2.2, CCHS 1.1 and CCHS 2.1 surveys (e.g. food insecurity), or were included as common content in one survey but were optional (selected by some but not all health regions) in another (e.g. sedentary activity).

Physical Activity Index

The Physical Activity Index is an index that represents the average daily energy an individual would expend on leisure time physical activity. It is calculated by summing the energy expenditure of each activity. This energy expenditure considers the intensity (expressed in Metabolic Equivalents [METs]), frequency and duration of the leisure time activity (e.g. jogging) in order to categorize that individual as *inactive* (physical activity index of <1.5 kcal/kg/d), *moderately active* (physical activity index of 1.5 to <3 kcal/kg/d), or *active* (physical activity index ≥3 kcal/kg/d).

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 inadequacy by comparing the distributions of requirements and intakes for the group and summing the probabilities.

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 to 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 will vary among individuals based on their age and sex.

Research Data Centres

Research Data Centres (RDCs) are centres which provide researchers with access, in secure university settings throughout the country, to Statistics Canada microdata from population and household surveys. RDCs are staffed by Statistics Canada employees. The RDC program is a partnership of Statistics Canada, the Social Sciences and Humanities Research Council (SSHRC) and universities. For more detailed information on RDCs, including locations, see www.statcan.ca/english/rdc/index.htm.

Resting Metabolic Rate

Resting Metabolic Rate (RMR) is a measure of the minimum number of Calories required by a person at rest, in a comfortable setting, to support his or her basic physiological functions. RMR is expressed as kcal/unit of time or kcal/kg/unit of time.

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), defined as the standard deviation of the observations divided by the square root of the sample size, gives an estimate of how close the mean or other parameter estimates of the sample are to your 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.

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.

List of Web Sites

This list was current at the time this guide was released. If a link is not active, try to search from the root directory. Alternatively, consult the online version of this document at www.hc-sc.gc.ca/fn-an/surveill/nutrition/index_e.html, *which will contain updated links.*

CCHS

www.hc-sc.gc.ca/fn-an/surveill/nutrition/commun/index_e.html

Health Canada Web site on the CCHS

www.statcan.ca/english/concepts/hs/index.htm

Main Statistics Canada CCHS Web site; information about all cycles of the CCHS

www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=5049&lang=en&db=IMDB&dbg=f&adm=8&dis=2

Detailed information from Statistics Canada about the CCHS 2.2; includes the questionnaires, a description of the survey, data sources and accuracy, and survey documentation

www.statcan.ca/english/sdds/document/5049_D8_T9_V1_E.pdf

CCHS 2.2 Technical User Guide for the Public Use Microdata File

www.statcan.ca/english/sdds/document/5049_D5_T9_V1_B.pdf

Documentation on the CCHS 2.2 response rate

www.statcan.ca/english/sdds/instrument/5049_Q1_V1_E.pdf

CCHS 2.2 English questionnaire

Canadian Health Measures Survey

www.statcan.ca/english/concepts/hs/measures.htm

Main page for this survey, which will collect physical and biochemical measures in 2007-2009

Dietary Reference Intakes

www.nap.edu

Web site of the National Academy Press; the DRI publications can be located by entering "Dietary Reference Intakes" in the find *box*

www.hc-sc.gc.ca/fn-an/nutrition/reference/index_e.html

Health Canada's DRI Web site; includes DRI tables and related links

Provincial Nutrition Surveys

www.hc-sc.gc.ca/fn-an/surveill/nutrition/prov/index_e.html

Automated Multiple-Pass Method

www.ars.usda.gov/Services/docs.htm?docid=7710

Description and validation of the method used for the 24-hr recall in the CCHS 2.2

Physical Activity Surveys

www.cflri.ca/cflri/pa/index.html

Surveys that used similar methodology to estimate physical activity as the CCHS 2.2

Behavioral Risk Factor Surveillance System

www.cdc.gov/brfss/index.htm

US survey that includes the Fruit and Vegetable module used in the CCHS 2.2

Health Behaviour in School-Aged Children Study

www.phac-aspc.gc.ca/dca-dea/7-18yrs-ans/hbschealth_e.html

A World Health Organization cross-national study; used as the source of physical activity questions for children in the CCHS 2.2

Food Security Survey Module

www.ers.usda.gov/briefing/foodsecurity/measurement.htm

www.fns.usda.gov/fsec/FILES/FSGuide.pdf

Guide to Measuring Household Food Security

Canadian Guidelines for Healthy Body Weights

www.hc-sc.gc.ca/fn-an/nutrition/weights-poids/cg_bwc_int-ld_cpa_int_e.html

Software for Intake Distribution Estimation

www.cssm.iastate.edu/software/side.html

Canadian Nutrient File

www.healthcanada.ca/cnf

Home page

www.hc-sc.gc.ca/fn-an/nutrition/fiche-nutri-data/user_guide_d_utilisation01_e.html

Users' Guide for the Canadian Nutrient File

USDA Food Composition Database

www.ars.usda.gov/ba/bhnrc/ndl

USDA National Nutrient Database for Standard Reference

Statistics Canada

www.statcan.ca

Home page

www.statcan.ca/cgi-bin/downpub/freepub.cgi

Free publications

www.statcan.ca/english/Dli/dli.htm

Data Liberation Initiative

www.statcan.ca/english/rdc/index.htm

Research Data Centres Program

cansim2.statcan.ca/cgi-win/cnsmcgi.exe?CANSIMFile=CII/CII_1_E.htm&RootDir=CII/

CANSIM home page

NHANES

www.cdc.gov/nchs/about/major/nhanes/datalink.htm

Access to data files

www.cdc.gov/nchs/data/nhanes/comp3.pdf

Survey content for 1999-2004

www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/usualintaketables2001-02.pdf

Report comparing 2001-02 survey data to DRIs

CSFII

www.ars.usda.gov/Services/docs.htm?docid=7716

Data tables from the 1994-96, 1998 survey

Food Statistics

www.statcan.ca:8096/bsolc/english/bsolc?catno=21-020-X&CHROPG=1

Online access to Food Statistics

www.statcan.ca/english/ads/23F0001XCB/

Information about Canada Food Stats (compendium on CD-ROM)

Notes

Notes

1. Introduction to this Guide and to the Canadian Community Health Survey (CCHS)

This document is intended to provide background information on Cycle 2.2 of the Canadian Community Health Survey (CCHS 2.2), the first national nutrition survey conducted by the Canadian government in over 30 years. Development and implementation of the CCHS 2.2 has been a joint initiative between Health Canada and Statistics Canada. Survey data were collected between January 2004 and January 2005. CCHS 2.2 is a rich source of detailed information on the following: food consumption using a 24-hour (hr) dietary recall for the total group and a repeat sub-sample; nutrient supplement intake; physical measurements; household food security; and other topics that support the interpretation of the 24-hr recall.

The purpose of this document is to ensure that the data from the CCHS 2.2 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, and limitations of the data. The guide is directed to anyone wanting to use the CCHS 2.2 data, including those interested in conducting analyses using the data, as well as those who want to use the data summaries (e.g. tables) released by organizations such as Statistics Canada and/or Health Canada. 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, this guide includes background information that may be familiar to some readers.

Although individuals planning to analyze the CCHS 2.2 data are one of the audiences for this guide, it is not intended to provide guidance on how analyses should be conducted. Statistics Canada provides supportive documentation for these users, including a data dictionary, specifications of derived variables, and a technical users guide. These documents can be accessed through the Statistics Canada Web site on the CCHS (www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=5049&lang=en&db=IMDB&dbg=f&adm=8&dis=2). At the time this guide was released, documentation was available for the first wave of data release, which includes physical measurements and household

food security. Documentation for the second wave of data release, which includes the 24-hr recall and nutrient supplement use, will be posted when available.

The remainder of this chapter provides an overview of the CCHS, and, in particular, of Cycle 2.2. **Chapter 2** introduces the Dietary Reference Intakes (DRIs), which were used as reference standards for CCHS 2.2, and describes how they can be used in interpreting data from 24-hr recalls. It also discusses critical issues related to the accuracy of 24-hr recall data to be aware of when interpreting survey results, and provides a brief discussion on comparing 24-hr recall data to food guides. **Chapter 3** presents several types of data tables that will be available from the CCHS 2.2. These include data tables that can be accessed online through Statistics Canada's CANSIM (Canadian Socio-economic Information Management) Web site, as well as those that will be released by Health Canada. **Chapter 4** describes other surveys or data sources that might be compared to the CCHS 2.2 results, and outlines issues that should be considered in making these comparisons. Finally, **Chapter 5** presents brief conclusions and describes future initiatives related to the survey.

1.1 Overview of the CCHS

1.1.1 What is the CCHS?

The CCHS consists of a series of cross-sectional surveys that was initiated in the year 2000, with a main objective of providing timely information on 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. To date, the CCHS has had a 2-year data collection cycle that consists of two distinct surveys; the first year (cycle X.1) is a general health survey that includes a sample of approximately 130,000 Canadians, large enough to allow data to be presented at the level of *health regions* within each province, whereas the second year (cycle X.2) focuses on a specific content area, has a total sample of approximately 35,000 and allows *provincial-level* estimates. Additional information about the CCHS is located at www.statcan.ca/english/concepts/hs/index.htm.

The general health questionnaire for the first year of each cycle (e.g. CCHS 1.1 in 2000/01, CCHS 2.1 in 2003) is designed to take about 45 minutes to complete, and includes 30 minutes of common content modules (which

are included in all surveys), 10 minutes of optional content modules (health regions can select a number of modules from those provided to include in surveys conducted in their region), and 5 minutes of socioeconomic and demographic content. Nutrition-related modules included in the common content to date have addressed food security, frequency of fruit and vegetable consumption, and self-reported height and weight. Beginning with cycle 4.1, which goes into the field in 2007, the CCHS general health survey (cycles X.1) will move to a rolling survey with approximately 65,000 individuals each year, rather than approximately 130,000 individuals every second year.

Questionnaires for the second year of each cycle (e.g. CCHS 1.2 in 2002, CCHS 2.2 in 2004) are designed to take about 60 minutes to complete, and include some common content as well as a specific focus that changes from one cycle to the next. The focus for the CCHS 1.2 was mental health and well-being, and nutrition was the focus of the CCHS 2.2. More information on the CCHS 2.2 is available on Health Canada's Web site at www.hc-sc.gc.ca/fn-an/surveill/nutrition/commun/index_e.html as well as from Statistics Canada (www.statcan.ca/english/concepts/hs/index.htm).

The CCHS 2.2 collected data on dietary intake, measured height and weight, and a number of other variables. It provides important information on food habits, nutrient intakes, and relative weights of Canadians. However, because it 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 will collect physical and biochemical measures from approximately 5,000 randomly selected Canadians in 2007–2009, will provide information on nutritional status for selected nutrients. More information on the CHMS is available from Statistics Canada's Web site (www.statcan.ca/english/concepts/hs/measures.htm).

1.1.2 Why Did the CCHS 2.2 Focus on Nutrition?

When consultations to elicit topics for the CCHS were conducted in 1999, nutrition was very high on the list of priorities. Before the CCHS 2.2 was conducted, the Nutrition Canada Survey (completed between 1970 and 1972 with participants of all ages) was the only other national level nutrition survey conducted by the Canadian government (Nutrition Canada, 1973). More recently, a series of provincial surveys was conducted collaboratively by Health Canada, provincial governments, and universities (www.hc-sc.gc.ca/fn-an/surveill/nutrition/prov/index_e.html). However, these

surveys were conducted over a 10-year period, beginning in 1990 with Nova Scotia and Quebec and finishing in 1999 with British Columbia (B.C.). Furthermore, provincial survey data on children's intakes were available only for the province of Quebec, which surveyed children aged 6 to 16 years in 1999. No intake data were available from children under 6 years of age, or from adults over 84 years of age. Because the food supply and food habits can change over time, data from the provincial surveys cannot be used to obtain a clear understanding of the nutrient intakes of Canadians as a whole, or to make meaningful comparisons among provinces. Data from the United States (US) are sometimes used as a surrogate for Canada, but this may not be appropriate. There are differences in the food supply, ethnocultural characteristics, food habits, and fortification practices between the two countries. Thus, availability of current Canadian data was a priority.

1.1.3 What Were the Objectives of the CCHS 2.2?

The main objective of the CCHS 2.2 was to provide reliable, timely information about dietary intake, nutritional well-being, and their key determinants to inform and guide programs, policies and activities of federal and provincial governments. The specific objectives of the CCHS 2.2 were to:

- Estimate the distribution of usual dietary intake in terms of foods, food groups, dietary supplements, nutrients and eating patterns among a representative sample of Canadians at national and provincial levels.
- Obtain measured data on height and weight, so as to be able to calculate Body Mass Index (BMI).
- Measure the prevalence of household food insecurity among various population groups in Canada.
- Collect data on selected health conditions and socioeconomic and demographic characteristics of respondents.

1.1.4 Who Was Included in the CCHS 2.2?

The target population includes all individuals aged 0 or above living in private dwellings in the 10 Canadian provinces. The survey also included strategies to ensure that a minimum number of individuals was sampled in each of 15 age–sex groups: <1 year (sexes combined), 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 30 years, 31 to 50 years, 51 to 70 years, and 71 years or above. These age groups correspond to the age ranges for which 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 First Nation Reserves or Crown Lands, in prisons or care facilities, or in some remote areas. Overall, the target population represents about 98% of the population of the 10 provinces.

A minimum of 80 respondents in each DRI age–sex group was allocated to each province and the remainder were assigned using a power allocation technique. Further information on sample size and allocation is available at www.statcan.ca/english/sdds/document/5049_D8_T9_V1_E.pdf. In addition, the provincial governments of Ontario, Manitoba, and Prince Edward Island (P.E.I.) paid for larger samples for their provinces. Within provinces, the sample was proportionally allocated to rural and urban strata based on the number of dwellings in each stratum.

The total sample of Aboriginal Canadians consisted of 1528 individuals; 657 males and 871 females. This sample was 3.1% Inuit, 37% Metis, and 59.1% North American Indian, all living off reserve. The sampling strategy included an oversampling of those aged 19 to 50 to allow for national level intake data. Additionally, the sample may be acceptable for other age groups of Aboriginal people depending on the characteristics to be studied.

Table 1.1 shows the actual sample size and the response rate by province. Detailed information about response rates is available at www.statcan.ca/english/sdds/document/5049_D5_T9_V1_B.pdf. In total, more than 35,000 individuals took part in the survey.

Table 1.1 Sample size and response rate for the CCHS 2.2 by province and for Canada

Province	Actual sample	Response rate (%)
Newfoundland and Labrador	1,734	83.3
Prince Edward Island*	1,430	79.2
Nova Scotia	1,705	78.6
New Brunswick	1,633	75.7
Quebec	4,780	75.8
Ontario*	10,921	72.7
Manitoba*	4,194	82.7
Saskatchewan	2,041	77.1
Alberta	3,021	77.4
British Columbia	3,648	77.1
CANADA	35,107	76.5

* *Provinces that paid for a larger sample size than would be obtained based on allocation in proportion to the square root of the provincial population.*

The overall response rate for Canada as a whole was 76.5%. The non-response adjustment applied to the survey weights was done by considering the effect of many socioeconomic variables. The high response rate, coupled with the statistical adjustment for non-response, suggest that the results of the survey can be considered representative of the population. This is an important consideration in assessing the results of any population survey: if response rates are 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 15%, whereas data from another survey (perhaps on another topic) with a high response rate might reveal a smoking prevalence of 25%.

However, the high response rate in the CCHS 2.2 and the steps taken to adjust the data for non-response suggest that the impact of non-response bias is likely minimal.

1.1.5 How Was the Survey Carried Out?

1.1.5.1 Sampling Frame. A complete description of the sampling frame used for the CCHS 2.2 is provided in the survey documentation prepared by Statistics Canada (www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=5049&lang=en&db=IMDB&dbg=f&adm=8&dis=2#b3). The sampling plan was a multistage stratified cluster design in which the dwelling was the sampling unit. The sampling strategy was designed to provide a sample that represents the population in terms of age, sex, geography, and socioeconomic status.

The process used to select the sample differed slightly among major urban centres, other cities, and rural areas, but the general process was similar. In a multistage process that considered geographical and socioeconomic characteristics, dwellings were selected from a variety of sampling frames (including the Labour Force Survey area frame, a frame based on the CCHS 2.1, the P.E.I. health care registry, and the Manitoba health care registry). The final sample was obtained by randomly selecting one individual from each selected dwelling.

1.1.5.2 Contacting Participants. Once dwellings had been identified to take part in the CCHS 2.2, an introductory letter and a brochure describing the study were sent to dwellings with a valid mailing address. A trained Statistics Canada interviewer made an initial personal contact with the dwelling and obtained basic demographic information on all residents. One person aged 0 or above was then randomly selected to participate in the complete survey, using selection probabilities that varied by age and sampling frame. For example, since the Canadian population has fewer infants aged less than 1 year than adult women aged 31 to 50 years, the probability of selecting infants under 1 year to fulfill the sampling quota was higher than for women aged 31 to 50 years.

1.1.5.3 Ensuring a High Response Rate. Several procedures were used to ensure a high response rate. Interviewers were asked to make a minimum of six personal visits or phone calls to a dwelling. If no one was at home during the initial visit, subsequent visits were made at different times of the day and on different days of the week. Those who initially declined participation were sent a follow-up letter from a senior interviewer, 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.

1.1.5.4 Conducting the Interview. All interviews were computer-assisted, and were conducted between January 14, 2004 and January 21, 2005 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 under the age of 6 years, the interview was conducted with a parent or guardian only, 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, and respondents aged 12 years or above answered on their own. Respondents were not informed ahead of time that a 24-hr recall would be a component of the interview.

A random subset of individuals 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. Those who asked what this interview would include were told that a second 24-hr recall would be conducted. The data from this 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). Most second interviews were conducted by telephone, although some were done in person. Previous research has shown that 24-hr recalls using similar methodology to that in this study 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), and this issue will be further examined using data from the CCHS 2.2.

1.2 Survey Components

The modules included in the CCHS 2.2 questionnaire are shown in Table 1.2. The entire questionnaire used in the CCHS 2.2 is available at www.statcan.ca/english/sdds/instrument/5049_Q1_V1_E.pdf. To provide readers with a general understanding of the types of information available from the CCHS 2.2, these modules are briefly described in the order in which they were included in the questionnaire. Users should note that in many cases the CCHS 2.2 modules were modified or abbreviated from the full modules used in Cycles 1.1 and 2.1 of the CCHS.

Table 1.2 CCHS 2.2 survey components

- Household and education (all ages)
- 24-hr recall (all ages)
- General health (age ≥ 12 years)
- Physical activities (age ≥ 12 years)
- Sedentary activities (age 12 to 17 years)
- Children's physical activity (age 6 to 11 years)
- Self-reported height and weight (subset age ≥ 18 years)
- Vitamin and mineral supplements (all ages)
- Vitamin and mineral supplement details (all ages)
- Measured height and weight (age ≥ 2 years)
- Women's health (age ≥ 9 years)
- Fruit and vegetable consumption (age ≥ 6 months)
- Chronic conditions (all ages)
- Smoking (age ≥ 12 years)
- Alcohol (age ≥ 12 years)
- Food security (all households)
- Sociodemographic characteristics (all ages)
- Labour force participation (age 15 to 75 years)
- Income (all ages)
- Administration (data sharing) (all ages)

1.2.1 Household and Education

At the initial contact, 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 and whether it was owned by a household member. One household member was randomly selected to be the survey respondent.

1.2.2 24-hr Recall

The 24-hr dietary recall was the first component of the CCHS 2.2. 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. Additional information is available at www.ars.usda.gov/Services/docs.htm?docid=7710.

The five steps in the AMPM, as they occurred in the CCHS 2.2, are:

1. ***Quick List.*** Respondents are asked to list all foods and beverages consumed on the day before the survey (midnight to midnight). Foods and beverages can be listed in any order respondents choose; there is no requirement to present food items in time sequence.
2. ***Forgotten Foods.*** A series of questions is asked to prompt the recall of foods that are commonly forgotten (e.g. snack foods, alcoholic and non-alcoholic beverages).
3. ***Time and Occasion.*** The time the respondent began eating or drinking each item is recorded, as well as what the respondent would call the eating occasion (e.g. snack, brunch, dinner).
4. ***Detail Cycle.*** At this point, a specific description of each food and beverage reported is obtained. Details include descriptions of the food, preparation methods, food additions, amounts consumed, and where the meal or snack was prepared. A Food Model Booklet that contained pictures of glasses, mugs, bowls, and so on was used to help respondents describe the size or amount of food consumed. Also, each occasion as well as the period between two eating occasions were reviewed to ensure that foods and beverages consumed had not been forgotten.
5. ***Final Review.*** The final step is a probe for any missed foods or details about foods.

Modifications of the USDA AMPM for the CCHS 2.2 included reviewing the food categories to reflect the Canadian food supply, incorporating metric measures, and translating the tool into French. Step 4 of the AMPM was also modified: the USDA method asks where each food item or beverage in the meal or snack was obtained and whether it was eaten at home or not. In preliminary testing, respondents found these questions to be too repetitive, so they were not included in the final interview. However, the question on where the meal or snack was prepared was retained.

It should be noted that the volume of breastmilk consumed by breast-fed infants cannot be estimated in the 24-hr recall conducted for the CCHS 2.2. 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 General Health

Five questions were included to assess respondents' perceptions of their general health, satisfaction with life in general, mental health, amount of stress, and sense of belonging to their local community. In each case, respondents selected from among four or five response options (e.g. *excellent, very good, good, fair, poor*).

1.2.4 Physical Activities

Respondents aged 12 or above were asked about leisure time physical activity during the past 3 months. Interviewers read a list of 22 activities (including an *other* category), and respondents selected all that applied. Responses of *other* were clarified. For each activity selected, respondents indicated how many times they did the activity during the past 3 months, and the average duration of each activity session. For the latter question, choices were 1 to 15 minutes, 16 to 30 minutes, 31 to 60 minutes, and more than 1 hour. This approach to estimate physical activity has been used previously in many Canadian surveys (www.cflri.ca/cflri/pa/index.html), including the CCHS 1.1 and 2.1.

The data on physical activity were combined to obtain a variable called the *physical activity index*, which represents the average daily energy expended on leisure time physical activity, expressed in kilocalories (kcal) per kilogram (kg) body weight per day (d). To calculate this index, the energy expenditure (EE) for each activity was first calculated as follows:

EE = (N x D x MET value)/91, where

N = the number of times the individual participated in the activity in the past 3 months

D = the average duration of each activity session in hours

MET (Metabolic Equivalent) value = the energy cost of the activity expressed in kcal/kg/hr

The MET reflects intensity of an activity, and is expressed as multiples of the resting metabolic rate (RMR), which is approximated

as 1 kcal/kg/hr. Thus, 1 MET = RMR, while an activity of 7 METS—as might occur while jogging—would require approximately 7 kcal/kg/hr, or seven times the energy expended while resting.

91 = the number of days in 3 months, thus converting activity in the past 3 months to an average daily value in kcal/kg/d

For example, consider someone whose leisure time physical activity includes jogging (MET value = 7) for 1 hour twice a week (26 times in 3 months) and doing yoga (MET value = 2.5) for 30 minutes once a week (13 times in 3 months):

- The EE for jogging would be (26 x 1 hr x 7 kcal/kg/hr)/91 d = 2.0 kcal/kg/d.
- The EE for yoga would be (13 x 0.5 hr x 2.5 kcal/kg/hr)/91 d = 0.18 kcal/kg/d.

The physical activity index was then calculated by summing the energy expended for each type of activity. For the example given above, the physical activity index would equal 2.0 + 0.18, or 2.18 kcal/kg/d. These totals were used to categorize individuals as *inactive* (physical activity index of <1.5 kcal/kg/d), *moderately active* (physical activity index of 1.5 to <3 kcal/kg/d), and *active* (physical activity index ≥3 kcal/kg/d). Thus, the individual in the example above would be classified as moderately active.

1.2.5 Sedentary Activities

In addition to the above questions on physical activity, respondents between 12 and 17 years of age were asked about the amount of leisure time they spent on a computer, playing video games, watching TV or videos, and reading.

1.2.6 Children's Physical Activity

For children aged 6 to 11 years, physical activity was defined as activity that increases their heart rate and makes them feel out of breath some of the time or warmer than usual. It could include, for example, sports, school activities, and playing with friends. Children (and/or their parent or guardian) were asked about the number of days in the past week and in a typical week that they were physically active for at least 60 minutes each day. They were also asked about the number of hours a week that they were physically active during free time at school, during class time

at school, outside of school in organized activity, and outside of school in unorganized activity. Finally, they were asked about the number of hours a day that they watched television or videos or played video games, or spent on a computer. The questions in this module were taken from the 2001/02 Health Behaviour in School-Aged Children (HBSC) study. This study, sponsored by the World Health Organization, is a cross-national survey conducted in over 20 countries every four years. More information is available at www.phac-aspc.gc.ca/dca-dea/7-18yrs-ans/hbschealth_e.html.

1.2.7 Self-Reported Height and Weight

A subset of 10% of participants aged 18 years or above was asked to self-report their height and weight at this point in the interview. These respondents would later have their height and weight measured (see Section 1.2.10), allowing for the comparison of self-reported and measured values. It should be noted, however, that individuals providing these self-reported data were likely aware that measured values would be obtained during the survey, as interviewers brought measuring equipment (e.g. scales) with them to the interview.

1.2.8 Vitamin and Mineral Supplements

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. In this module, participants were asked if they had taken any supplements during the past month, and if so, how many different supplements were taken. Note that although the title of this module was *Vitamin and Mineral Supplements*, information was also collected on other nutritional supplements, such as fish oils. However, use of herbal and/or homeopathic supplements was not determined.

At the time of release of this guide, the information collected in the module on Vitamin and Mineral Supplement Details was still being validated. The wave 2 release of data only contains information on whether vitamin and mineral supplements were consumed.

1.2.9 Vitamin and Mineral Supplement Details

Individuals who had used one or more nutritional supplements during the past month were asked to locate the supplement container(s), from which the Drug Identification Number (DIN) was recorded if available. If the DIN was not available, the brand name, product description, and dosage of the supplement were recorded. For each supplement, respondents stated how often they took the supplement during the past month, as well as the amount usually taken each time.

It should be noted that the reference period(s) of the 24-hour recall data differs from that of the vitamin and mineral supplements data. Because of this, assumptions would need to be made in order to determine total nutrient intake from both food and supplements combined.

1.2.10 Measured Height and Weight

Height (in centimetres) and weight (in 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). Self-reported height and weight were obtained for the 10% subsample described earlier (Section 1.2.7) and also from those who declined to be measured but agreed to report their values instead. Among respondents aged 2 or over, 63% 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), and the individual was not physically able to be measured.

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]), and BMI was subsequently classified as *underweight*, *normal weight*, *overweight*, or *obese*. For non-pregnant adults aged 18 or above, the BMI (kg/m^2) ranges were: <18.5 = underweight; 18.5 to 24.9 = normal weight; 25 to 29.9 = overweight; and ≥ 30 = obese (Health Canada, 2003). This classification system is in accord with the weight classification system released by the World Health Organization in 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 CCHS 2.2, it is the most useful indicator, to date, of weight-related health risk.

Children's BMI was classified using age- and sex-specific international cut-off points for overweight and obesity, defined based on centile curves for BMI drawn to pass through BMI of 25 and 30 respectively, at age 18 years (Cole, Bellizi, Flegal, & Dietz, 2000). These centile curves for BMI were derived by averaging data from nationally representative cross-sectional studies in Brazil, Great Britain, Hong Kong, the Netherlands, Singapore, and the United States. For example, the overweight cut-off (corresponding to an adult BMI of 25) for 7-year-old girls is 18.03, while the cut-off for obesity (corresponding to adult BMI of 30) is 21.01 (Cole et al., 2000). It should be noted that these values differ from those used by the United States Centers for Disease Control and Prevention (CDC), which define *at risk of overweight* as a BMI-for-age-and-sex between the 85th and 95th percentiles of the CDC growth charts, and *overweight* as above the 95th percentile (Kuczmarski et al., 2000). The CDC growth charts were derived from measured heights and weights of US children. Canada chose to use the international standards because they were constructed using data from a number of countries, rather than just the US, and might therefore be more appropriate for a greater variety of ethnicities found in Canada's multicultural population.

1.2.11 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, and all females 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.

1.2.12 Fruit and Vegetable Consumption

Participants were asked to state how often (per day, week, month, or year) they consumed each of the following: fruit juices; fruit (not counting juice); green salad; potatoes (not including french fries, fried potatoes or potato chips); carrots; and vegetables other than carrots, potatoes or salad. The questions are based on those asked in the fruit and vegetable module of the Behavioral Risk Factor Surveillance System (BRFSS) of the CDC in the

US (www.cdc.gov/brfss/index.htm) and were also included in the CCHS 1.1 and 2.1. Note that the data from this module provide information on *frequency of consumption*, rather than on the amount consumed on each occasion, and do not include consumption of vegetables in mixed dishes. The module thus tends to underestimate consumption (Field et al., 1998). Data from this module are not comparable to the 24-hr recall data, which included detailed information on the types and amounts of fruits and vegetables consumed. For example, if someone consumed a 500-millilitre (ml) portion of juice once a day, this would contribute *one* to the daily frequency of intake in the fruit and vegetable module. However, the same 500-ml portion of juice, when analyzed from 24-hr recall data, would correspond to *four* servings from the Vegetable and Fruit group of the 1992 *Canada's Food Guide to Healthy Eating* (CFGHE)(Health Canada, 1997), as the standard serving size for juice is 125 ml.

1.2.13 Chronic Conditions

Chronic health conditions can influence the food choices of an individual. In this section, participants were asked if they had been diagnosed with any of the following chronic health conditions by a health professional: high blood pressure, diabetes, heart disease, cancer, a bowel disorder such as Crohn's Disease or colitis, osteoporosis (respondents aged 50 years or above), or any other long-term physical or mental health condition.

1.2.14 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. Those who had were asked whether they currently smoked cigarettes daily, occasionally, or not at all. Current daily or occasional smokers were asked the number of cigarettes they smoked. Those who had stopped smoking were asked when they had stopped.

1.2.15 Alcohol

Alcohol consumption can play a major role in a person's overall diet and the amount of energy (Calories) they consume. For this series of questions, a "drink" was defined as one bottle or can of beer or a glass of draft, one glass of wine or a wine cooler, or one mixed drink or cocktail with 1.5 ounces of liquor, such as vodka, rum, or gin. Participants aged

12 years or above were asked if they had consumed a drink during the past year. Those who reported one or more drinks in the past year were asked how often they drank alcoholic beverages, and how many times they had five or more drinks on one occasion. This module thus provides information on the *frequencies* of alcohol consumption and of heavy drinking rather than on the amounts consumed.

1.2.16 Food Security

Food security[1] is an important determinant of nutritional health. Accordingly, questions were included that addressed an important element of "food security", that is, household food access issues in the context of financial resource constraint. The 18-item US Food Security Survey Module developed by the USDA Food and Nutrition Service and Economic Research Service was used (www.ers.usda.gov/briefing/foodsecurity/).

Through multiple indicator questions, the food security module captures and distinguishes the various levels of severity with which household food insecurity is experienced. All questions in the module address the food situation in the household during the past 12 months.

A scale score for the household is determined by its overall pattern of response to the set of indicator questions. Traditionally, the following categories of food security/insecurity have been derived from the responses: *food secure*; *food insecure without hunger*; and *food insecure with hunger*.

A proposal to modify the derived category labels described above is being considered for reporting findings from the CCHS 2.2. The proposed changes to category labels better reflect the particular characteristics of food security described by the US Food Security Survey Module: household food *access* in the context of financial resource constraint. A full description of these and other considerations in interpreting the data from the food security module will be presented in a report on food security, to be released by Health Canada in 2006.

[1] 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 (Agriculture and Agri-Food Canada. *Canada's Action Plan for Food Security: A Response to the World Food Summit*. 1998).

1.2.17 Sociodemographic Characteristics

Demographic questions included the respondents' country of birth, ancestral ethnic or cultural group, languages spoken, language spoken most often at home, language first learned at home that could still be understood, and self-identified ethnic/cultural/racial background. For the first time in the CCHS, Aboriginal ethnicity was expanded to include North American Indian, Metis, and Inuit. Questions were also asked about student status.

1.2.18 Labour Force Participation

For those between the ages of 15 and 75 years, current employment status and employment status over the past 12 months were ascertained.

1.2.19 Income

Total household income before taxes and the respondent's personal income (for those aged 15 years or above) were queried.

1.2.20 Administration (data sharing)

Participants were asked whether they would provide their permission to link information collected during the interview to past and continuing use of health services. Those who agreed were asked to provide their provincial health care number. Permission was also asked to share the respondent's interview information with provincial Ministries of Health, l'Institut de la statistique du Québec (Quebec respondents only) and Health Canada.

Notes

Notes

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 compared to the Dietary Reference Intakes (DRIs) to estimate the prevalence of inadequate and excessive *nutrient* intakes in the population. However, 24-hr dietary intake data can also be compared to recommendations for *food* intake provided by food guides. Accordingly, a brief description of comparing intakes to the food guide is 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 CCHS 2.2. Understanding the definitions of each of the DRIs and how they were derived is important in understanding the meaning of nutrient intake data from the CCHS 2.2. For additional information, the DRI reports should be consulted (Institute of Medicine [IOM], 1997, 1998a, 1998b, 2000a, 2000b, 2000c, 2003, 2004, 2005). These reports can be ordered or accessed online through the National Academy Press Web site (www.nap.edu; enter "dietary reference intakes" in the *search titles* box). The Health Canada Web site also provides useful information on DRIs and links to the IOM reports: www.hc-sc.gc.ca/fn-an/nutrition/reference/index_e.html.

DRIs are nutrient reference standards to be used for planning and assessing diets of apparently healthy Canadians and Americans. The DRIs were used as the standards for assessing the nutrient intakes of Canadians in the CCHS 2.2. As summarized in Table 2.1, the DRIs include estimates of

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

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. The process was overseen by the Standing Committee on the Scientific Evaluation of Dietary Reference Intakes of the Food and Nutrition Board, within the Institute of Medicine of The National Academies. Instead of releasing a report that covered all nutrients in a single volume, as was done in the past, a series of reports on groups of related nutrients was released between 1997 and 2004, reflecting the work of nutrient panels composed of Canadian and American scientists (IOM 1997, 1998a, 2000a, 2000b, 2004, 2005). 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, 2000c, 2003).

Table 2.1 **Dietary Reference Intakes: definitions***

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

Recommended Dietary Allowance (RDA): the average daily dietary nutrient intake level 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.

* *Modified from: IOM, 2005.*

Appendix 1 (page 87) shows the DRIs for all nutrients. 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, each DRI has a specific definition, and the terms within the DRIs for a nutrient cannot be used interchangeably.

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, 2005). Several aspects of this definition warrant further elaboration:

- ***Daily intake value.*** Although all DRIs are expressed as amounts per day, they are more appropriately considered as average intakes over a period of time (e.g. weeks or months).
- ***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 2** (page 97) 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.

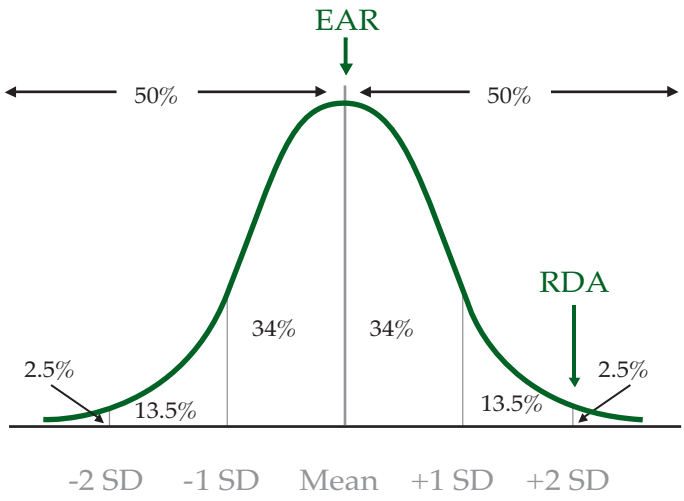
2.1.2 Recommended Dietary Allowance (RDA)

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, 2005). 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 (~2.5%) 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 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 is equal to 1.4 x EAR (IOM, 2000b).

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, 2000b). 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, 2000b).

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, 2005).

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 2** (page 97). 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 an 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, including calcium and vitamin D, 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. Eventually, it is hoped that additional knowledge of nutrient requirements will allow 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, 2005). 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, 2000b), an amount which may be exceeded by individuals while being medically monitored for adverse effects.

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 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 folates (IOM, 1998a).

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: in some cases, adverse effects have not been identified (e.g. vitamin B_{12}); however, in other situations adverse effects are known to occur but data were insufficient to set a UL (e.g. for many nutrients, ULs have not been set for infants). Thus, in the absence of a UL, extra caution may be warranted in consuming intakes above recommended levels.

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, 2005). Individuals who habitually consume intakes above or below this range are 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 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 experimental data reveal such associations. Accordingly, the AMDR provides guidance on how to distribute energy intake in a manner that is 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, 2005). 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. In children and in pregnant or lactating women, the EER also includes energy needs associated with growth or the secretion of milk at rates consistent with good health. Equations were developed for different life-stage and gender groups, and for individuals who are normal weight or overweight (IOM, 2005).

Use of these equations requires knowledge of the individual's exact 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 1** (page 87).

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

EER = 354 - (6.91 x age [years]) + PA x { (9.36 x weight [kg]) + (726 xheight [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, 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, 2005). 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

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 CCHS 2.2; thus, users should be aware that nutrient intake data contained in the CCHS 2.2 do not characterize *individuals*' usual intakes 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 at the individual level.

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 CCHS 2.2, 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; they would not have scurvy (the deficiency disease that occurs with a severe shortage of vitamin C). Dietary intake data is one type of data that can be used to suggest a particular condition; objective measures of nutritional status would be necessary to confirm the condition. In the paragraphs that follow, principles that underlie the methods used to assess nutrient intakes of groups in the CCHS 2.2 are described, and are highlighted in Table 2.2.

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

- When certain assumptions are met, the percent of a group with usual intake below the EAR estimates the prevalence of inadequate intakes
- To estimate nutrient inadequacy, a *usual intake distribution* is needed
- 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
- The percent of a group with intakes above or below the AMDR is at potential risk
- Assessing energy intake adequacy: use Body Mass Index
- Comparing intake to the EER may provide an indication of underreporting

2.2.1 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 indicator of adequacy used to set the EAR) can be estimated as the proportion of the group with *usual intake* below the EAR. (More information on what *usual intake* means is provided in the next section.) For example, if 20% of a group had usual niacin intakes below the EAR (and intakes had been estimated accurately), one would expect about 20% to have urinary excretion of niacin metabolites below the level used to set the EAR for niacin. It does not mean that 20% would have pellagra, the deficiency disease that occurs when niacin intakes are very low over a period of time. It should also be noted that this assessment cannot 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 its requirement.

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 3** (page 101) and IOM, 2000b, 2000c.

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

- ***Intakes and requirements must not be correlated.*** This is thought to be true for most nutrients, but is known *not* to be true for energy, as individuals with higher energy requirements have higher energy intakes.
- ***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 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. This method will be used to estimate the prevalence of inadequate iron intakes in the CCHS 2.2.

- ***The distribution of intakes must be more variable than the distribution of requirements.*** This is thought to be true among groups of free-living individuals, as were studied in the CCHS 2.2. 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.

2.2.2 To Estimate Nutrient Inadequacy, a Usual Intake Distribution is Needed

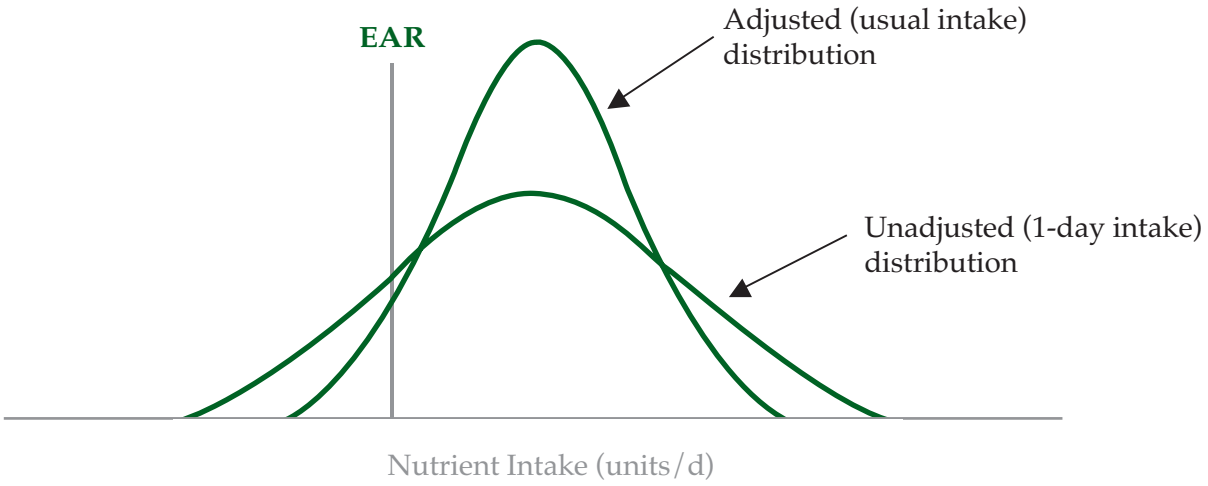
Regardless of whether the EAR cut-point method or the probability method is used to estimate the prevalence of inadequacy in a group, information on the *distribution of usual intakes* within the group is required. When single 24-hr recalls or diet records are obtained from members of a group, the variability of the nutrient intakes will reflect both differences between individuals 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).

To obtain a distribution of usual intakes for a group, the distribution of observed intakes (i.e. that obtained from a single 24-hr recall) must be adjusted to remove the effects of within-person variability, so that the distribution reflects only between-person variability. 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 in Figure 2.2, the adjusted usual intake distribution is less variable than a distribution using only a single 24-hr recall. This is critical when assessing the prevalence of nutrient inadequacy in a group: it can be seen in the figure that the proportion of the group with intakes below the EAR is lower with the

usual (i.e. adjusted) intake distribution, compared to the unadjusted (1-day) distribution. Thus, failure to adjust the intake distribution to obtain the usual intake distribution results in incorrect estimates of the prevalence of inadequate 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.



In the CCHS 2.2, a second 24-hr recall was obtained from 10,786 respondents (i.e. a representative subsample). The number of repeat interviews was determined using an approach that identified the point at which no further benefits in adjusting single-day intakes was provided by conducting additional second interviews. These data were used to obtain usual intake distributions for various age–sex groups. The adjusted (usual intake) distributions will be presented in the tables of data from CCHS that describe usual intakes (versus 1-day intakes), and will also be used to estimate the proportions with inadequate intakes.

Several methods to obtain usual intake distributions are available for those who want to analyze the data themselves. A method was proposed by the National Research Council (1986) and was later adapted for use with standard statistical programming software (Karpinski & Nargundkar, 1992). The method was further developed using a semiparametric approach to attain usual intake distributions (Nusser, Carriquiry, Dodd, and Fuller, 1996). Software programs that use this approach are available for purchase from Iowa State University. Two versions are available: SIDE (Software for Intake Distribution Estimation), written in the SAS/IML© language; and C-SIDE, a more user-friendly C Language/X Windows based version. These programs include a step that adjusts the means of the second (and subsequent) recalls so that they equal the means from the first recall. Further information is available at www.cssm.iastate.edu/software/side.html.

2.2.3 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.

2.2.3.1 If Group Median Intake Meets or Exceeds the AI, Prevalence of Inadequacy 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. 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, 2004). Accordingly, a group of 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 set using other methods, there is less confidence that a median intake at or above the AI is associated with a low prevalence of inadequacy. For example, the AIs for calcium and vitamin D were not set based on population intakes (IOM, 1997). Thus, even if median calcium intake of Canadian teen females exceeded the AI of 1300 mg/d, it is *possible* that some proportion of the group could have inadequate intakes (and would therefore not be retaining calcium at the

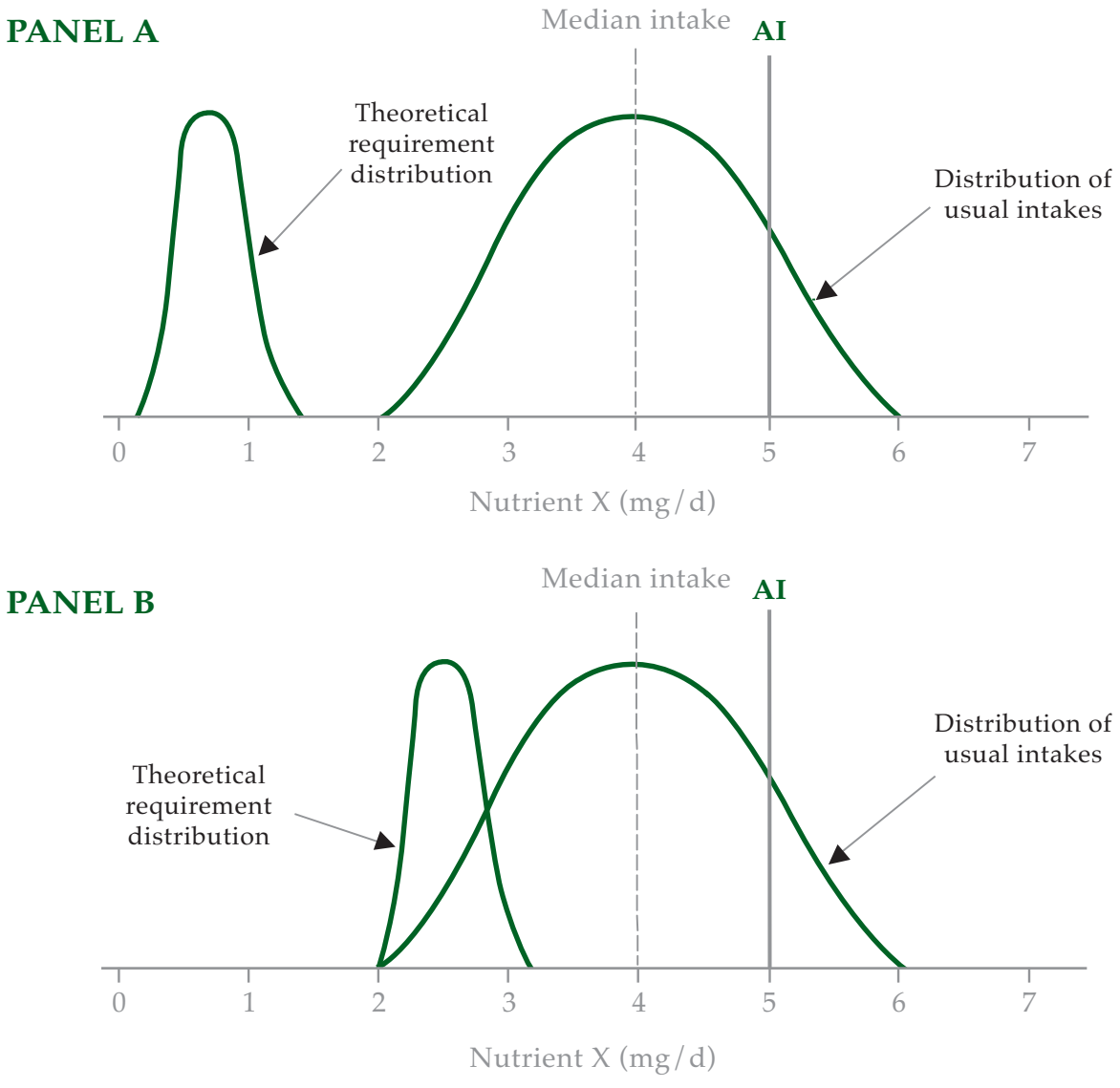
desirable rate). But because requirements are not known, we have no idea what this proportion would be, or whether it would be zero (that is, it is possible everyone in the group could be meeting their needs).

2.2.3.2 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 be meeting their needs. This would occur if the average requirement for Nutrient X (if it could be determined) was far 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)**

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 the intake of no one in the group would be inadequate (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.



2.2.4 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, the proportion of the group that actually experienced diarrhea as a result of excess 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 or an overlap between the adult RDA and the UL for young children. Surveys in the US have revealed that young children have a high prevalence of intakes above the UL for nutrients such as vitamin A and zinc; however, few studies have been conducted in children to assess the effects of such intakes. This suggests that there may be a need for additional research to refine the ULs for young children, based on studies conducted in children.

2.2.5 It is Not Appropriate to Use the RDA 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, has been used incorrectly to make inferences about nutrient inadequacy in groups. It had been assumed incorrectly that: 1) groups with mean intake at or above the RDA had adequate intakes; or 2) the proportion of a group with intakes below the RDA was inadequate. The reasons these inferences are incorrect are described briefly below.

1. ***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. For example, men aged 51 to 70 years in the British Columbia Nutrition Survey had a mean (± standard error of the mean [SEM]) vitamin C intake from food plus supplements of 255 ± 26 mg/d, much higher than the RDA of 90 mg/d. This comparison might lead one to believe that inadequate vitamin C intake was not a problem in this group. However, appropriate analysis of the data revealed that 26% of the group had usual intakes below the EAR of 75 mg/d.

2. ***Using the proportion of the group with intakes below the RDA to indicate the proportion with inadequate intakes.*** The prevalence of inadequate intakes (percent below the EAR) could be near zero in a group in which a measurable proportion (e.g. 10% to 15%) of individuals had intakes below the RDA.

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

2.2.6 The Percent of a Group with Intakes Above or Below the AMDR is at Potential Risk

The proportion of a group with usual intake above or below the AMDR is at potential risk of affecting intakes of essential nutrients and the development of chronic diseases that affect long-term health. For example, diets below the AMDR for carbohydrate (or above the AMDR for fat) could adversely affect intakes of folate and fibre.

2.2.7 Assessing Energy Intake Adequacy: Use Body Mass Index

Theoretically, 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 be possible to assess the adequacy of a group's energy intake by comparing it to the mean predicted EER for the group, provided one could estimate activity levels accurately. If mean intake was equal to EER, energy intake could be assumed adequate, while mean intakes below or above mean EER would be assessed as inadequate or excessive, respectively.

However, because underreporting of food intake is ubiquitous, and because body weight is a valid, reliable measure, it is more appropriate to assess the adequacy of a group's energy intake by assessing their relative weight, most commonly using BMI. The proportion of a group of adults

with BMI below the normal range of 18.5 to 24.9 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-based BMI standards for underweight and overweight exist and should be used (Cole et al., 2000). The limitations of BMI noted in Section 1.2.10 should be kept in mind. However, at a population level, as in the CCHS 2.2, 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) to 24-hr recall data on energy intake. There are several reasons why this may not be useful:

- As has already been mentioned, data from single 24-hr recalls do not characterize usual intakes of individuals accurately.
- As will be described in Section 2.3.1.4, data suggest that overweight or obese individuals are more likely to underreport food intake than normal weight individuals.
- Comparing energy intake to relative weight status reflects only one side of the energy balance equation as it does not consider energy expenditure.
- Relative weight at any point in time also reflects previous energy intake and expenditure.

2.2.8 Comparing Intake to the EER May Provide an Indication of Underreporting

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 underreporting may have occurred in a group. (For more information on underreporting, see Section 2.3.1.) One could compare the mean intake of a group (estimated from 24-hr recalls) with their mean EER based on their estimated physical activity level. If mean intake was considerably below mean EER for the estimated physical activity level, it is likely that underreporting occurred for the group. Conversely, if mean intake approximated the mean EER, substantial underreporting 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, underreporting would almost certainly have occurred.

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.

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.
- Food intake is systematically underreported by adults—this may lead to underreporting of nutrient intake.
- Underreporting is not consistent among individuals or across foods—this has implications for interpreting nutrient intake data.
- Several methods exist to explore possible implications of underreporting.

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 1.2.1) 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 underreporting; see Section 2.3.1.4), and including tools to assist with portion size estimation.

Recent 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. Obese individuals were at least as accurate as normal-weight individuals: normal-weight women actually tended to overreport food intake. 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.

AMPM is also being validated against the doubly-labelled water method of assessing energy expenditure (if body weight is stable over time, by definition energy intake from food and beverages must equal energy expenditure). In this comprehensive study (Rhodes et al., 2004), 524 weight-stable adults aged 30 to 69 years and with BMI 18 to 44 kg/m^2 completed three multiple-pass method 24-hr recalls to estimate energy intake, had total energy expenditure (TEE) measured over 14 days using doubly-labelled water, wore physical activity monitors, and had physical fitness and body composition measured. *Acceptable reporters* were those who were within the 95% confidence limits for the ratio of energy intake to TEE. Preliminary results (reported in abstract form) indicate that >80% of participants were classified as acceptable reporters, with women more likely than men to be energy underreporters (Rhodes et al., 2004).

2.3.1.2 Proxy Reporting for Infants and Young Children May Affect Accuracy. When interpreting 24-hr recall data it is also important to consider who provided the recall data. Infants and 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 CCHS 2.2, the interview for children under the age of 6 years was conducted with a parent or guardian alone, 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 that indicate 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 CCHS 2.2, 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 provide 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 Food Intake is Systematically Underreported by Adults—This may Lead to Underreporting of Nutrient Intake.

The introduction of the doubly-labelled water method to determine energy expenditure has allowed an assessment of the accuracy of methods used to estimate food intake. By definition, when body weight is stable, energy intake from food and beverages must equal energy expenditure. Thus, studies comparing reported dietary intake to simultaneous measurements of energy expenditure provide insight into whether there is systematic error associated with dietary intake assessment. Reviews of this work reveal that energy intake, whether assessed using 24-hr recalls, food records, or food frequency questionnaires, systematically underestimates usual energy expenditure (Trabulsi & Schoeller, 2001). This underestimation (often referred to as *underreporting*) may be related to eating less than usual on the days on which food intake is recorded; to inaccurate recall of the amount of food that was consumed; and/or to omitting or forgetting certain types of foods.

The issue is relevant because if food intake is underreported, it is likely that nutrient intakes may also be underestimated. That in turn has the potential to lead to inflated estimates of the prevalence of inadequate nutrient intakes.

2.3.1.4 Underreporting is Not Consistent Among Individuals or Across Foods—This Has Implications for Interpreting Nutrient Intake Data. At first glance, it could appear that a simple solution to underreporting would be to simply multiply reported energy and nutrient intakes derived from reported food intakes by a factor that would correct for the degree of underreporting. However, this would not be appropriate because underreporting is not a consistent occurrence: the probability of underreporting is not consistent among individuals, nor is underreporting proportional across all types of foods.

Research conducted to assess personal characteristics associated with underreporting has revealed factors that are more common among those who underreport (Livingstone & Black, 2003). 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 underreporters include body dissatisfaction, not smoking, 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 underreporting is more common among those with high BMI, one might conclude (perhaps incorrectly) that the overweight group had lower intakes.

Another characteristic that has been examined with regard to underreporting is the age of the respondent. Although the available data are not completely consistent, several studies suggest that mean reported energy intakes of school-aged children are similar to 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). Among infants and young children (whose intakes are reported by parents or caregivers), there is even some evidence that energy intake may be overreported (Devaney, Ziegler, Pac, Karwe & Barr, 2004). Thus, differential underreporting may need to be considered in interpreting intakes of children of different ages.

Studies also have been done to examine the nature of underreporting, to determine whether it is primarily related to errors in portion size estimation (so that all food are proportionally underreported), or whether some types of foods are more likely to be underreported. Most research suggests that the latter is true (Livingstone & Black, 2003). Those who

underreport 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 underreport 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 underreporters, lead to potentially misleading findings of higher micronutrient density (ratio of micronutrient intake to energy intake) among underreporters.

2.3.1.5 Several Methods Exist to Explore Possible Implications of Underreporting. Unfortunately, there is no completely accurate way to adjust for the effects of underreporting. In the years since recognizing the underreporting 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). 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 underreporting), invalid reporters may be identified and excluded from the data set. Various cut-offs to identify energy underreporters (and overrreporters) were initially proposed by Goldberg et al. (1991) and subsequently refined by Black (2000a). The energy intake cut-offs are expressed as multiples of basal metabolic rate (BMR), and vary depending on the number of days of diet records or recalls, 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). An individual with a BMR of 1500 kcal/d would thus be classified as an underreporter if reported intake was below 1305 kcal/d (0.87 x 1500), and as an overreporter if reported intake exceeded 4125 kcal/d (2.75 x 1500). If the diet recall or record was for 4 days, the lower cut-off would be 1.02 times

BMR (a reported intake of 1530 kcal for a BMR of 1500 kcal/d). And if the record was kept for 4 days and PAL was 1.75 (within the active range), the lower cut-off would be 1.19 times BMR (a reported intake of 1785 kcal/d for a BMR of 1500 kcal/d). Note that this approach has a low sensitivity at the individual level; that is, it does not identify all underreporters. However, sensitivity is improved by knowledge of the individual's PAL, rather than assuming an average PAL (Black, 2000b).

Dietary intake methodology is continuously being refined in an effort to improve reporting accuracy and to limit the impact of underreporting. However, it is clear that those interpreting dietary intake data must consider the implications of underreporting for any conclusions that are drawn.

2.3.2 Accuracy and Completeness of Nutrient Databases

The database used for the CCHS 2.2 included a supplemented 2001b Canadian Nutrient File (CNF), a recipe file and survey foods (food items that were not in the CNF but had some nutritional information available). The CNF is frequently updated, and the 2005 version contained 5370 foods with up to 129 food components (e.g. energy, macronutrients and micronutrients). More information about the CNF is available at www.healthcanada.ca/cnf. It includes data from the USDA National Nutrient Database for Standard Reference (up to and including SR17) for foods that correspond to the Canadian market. More information on the USDA database is found at www.ars.usda.gov/ba/bhnrc/ndl. Modifications included in the CNF consist of levels of fortification and regulatory standards specific to Canada, some *Canadian only* foods, and some brand name foods. All foods in the CNF have been assigned a 1992 CFGHE food group and a corresponding serving size, when applicable. Classifications will be updated with the coming revision of the CFGHE.

Users should be aware that the CNF does not have complete values for all 129 food components for every food. For example, although the database is 100% complete for energy, carbohydrate, fat, and protein, only 46% of foods have values for vitamin E (alpha-tocopherol). The completeness of the database for each of the 129 food components is available in the CNF Users' Guide (www.hc-sc.gc.ca/fn-an/nutrition/fiche-nutri-data/user_guide_d_utilisation01_e.html; see the section on nutrient code listing). Nutrients for which the database is considered substantially incomplete are not reported for the CCHS 2.2: these include vitamin E and *trans* fatty acids in foods. However, vitamin E intakes from supplements were quantified in the survey.

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. Efforts were made to address this in the CCHS 2.2. For many mixed dishes, the recipe database from the USDA was used. Recipes in that database were modified to reflect the Canadian food supply and Canadian recipes (e.g. tourtière) 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, when menus used in the Dietary Approaches to Stop Hypertension study were analyzed chemically and using nutrient database values, all 13 nutrients studied were within 10% of the chemically determined values (McCullough et al., 1999). In contrast to underreporting, 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 the Food Guide

When comparing food intakes to food guides, it is important to be aware of key differences between food guide recommendations and DRIs. However, at least one consideration applies equally to data on nutrient intakes and on food group intakes: *distributions* of usual intakes often provide useful information. These points are discussed below, using examples from CFGHE, released in 1992 (Health Canada, 1997). Readers should note that CFGHE was undergoing revision at the time this document was written. Thus, the examples provided may not apply specifically to the revised food guide, although the principles they illustrate would still be applicable.

2.4.1 Food Guides are Intended to Guide Food Intakes and to Result in a Low Risk of Nutrient Inadequacy; Food Guides Cannot be Used to Assess Inadequacy of Nutrient Intakes

Food guides are educational tools intended—among other purposes—to help individuals obtain adequate nutrient intakes. They assist individuals in making food choices that promote health and reduce the risk of nutrition-related chronic disease.

The number of servings consumed by an individual may be compared to the number recommended for each food group as a crude means of assessing which nutrients might be inadequate in the individual's diet. For example, someone who habitually consumed low intakes of fruits and vegetables might have inadequate intakes of nutrients such as vitamin A, vitamin C, and folate. This method, however, cannot provide definitive information on dietary adequacy of an individual.

Population surveys may report the proportions of the population with usual intakes that meet or do not meet the recommendations for each of the food groups. (In this regard, note that one-day intake distributions of food group servings should be adjusted to remove within-person variability, similar to what is done to obtain distributions of usual nutrient intake; see Section 2.2.2.) Data on the proportions of the population that meet food group recommendations provide information about whether nutritional guidance is being followed. However, the results cannot be used to assess adequacy of the nutrient intakes of the population.

2.4.2 Results of Food Group Analysis May Differ from Results of Analysis of Nutrient Intake Adequacy

Inferences made by examining food group adequacy (i.e. the proportion of the population consuming the recommended number of servings from food groups) may be quite different from what would be concluded by assessing nutrient adequacy as described in Section 2.2. For example, the recent British Columbia Nutrition Survey found that 73% of adult women consumed fewer than five servings of vegetables and fruit per day (B.C. Ministry of Health Services, 2004a), and thus did not meet the minimum recommendations from the 1992 CFGHE. This might lead one to expect a high prevalence of inadequate vitamin C intakes, yet in the B.C. survey, the prevalence of inadequate (% <EAR) vitamin C intakes from food ranged from 20% to 33% among women in different age groups (B.C. Ministry of Health Services, 2004b), considerably less than the 73% with low vegetable and fruit intakes. There are several reasons for discrepancies between food group analysis and nutrient intake adequacy analysis:

1. Food guides are designed to provide one pattern of dietary intake, but there is more than one pattern through which an individual can achieve a healthful diet.
2. Most nutrients are provided by more than one food group. For example, although folate is found in foods from the vegetables and fruit group, fortified grain products also contribute to intakes of this vitamin. If most of the population had generous intakes of fortified grain products, it is possible that most could have adequate folate intakes, even if vegetable and fruit intakes were low.

2.4.3 Distributions of Intakes from Food Groups May Provide Useful Information

The previous section described why the percentage of a group with intakes below the minimum food group recommendations may not correspond to the group prevalence of nutrient inadequacy. For this reason, and others, it may be more useful to provide information on food group intakes as *distributions*, rather than as mean intakes or as proportions above or below the minimum recommendation. For example, Table 2.4 illustrates three possible scenarios. In all three, only 30% of the population meets the minimum recommendation of five servings of vegetables and fruit from the 1992 CFGHE. However, their distributions are very different and would require different approaches.

Table 2.4 **Illustration of three scenarios in which 70% of a group falls below the 1992 *Canada's Food Guide to Healthy Eating* minimum of five servings of vegetables and fruit**

	Usual intake of vegetables and fruit (servings/d)					
Scenario	<1	1-1.9	2-2.9	3-3.9	4-4.9	≥5
A	-	-	-	-	70%	30%
B	-	-	15%	25%	30%	30%
C	30%	10%	10%	10%	10%	30%

Notes

3. The CCHS 2.2 Data

The CCHS 2.2 data were scheduled for release in two waves. The first data release occurred on July 6, 2005, and included all modules from the general health questionnaire except those on nutritional supplements and on the 24-hr recall. The second data release (anticipated in summer 2006) will contain data from 24-hr recalls. This section describes the raw data files that contain the CCHS 2.2 data, and how summary reports of the data can be accessed. It also provides an overview of the types of information that will be available based on analyses of 24-hr recall data.

3.1 CCHS 2.2 Data Files

The raw data collected in the CCHS 2.2 are contained in three sets of different files: the Master Files, the Share Files, and the Public Use Microdata Files (PUMF). As described below, these files have some differences that are related to confidentiality issues, and their results may differ slightly. Documentation for these data files can be located at www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=5049&lang=en&db=IMDB&dbg=f&adm=8&dis=2#4.

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 access the Master Files through Research Data Centres (RDCs) at some Canadian universities. Information about the RDC program is available at www.statcan.ca/english/rdc/index.htm.

3.1.2 Share Files

These files contain all variables for respondents who agreed to have their information shared with the survey share partners. In this case the share partners are the provincial Ministries of Health and Health Canada. The Share Files contain all of the variables available on the Master Files but for about 95% of the respondents. The files are weighted so that the Master Files and Share Files produce comparable results.

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. The PUMF are available through universities participating in the Data Liberation Initiative, and may also be available on request. For more information about the Data Liberation Initiative, see www.statcan.ca/english/Dli/dli.htm. Users requiring access to information excluded from the microdata files may purchase custom tabulations from the Master File. Outputs are vetted for confidentiality before being provided to users.

Furthermore, in some instances where access to RDCs is not feasible and the PUMF do not provide enough information for their project, researchers can apply for remote access to the data sets. Once their project is approved, researchers are provided with synthetic data from which they develop and test their computer programs (in SAS or SPSS), and then transmit them to the Population Health Surveys Data Access Unit at Statistics Canada via a dedicated e-mail address. The programs are run on the secure data servers by Data Access Unit staff, who also vet the outputs for disclosure issues, and return the vetted outputs to the user via e-mail. Remote access to the CCHS data is offered free of charge, but is restricted to projects with demonstrated needs.

3.2 CANSIM Summary Tables

CANSIM is an online resource for Canadian socioeconomic statistics on labour, health, income, trade, education, manufacturing, investment and other factors. Selected data are available free of charge from Statistics Canada, while other data are available for a fee. CANSIM does not provide all of the data available from the CCHS 2.2, but five tables were generated for the release of the first wave of data. These tables were on BMI of adults (excluding pregnant women), BMI of children, food insecurity, physical activity for those aged 6 to 11 years, and sedentary activity for those aged 12 to 17 years. When the second wave of data is released, a series of nutrition-related tables will be produced for CANSIM.

The section below describes how to access free data from the CCHS 2.2 and how to search the CANSIM site. Although in many cases fees are charged to access data through CANSIM, the site also provides links to a user guide and online tutorials.

3.2.1 Accessing Free Data from the CCHS 2.2

To access free data, go to www.statcan.ca/cgi-bin/downpub/freepub.cgi (and then to step #5 below).

Alternatively, you can navigate to this site as follows:

1. Enter www.statcan.ca in your Web browser
2. Select *English* or *Français*
3. Select *Our Products and Services* in the blue menu bar
4. Select *Browse our free internet publications (PDF or HTML)*
5. Select *Health*, and in the next screen, select the text *Nutrition: Findings from the Canadian Community Health Survey* (catalogue number 82-620-M).
6. This takes you to a screen that will list data available from the survey. As of May 2006, this consisted of *Measured Obesity*. Under HTML Free, select *View*.
7. You will now be viewing a screen listing two publications: 1) *Adult obesity in Canada: measured height and weight*; and 2) *Overweight Canadian children and adolescents*. In the menu bar on the left side of the screen, click on *Data tables*.
8. The next screen lists data tables available from the CCHS 2.2. Note that several formats are available for each data topic. For example, "Measured adult body mass index (BMI), household population aged 18 and over excluding pregnant females" includes tables available through CANSIM, as well as summary tables (*by age group and sex, Canada; by sex, Canada and provinces*) in both HTML and PDF formats. These summary tables may meet the needs of many users, but do not include all of the available data. For example, someone interested in the prevalence of overweight and obesity by age group and sex in a particular province would not find the relevant data in the summary tables. However, these data could be retrieved by selecting the CANSIM button, and following the steps described in Section 3.2.3.

3.2.2 Searching the CANSIM Site

The CANSIM home page is located at cansim2.statcan.ca/cgi-win/cnsmcgi.exe?CANSIMFile=CII/CII_1_E.htm&RootDir=CII/.

Alternatively, to navigate to the CANSIM site:

1. Enter www.statcan.ca in your Web browser
2. Select *English* or *Français*
3. Select *Our Products and Services* in the blue menu bar
4. Select *CANSIM* under the heading *Access our online databases*
5. You should now be at the CANSIM site. It has links to a user guide (in PDF), online tutorials, and frequently asked questions.

3.2.3 Generating CANSIM Tables

Click on the *CANSIM* button next to the data you wish to access.

Screen 1: The Web page lists a table number and title. On the rest of the page, the CANSIM system presents users with a series of menus to select the specific data for the table they wish to generate. Menus include *geography, age, sex*, the topic of interest, and *characteristics*. At least one item must be selected from each menu. To select more than one item, click on the desired items while pressing the *Control* key; to select all items, click on *Select All*. For example, if the topic of interest were adult Body Mass Index, users have the following options when generating their table:

- ***Geography.*** Users may select data for Canada as a whole, and for any or all of the provinces.
- ***Age group.*** Users may select all ages, or choose one or more distinct age categories.
- ***Sex.*** Users may select both sexes combined, males, and/or females.
- ***Body Mass Index.*** Any or all BMI categories may be selected (i.e. underweight, normal weight, overweight, obese, obese class I, obese class II, obese class III, not reported). If the data of interest were on another topic, choices relevant to that topic would be presented in this menu.
- ***Characteristics.*** It is possible to choose either the number in each category (the numbers reflect the number of Canadians) or the percentages. In most cases, data on percentages are more useful than on the total number of Canadians in a given category. For both number and percent, one can also select the lower and higher 95%

Confidence Intervals (CIs), and the coefficient of variation for the number or percent. Selecting the lower and higher 95% CIs can be used to provide a crude estimate of whether differences between groups are statistically significant, as described in Section 4.1.

Once you have specified the data you want included in the table, click on *Retrieve as a Table*.

Screen 2: On this screen, the list of data you have requested is presented. You can choose to *Modify Request* or *Continue*. Select *Continue* to proceed.

Screen 3: This page requires that you select an output format for the data table. A number of different formats are available, either as screen output (HTML tables, with data in columns or rows) or as downloadable files that can be entered into spreadsheets or databases. To simply view the table on your computer screen, a convenient format to choose is *HTML Table: If possible with a maximum of 12 columns*. Other options that may be specified on this page include the frequency of the output data, whether it is presented as retrieved or in other ways, and whether it is presented in English or French. The use of one of the *CSV file for spreadsheet use* options allows the data table to be downloaded into a spreadsheet program. Statistics Canada assumes responsibility for the quality of data as retrieved with the frequency unchanged (the default options), and notes that clients take responsibility for any manipulations made to the original data. Once you have selected the output format, click the *GO* button at the bottom of this page.

Screen 4: The table you have specified will now be generated.

3.2.4 Sample CANSIM Table

On the next page, the output from a simple CANSIM table on BMI is shown. The data are from the CCHS 2.2, and were generated by selecting *Canada* (under Geography); *total – 18 years and over* (under Age group); *both sexes*, *males*, and *females* (under Sex); *underweight*, *normal weight*, *overweight*, and *obese* (under Body Mass Index); and *percent*, *low 95% confidence interval, percent* and *high 95% confidence interval, percent* (under Characteristics). More complex tables could be generated by selecting Canada and all provinces, several separate age groups, and so on.

Table 3.1 [1] Measured adult body mass index (BMI), by age group and sex, household population aged 18 and over excluding pregnant females, Canadian Community Health Survey cycle 2.2, Canada excluding territories, 2004

Survey or program details:
Canadian Community Health Survey - Nutrition – 5049

Geography=Canada
Age group=Total, 18 years and over

See Section 4.1 to estimate whether the proportions of males and females in a given BMI category (e.g. obese) are different.

Measured adult body mass index[2,3,4,5]	Underweight, measured adult body mass index under 18.50			Normal weight, measured adult body mass index 18.50 to 24.99			Overweight, measured adult body mass index 25.00 to 29.99			Obese, measured adult body mass index 30.00 or higher		
Characteristics[6,7,8] / Sex	Percent	Low 95% confidence interval, percent	High 95% confidence interval, percent	Percent	Low 95% confidence interval, percent	High 95% confidence interval, percent	Percent	Low 95% confidence interval, percent	High 95% confidence interval, percent	Percent	Low 95% confidence interval, percent	High 95% confidence interval, percent
Both sexes	2.0	1.5	2.4	38.9	37.2	40.6	36.1	34.3	37.8	23.1	21.7	24.5
Males	1.4[E]	0.8[E]	2.1[E]	33.6	31.0	36.2	42.0	39.3	44.8	22.9	20.7	25.2
Females	2.5	1.8	3.2	44.1	41.8	46.3	30.2	28.1	32.3	23.2	21.3	25.1

Source: Statistics Canada

Symbol Legend

E = Use with caution

Footnotes:

1. Data source: Statistics Canada, Canadian Community Health Survey, Nutrition, 2004
2. A definition change was implemented in 2004 to conform with Health Canada guidelines for body weight classification.
3. Measured body mass index (BMI) is calculated by dividing the respondent's measured body weight (in kilograms) by their measured height (in metres) squared.
4. The index is: less than 18.50 (underweight); 18.50 to 24.99 (normal weight), 25.00 to 29.99 (overweight); 30.00 to 34.99 (obese, class I); 35.00 to 39.99 (obese, class II); 40.00 or greater (obese, class III).
5. Body mass index (BMI) is a method of classifying body weight according to health risk. According to the World Health Organization (WHO) and Health Canada guidelines, health risk levels are associated with each of the following BMI categories: normal weight = least health risk; underweight and overweight = increased health risk; obese, class I = high health risk; obese, class II = very high health risk; obese, class III = extremely high health risk.
6. Bootstrapping techniques were used to produce the coefficient of variation (CV) and 95% confidence intervals (CIs).
7. Data with a coefficient of variation (CV) from 16.6% to 33.3% are identified by an (E) and should be interpreted with caution.
8. Data with a coefficient of variation (CV) greater than 33.3% were suppressed (F) due to extreme sampling variability.

3.3 Health Canada Tables

After the release of the second wave of the CCHS 2.2 data, Health Canada plans to develop a compendium of tables based on the 24-hr recall and supplement use data. Examples of the types of tables that may be produced include:

- ***Energy and nutrients.*** These tables would describe Canadians' usual intakes of energy, macronutrients, fibre, vitamins, and minerals from both food sources alone and from the combination of food sources and supplements. Comparisons to DRIs would be provided (e.g. proportions below the EAR, above the UL, within the AMDR categories). (See Tables 3.2 to 3.4 for examples.)
- ***Food-related tables.*** At the time this guide was written, CFGHE was being revised. When the revised Food Guide is released, it will be possible to develop a series of tables to show percentiles of usual intake from the food groups in the Food Guide. Tables would also be produced to describe the food sources of nutrients.
- ***Nutritional supplements.*** Tables could report the numbers of supplements taken within the past month, and the proportion of the population consuming supplements containing various nutrients.
- ***Eating patterns.*** Tables on this topic could include the percent of the population consuming various meals, the average number of snacks consumed per day, the proportions of meal and snack episodes from commercial sources, and the sources of energy and macronutrients by meal or snack.

Tables 3.2 through 3.4 provide examples of the nutrient tables. Table 3.2 displays intake from food sources for a nutrient with an EAR (vitamin C is the example used), whereas Table 3.3 shows intake from food for a nutrient with an AI (calcium is the example). Table 3.4 presents data on the percentage of energy from fat, in relation to the AMDR.

Table 3.2 Vitamin C intakes (expressed as mg/d) from food sources, by age group and sex, Canada excluding territories, 2004

Sex	Age group (years)	n	Mean ± SEM	Percentiles (and SEM) of usual intake							EAR	% < EAR (95% CI)	UL	% > UL (95% CI)
				5th	10th	25th	50th	75th	90th	95th				
Both	4-8	3343	144 ± 3	60 (6)	74 (6)	102 (5)	137 (4)	178 (5)	222 (9)	253 (13)	22	[F]	650	0 (0,0)
Male	9-13	2149	156 ± 5	58 (4)	73 (5)	103 (5)	146 (6)	198 (9)	258 (13)	302 (18)	39	[F]	1200	0 (0,0)
	14-18	2397	163 ± 5	56 (5)	70 (5)	102 (6)	151 (7)	215 (9)	286 (13)	334 (17)	63	7 (4, 10)[E]	1800	0 (0,0)
	19-30	1897	158 ± 7	55 (6)	68 (6)	97 (7)	143 (8)	205 (11)	273 (16)	321 (20)	75	13 (7, 19)[E]	2000	0 (0,0)
	31-50	2751	128 ± 4	40 (4)	51 (4)	77 (4)	116 (5)	171 (6)	230 (10)	273 (14)	75	24 (18, 29)	2000	0 (0,0)
	51-70	2725	130 ± 5	38 (3)	50 (3)	76 (4)	117 (5)	172 (7)	236 (11)	281 (15)	75	24 (20, 29)	2000	0 (0,0)
	71+	1601	111 ± 4	32 (3)	42 (3)	66 (4)	101 (5)	148 (6)	201 (9)	238 (11)	75	32 (26, 37)	2000	0 (0,0)
Female	9-13	2043	147 ± 4	59 (5)	72 (5)	100 (5)	137 (5)	182 (7)	227 (9)	258 (12)	39	[F]	1200	0 (0,0)
	14-18	2346	147 ± 4	53 (4)	67 (4)	96 (5)	138 (5)	189 (7)	245 (10)	284 (13)	56	6 (3, 8)[E]	1800	0 (0,0)
	19-30	1915	132 ± 5	49 (5)	60 (5)	84 (6)	121 (6)	170 (8)	222 (11)	256 (14)	60	10 (5, 15)[E]	2000	0 (0,0)
	31-50	2851	117 ± 4	34 (2)	44 (3)	68 (3)	105 (4)	154 (5)	210 (8)	252 (10)	60	20 (16, 24)	2000	0 (0,0)
	51-70	3407	121 ± 3	40 (3)	52 (3)	76 (3)	110 (4)	154 (5)	204 (7)	238 (9)	60	15 (11, 18)	2000	0 (0,0)
	71+	2770	107 ± 3	34 (2)	44 (2)	67 (3)	100 (3)	140 (4)	181 (6)	210 (8)	60	20 (17, 24)	2000	0 (0,0)

Source: Statistics Canada, CCHS 2.2

Symbol Legend

E = Data with a coefficient of variation (CV) from 16.6% to 33.3% are identified by an (E) and should be interpreted with caution.

F = Data with a coefficient of variation (CV) greater than 33.3% were suppressed (F) due to extreme sampling variability.

Footnotes:

1. SEM = Standard Error of the Mean
2. The intake distribution was adjusted to remove within-person variability using SIDE software (Iowa State University, 1996) and the method presented in Nusser SM, Carriquiry AL, Dodd KW, Fuller WA. A semiparametric transformation approach to estimating usual daily intake distributions. *J Am Stat Assoc* 1996;91:1440-1449.
3. EAR = Estimated Average Requirement. For vitamin C, the requirement is based on intakes to achieve near-maximal neutrophil ascorbate concentrations. The requirement for smokers is estimated to be 35 mg/d higher than that of non-smokers; however, data in this table do not consider smoking status.
4. The percentage of the usual intake distribution below the EAR approximates the prevalence of inadequate dietary intake. The 95% CI (Confidence Interval) is the range within which there is a 95% degree of confidence that the true prevalence of inadequacy could lie.
5. UL = Tolerable Upper Intake Level. For vitamin C, the UL is based on potential risk of osmotic diarrhea and gastrointestinal disturbances.
6. The percentage of the usual intake distribution above the UL approximates the proportion at potential risk of adverse effects of excessive intake. The 95% CI (Confidence Interval) is the range within which there is a 95% degree of confidence that the true prevalence of intakes above the UL could lie.

Table 3.3 Calcium intakes (expressed as mg/d) from food sources, by age group and sex, Canada excluding territories, 2004

Sex	Age group (years)	n	Mean ± SEM	Percentiles of usual intake							AI	% > AI (95% CI)	UL	% > UL (95% CI)
				5th	10th	25th	50th	75th	90th	95th				
Both	4-8	3343	1038 ± 16	583 (21)	666 (19)	817 (17)	1007 (18)	1237 (25)	1482 (38)	1647 (49)	800	77 (73, 81)	2500	[F]
Male	9-13	2149	1208 ± 26	607 (26)	704 (26)	892 (26)	1151 (30)	1473 (40)	1820 (55)	2060 (72)	1300	37 (32, 43)	2500	1 (0,2)[E]
	14-18	2397	1287 ± 27	682 (36)	792 (35)	1003 (33)	1279 (33)	1608 (42)	1957 (58)	2194 (71)	1300	48 (42, 54)	2500	2 (1,3)[E]
	19-30	1897	1102 ± 34	507 (31)	597 (31)	777 (32)	1028 (37)	1341 (53)	1686 (79)	1925 (101)	1000	53 (46, 60)	2500	[F]
	31-50	2751	933 ± 20	437 (22)	515 (22)	673 (22)	889 (23)	1151 (30)	1455 (44)	1677 (58)	1000	38 (33, 43)	2500	[F]
	51-70	2725	827 ± 16	390 (26)	457 (25)	587 (22)	773 (20)	1025 (41)	1303 (90)	1488 (128)	1200	14 (10, 18)	2500	[F]
	71+	1601	774 ± 32	335 (28)	398 (27)	525 (26)	708 (29)	944 (40)	1212 (59)	1403 (77)	1200	[F]	2500	[F]
Female	9-13	2043	991 ± 24	522 (23)	601 (23)	752 (23)	950 (26)	1184 (33)	1432 (47)	1601 (59)	1300	17 (12, 21)	2500	[F]
	14-18	2346	913 ± 20	420 (21)	501 (21)	661 (22)	882 (23)	1154 (33)	1449 (50)	1654 (66)	1300	16 (12, 20)	2500	[F]
	19-30	1915	864 ± 26	406 (24)	478 (24)	623 (24)	819 (27)	1057 (36)	1310 (50)	1483 (62)	1000	30 (24, 36)	2500	[F]
	31-50	2851	828 ± 18	381 (19)	450 (20)	591 (21)	787 (22)	1027 (27)	1293 (40)	1484 (52)	1000	27 (23, 32)	2500	[F]
	51-70	3407	748 ± 13	336 (14)	402 (14)	527 (14)	697 (15)	915 (19)	1173 (35)	1357 (50)	1200	9 (7, 12)	2500	[F]
	71+	2770	689 ± 15	341 (16)	397 (17)	509 (18)	663 (20)	855 (23)	1070 (31)	1222 (39)	1200	6 (4, 7)	2500	0 (0,0)

Source: Statistics Canada, CCHS 2.2

Symbol Legend

E = Data with a coefficient of variation (CV) from 16.6% to 33.3% are identified by an (E) and should be interpreted with caution.

F = Data with a coefficient of variation (CV) greater than 33.3% were suppressed (F) due to extreme sampling variability.

Footnotes:

1. SEM = Standard Error of the Mean
2. The intake distribution was adjusted to remove within-person variability using SIDE software (Iowa State University, 1996) and the method presented in Nusser SM, Carriquiry AL, Dodd KW, Fuller WA. A semiparametric transformation approach to estimating usual daily intake distributions. *J Am Stat Assoc* 1996;91:1440-1449. For nutrients with an AI, the prevalence of inadequate intakes is likely low when median intake (50th percentile) meets or exceeds the AI (although there is less confidence in this statement if the AI was not based on intakes of a healthy population). No statements regarding the prevalence of inadequacy can be made when a group's median intake is below the AI.
3. AI = Adequate Intake. For calcium, the AI for those >1 y was based on desirable calcium retention/factorial method, calcium balance, change in bone mineral content or density, depending on the age group.
4. The percentage of the usual intake distribution above the AI almost certainly meets their needs. The 95% CI (Confidence Interval) is the range within which there is a 95% degree of confidence that the true prevalence of intakes above the AI could lie. The adequacy of intakes below the AI cannot be assessed, and should not be interpreted as being inadequate.
5. UL = Tolerable Upper Intake Level. For calcium, the UL is based on potential risk of the milk-alkali syndrome.
6. The percentage of the usual intake distribution above the UL approximates the proportion at potential risk of adverse effects of excessive intake. The 95% CI (Confidence Interval) is the range within which there is a 95% degree of confidence that the true prevalence of intakes above the UL could lie.

Table 3.4 Fat intakes as a percentage of total energy intake, by age group and sex, Canada excluding territories, 2004

Sex	Age group (years)	n	Mean ± SEM	Percentiles of usual intake							AMDR	% < AMDR (95% CI)	% > AMDR (95% CI)
				5th	10th	25th	50th	75th	90th	95th			
Both	4-8	3343	30.1 ± 0.2	24.9	26.0	28.0	30.1	32.3	34.3	35.5	25-35	5.5 (2, 8.9)[E]	6.7 (2.9, 10.6)[E]
Male	9-13	2149	30.9 ± 0.3	25.6	26.7	28.7	30.9	33.1	35.2	36.4	25-35	[F]	11 (5.5, 16.5)[E]
	14-18	2397	31.5 ± 0.3	25.9	27.1	29.1	31.4	33.8	36.0	37.3	25-35	[F]	15.6 (9.7, 21.6)[E]
	19-30	1897	31.1 ± 0.3	24.2	25.7	28.2	31.0	33.9	36.5	38.0	20-35	[F]	17.4 (9.3, 25.5)[E]
	31-50	2751	31.6 ± 0.4	22.8	24.6	27.9	31.6	35.4	38.6	40.6	20-35	[F]	27.3 (21, 33.6)
	51-70	2725	31.5 ± 0.3	23.6	25.2	28.1	31.4	34.7	37.7	39.5	20-35	[F]	23 (17.1, 28.8)
	71+	1601	30.7 ± 0.4	21.5	23.4	26.7	30.5	34.3	37.7	39.8	20-35	2.7 (1.1, 4.4)[E]	21.3 (15.8, 26.8)
Female	9-13	2043	30.5 ± 0.3	24.4	25.7	28.0	30.4	33.0	35.3	36.8	25-35	6.8 (2.9, 10.8)[E]	11.5 (6, 17)[E]
	14-18	2346	30.8 ± 0.3	25.0	26.3	28.5	30.9	33.4	35.7	37.0	25-35	[F]	13.5 (6.1, 20.8)[E]
	19-30	1915	30.5 ± 0.4	24.4	25.7	27.8	30.2	32.7	34.9	36.3	20-35	[F]	[F]
	31-50	2851	32.2 ± 0.3	24.5	26.2	29.1	32.2	35.5	38.4	40.1	20-35	[F]	28.1 (22.2, 34)
	51-70	3407	31.2 ± 0.3	23.2	25.0	27.9	31.1	34.6	37.7	39.5	20-35	[F]	22.5 (17.6, 27.5)
	71+	2770	30.3 ± 0.3	22.8	24.4	27.2	30.3	33.6	36.5	38.3	20-35	[F]	16.7 (11.9, 21.5)

Source: Statistics Canada, CCHS 2.2

Symbol Legend

E = Data with a coefficient of variation (CV) from 16.6% to 33.3% are identified by an (E) and should be interpreted with caution.

F = Data with a coefficient of variation (CV) greater than 33.3% were suppressed (F) due to extreme sampling variability.

Footnotes:

1. SEM = Standard Error of the Mean
2. The intake distribution was adjusted to remove within-person variability using SIDE software (Iowa State University, 1996) and the method presented in Nusser SM, Carriquiry AL, Dodd KW, Fuller WA. A semiparametric transformation approach to estimating usual daily intake distributions. *J Am Stat Assoc* 1996;91:1440-1449.
3. AMDR = Acceptable Macronutrient Distribution Range, expressed as a percentage of total energy intake.
4. Intakes below or above the AMDR may be associated with chronic disease risk. The 95% CI (Confidence Interval) is the range within which there is a 95% degree of confidence that the true prevalence of intakes below or above the AMDR could lie.

Notes

Notes

4. Using the Data to Make Comparisons

As stated in Chapter 1, the main objective of the CCHS 2.2 was to provide reliable, timely information about dietary intake, nutritional well-being, and their key determinants to inform and guide programs, policies and activities of federal and provincial governments. This objective can be met based on data from the CCHS 2.2 alone, and does not require comparisons to data from other surveys. Insights might be gained by making comparisons within the CCHS 2.2 data itself. For example, does the prevalence of nutrient inadequacy vary by age group or between men and women?

Further insights could potentially be gained by comparing the CCHS 2.2 data to other surveys, such as the CCHS 1.1 and 2.1, the provincial nutrition surveys, the Nutrition Canada national survey, nutrition surveys from the United States, and to data on the food supply. For example, data from the provincial nutrition surveys might be compared to provincial data from CCHS 2.2 to assess whether dietary intakes or other nutrition-related variables have changed over time. The sections that follow describe issues to be aware of when making such comparisons.

4.1 Making Comparisons Within the CCHS 2.2

Summary tables from the CCHS 2.2 are frequently available by age group and sex. Users of these tables may want to know whether real differences exist between, for example, older and younger individuals, or between 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 CIs provided in the CANSIM tables. A CI is a range within which there is a specified degree of confidence (commonly 95%) that the variable's true value could lie. CIs reflect uncertainty that arises due to extrapolating from the sample that was measured to the Canadian population. For example, the CCHS 2.2 reported that 42% of Canadian adult men were overweight and that 22.9% were obese (see Table 3.1). However, because the survey did not determine the BMI of every adult Canadian man, the true prevalence of overweight and obesity for the adult male population could be slightly higher or lower than the value for those who took part in the CCHS 2.2.

If one repeated the CCHS 2.2 100 times, selecting a different representative sample and measuring BMI each time to determine the prevalence of overweight and obesity, the 95% CI for prevalence of overweight and obesity would include 95 of the 100 prevalences. The 95% CIs for the prevalence of overweight and obesity in Canadian men range from 39.3% to 44.8% and from 15.2% to 24.7%, respectively, and thus provide an estimate of the possible ranges of the true prevalences in the Canadian adult male population.

Knowledge of the 95% CI can assist one in assessing whether apparent differences between groups are true differences, or simply reflect sampling variability. If the 95% CIs for two groups do not overlap, they are significantly different, while if there is extensive overlap between the 95% CIs, they do not differ significantly. Table 4.1 below shows the prevalence of overweight and obesity among Canadian men aged 35 to 44 years and 45 to 64 years. It can be seen that the prevalence of overweight does not differ by age group: the 95% CI of 37.3% to 51.7% for men aged 35 to 44 years overlaps almost completely with the 95% CI of 39.2% to 48.4% for men aged 45 to 64 years. Thus, the reported prevalences of 44.5% and 43.8% are not different. However, the prevalence of obesity does differ by age: there is no overlap between the 95% CI of 15.2% to 24.7% in the younger men and the 95% CI of 25.7% to 33.8% in the older men. Thus, the prevalence of 20.0% in the younger men is significantly lower than the prevalence of 29.8% in the older men.

Table 4.1 **Prevalence of overweight and obesity in Canadian men aged 35 to 44 and 45 to 64 years**

Age group	Measured adult body mass index	Prevalence (%)	95% CI
35 to 44 years	Overweight (BMI 25.00 to 29.99)	44.5	37.3 - 51.7
	Obese (BMI 30.00 or higher)	20.0	15.2 - 24.7
45 to 64 years	Overweight (BMI 25.00 to 29.99)	43.8	39.2 - 48.4
	Obese (BMI 30.00 or higher)	29.8	25.7 - 33.8

Source: Statistics Canada, CCHS 2.2

Frequently, 95% CIs will not be reported in tabulated data. However, they can often be calculated from measures of variability (such as the SEM) provided in many summary tables. To estimate the 95% CI from the mean and the SEM, subtract twice the SEM from the mean to determine the lower boundary, and add twice the SEM to determine the upper boundary. For example, if the mean ± SEM vitamin C intake is reported as 120 ± 7 mg/d, the 95% CI would be 106 mg/d to 134 mg/d (120 ± [2 x 7]).

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 examples on overweight and obesity described above, where there is either no overlap or almost complete overlap. When partial overlap exists, differences may or may not be significant. In such cases, or indeed, for any comparison, it is also possible to do statistical testing using the z-test. Methods to do this are described in Statistics Canada's CCHS 2.2 Technical User Guide (www.statcan.ca/english/sdds/document/5049_D8_T9_V1_E.pdf; see Chapter 11).

A final consideration regarding differences between groups relates to the question "So what?" Not infrequently, particularly in large surveys, statistically significant differences may have little biological importance. In the example of overweight and obesity provided above, the prevalence of obesity was significantly higher in men aged 45 to 64 years than among men aged 35 to 44 years, though a major finding was that a high proportion of men in both age groups were either overweight or obese.

4.2 Canadian Community Health Survey Cycles 1.1 and 2.1

The first two cycles of the CCHS included several similar question modules to those included in the CCHS 2.2 (see Table 4.2). In some cases, such as fruit and vegetable consumption, the questions were included in the common content section of the CCHS 1.1 and 2.1 (which were included in surveys in all health regions), and were identical to those included in the CCHS 2.2. In theory, this means that changes over time could be assessed with confidence across surveys. However, in the CCHS 2.2 the questions in the fruit and vegetable module were asked following the 24-hr recall, whereas this did not occur in the CCHS 1.1 and 2.1. As a result, questions in the module were likely answered differently in the CCHS 2.2. Health Canada statisticians thus recommend against making comparisons between the fruit and vegetable module in the CCHS 2.2 and the same module in the CCHS 1.1 and 2.1.

For other topics, the questions differed among surveys (e.g. food insecurity), or were included as common content in one survey but were optional (selected by some but not all health regions) in another survey (e.g. sedentary activity). Because national data are not available for optional content modules in the CCHS 1.1 and 2.1, comparisons to the CCHS 2.2 may not be appropriate. Finally, in some cases the question modules used in the CCHS 2.2 were abbreviated or modified versions of those used in cycles 1.1 and 2.1. For example, in the CCHS 2.2 some questions were dropped from the General Health, Physical Activities, Smoking, and Alcohol modules used in CCHS 2.1. This would limit the extent of comparisons that could be made between surveys.

Table 4.2 Comparison of questionnaire modules in the CCHS 2.2 to modules in the CCHS 1.1 and 2.1

Module	CCHS 2.2	CCHS 1.1	CCHS 2.1
Fruit and Vegetable Consumption	Intake frequency of fruit juice, fruit, green salad, potatoes, carrots, other fruits and vegetables (asked following 24-hr recall)	Identical module used as CCHS 2.2 (common content) (no 24-hr recall)	Identical module used as CCHS 2.2 (common content) (no 24-hr recall)
Dietary Supplements	Nutritional supplements used in the past month (and their content); did not include herbal supplements	Not addressed	Whether any supplements were used in past 4 weeks; number of days used (optional content)
Food Security	Multi-part module (up to 18 questions)	Contained three questions only, which differed from CCHS 2.2 (common content)	Same questions as CCHS 1.1 (optional content)
Physical Activity	Leisure activities in past 3 months (frequency and duration)	Same questions as CCHS 2.2, plus three questions on non-leisure activity (common content)	Same questions as CCHS 1.1 (common content)
Sedentary Activity	Four questions on leisure time computer use, video games, TV, reading (only for age 12 to 17 years)	Same questions as CCHS 2.2 (optional content; included for age ≥12 years)	Same questions as CCHS 2.2 (optional content; included for age ≥12 years)
Children's Physical Activity	Questions on activity at and outside of school; frequency of watching TV and using a computer (for age 6 to 11 years)	Not addressed	Not addressed
Alcohol	Frequency of use in past 12 months; frequency of ≥5 drinks on one occasion	Same questions as CCHS 2.2, plus additional questions (common content)	Same questions as CCHS 1.1 (common content)
Smoking	Current and past smoking habits	Same questions as CCHS 2.2, plus additional questions (common content)	Same questions as CCHS 1.1 (common content)

4.3 Provincial Nutrition Surveys

4.3.1 Overview of the Surveys

The provincial nutrition surveys were conducted as collaborations among the federal government, provincial governments, and universities during the 1990s. All surveys included a 24-hr recall, anthropometric assessment (measured height, weight, and waist and hip circumference), a food frequency questionnaire, a provincial-focused questionnaire, and a demographic profile. The surveys had many features in common: for example, standard procedures were used to identify a representative sampling frame in each province, the dietary recall methodology was standardized, all data input occurred at Health Canada, and similar methods were used to obtain adjusted usual intake distributions. To date Nova Scotia, P.E.I., Québec (Adult and Youth surveys), Saskatchewan, Ontario, B.C., Newfoundland and Labrador, and New Brunswick have published reports on dietary intake patterns in their provinces. Additional information is available at www.hc-sc.gc.ca/fn-an/surveill/nutrition/prov/index_e.html.

4.3.2 Comparing to the CCHS 2.2

Comparing data obtained in the provincial surveys with data from the CCHS 2.2 is complicated by a number of variables that may differ between surveys, examples of which are described below. Those wishing to make comparisons between the provincial survey reports and provincial data obtained in the CCHS 2.2 will need to examine the relevant provincial survey reports carefully.

4.3.2.1 Overall Survey Methodology. The provincial surveys were conducted during two seasons, whereas data collection for the CCHS 2.2 spanned the entire year. Thus, some foods that are consumed seasonally may have been reported more or less frequently in the provincial surveys than in the CCHS 2.2. Furthermore, with the exception of the Quebec Youth Survey (ages 6 to 16), provincial surveys were limited to adults, and had an upper age range of 74 years in all provinces except B.C., which included adults to age 84.

4.3.2.2 Method Used to Obtain 24-hr Recall. Methods that include additional probing steps to facilitate recall could potentially result in higher reported intakes, complicating comparisons between surveys. The CCHS 2.2 used a five-step multiple-pass method to conduct 24-hr recalls,

whereas the provincial surveys used a three-step method that did not include probing for foods that are frequently forgotten. Furthermore, the provincial surveys used a paper-and-pen collection method that allowed for more variability in collection of details, whereas the computer-assisted AMPM used in the CCHS 2.2 had a programmed set of questions. Finally, second interviews for the provincial surveys were conducted in person, but for the CCHS 2.2, this was done by telephone in most cases. However, studies have shown that in-person and telephone interviews yield similar results (Brustad et al., 2003; Godwin et al., 2004; Tran et al., 2000), and this issue will be further examined using data from the CCHS 2.2.

4.3.2.3 Differences in Fortification of the Food Supply. Addition of folic acid to all white flour and to pasta products labelled *enriched* became mandatory as of November 1998. Thus, the CCHS 2.2 and provincial surveys from Ontario, B.C., Quebec youth, and Manitoba reflect this fortification; other provincial survey reports do not. The differences in the food supply reflect real differences over time in nutrient availability for consumption, and may be a reason why some provinces would show greater or lesser differences when provincial survey data are compared with the CCHS 2.2 intake data.

4.3.2.4 Differences in Reference Standards and Age Groups. The CCHS 2.2 will assess dietary intakes against the DRIs and will report the estimated prevalence of inadequate intakes for nutrients that have an EAR (see Section 2.2). The DRIs and methods to use them in interpreting intakes were being developed in the late 1990s, when several provincial surveys were occurring. Among the provincial surveys published at the time this guide was written, the estimated prevalences of inadequate nutrient intakes were reported for P.E.I. and Newfoundland and Labrador (intake from foods and beverages only), and for B.C., Quebec youth and Ontario (also assessed the contribution of supplements).

The CCHS 2.2 will tabulate results using the DRI age groups. For adults, these are 19 to 30, 31 to 50, 51 to 70, and over 70 years. The DRI age groups were also used in the reports of the B.C. and the Newfoundland and Labrador nutrition surveys, whereas published tabulations of nutrient intake data from the Nova Scotia, Quebec adult survey, Saskatchewan, Ontario, and P.E.I. surveys were for men and women aged 18 to 34, 35 to 49, 50 to 64, and 65 to 74 years.

4.3.2.5 Differences in Data Presentation. Some of the provincial surveys reported only mean nutrient intakes (e.g. Nova Scotia), while others presented means ± SEM (e.g. Ontario, B.C.), and others also included 95% CIs (e.g. P.E.I.). Those without access to the raw data cannot assess the significance of apparent differences unless measures of

variability such as the SEM or the 95% CI are reported. Survey reports also differ in terms of how or whether data on the contribution of supplements to nutrient intakes are provided.

4.3.2.6 Differences in Response Rates. The CCHS 2.2 had a high response rate which suggests that it is representative of the Canadian population. Response rates in the provincial surveys were generally lower, and varied from 29% for the Ontario survey to over 80% for the Nova Scotia survey. As described earlier (Section 1.1.4), individuals who choose to participate in nutrition surveys are frequently healthier than those who do not participate, and when the response rate is low, the results may present a more favourable picture than if a higher response rate had been attained. Comparing data from a provincial survey with a low response rate to provincial data from CCHS 2.2 (which had a high response rate) should therefore be done with caution.

4.4 Nutrition Canada Survey

4.4.1 Overview of the Survey

The Nutrition Canada national survey is 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. 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.[3]

The sampling design for the Nutrition Canada provincial survey is most comparable to the CCHS 2.2 sample. The Nutrition Canada provincial survey was stratified by region (Atlantic, Quebec, Ontario, Prairies, and B.C.), income (low income and other income), season (winter or summer), and area (metropolitan, urban, and rural). A random sampling strategy was used to identify males and females in 10 age–sex categories (males and females together for ages 0 to 4 and 5 to 9 years, and males and females separately for ages 10 to 19, 20 to 39, 40 to 64, and 65 years and above). More than 27,000 individuals were selected for the survey, 46% of whom

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

attended the survey clinics. The final sample size was thus 12,795, plus 894 pregnant women in their third trimester of pregnancy (who were recruited through local health units and were therefore not a probability sample).

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 24-hr recall of the previous day's intake, and included intake of vitamin and mineral supplements. Interviews for children under the age of 12 years were conducted with the child's mother or other adult caretaker, although children aged 6 though 12 years were present at the interview and contributed to it. Blood and urine samples were analyzed for a variety of indicators of vitamin, mineral, and protein status.

4.4.2 Interpretive Standards

Interpretive standards were developed for the survey (Nutrition Canada, 1973). For dietary data, these were used to classify individuals' intakes of protein, iron, calcium, vitamin D, vitamin A, thiamin, riboflavin, and niacin as *inadequate* (thought to reflect intakes below minimum requirements), *less than adequate* (thought to reflect intakes above minimal requirements but below adequate intakes), or *adequate* (thought to reflect intakes providing a desirable measure of safety in meeting nutrient requirements). Note that the standards used did not necessarily correspond to the Recommended Nutrient Intakes (Health and Welfare Canada, 1976) at that time, and also do not correspond to the interpretive standards used in the CCHS 2.2. For example, for vitamin C, inadequacy was defined as intakes below 10 mg/d, while adequacy was defined as intakes over 30 mg/d.

The interpretive standards for relative weight were based on the Ponderal Index (PI), which is calculated as height (inches)/cubic root of weight (pounds). Ranges for high risk, moderate risk, and low risk for obesity were *below* 11.6, 11.6 to 12.5, and *above* 12.5, respectively, for individuals aged 20 or above. These values do not translate directly to the BMI cut-offs of 25 and 30 kg/m^2 used in the CCHS 2.2, as shown in Table 4.3. Note also that the relationship between the cut-points is not consistent: at relatively shorter heights, such as 1.6 m, the cut-offs for risk are lower using the PI than the BMI, while at greater heights, such as 1.8 m, the opposite is true.

Table 4.3 Weight (kg) at a BMI of 25 or 30, or a Ponderal Index (PI) of 12.5 or 11.6

Height	BMI = 25[a]	PI = 12.5[b]	BMI = 30[c]	PI = 11.6[d]
1.6 m	64.0	58.1	76.8	72.8
1.8 m	81.0	82.8	97.2	103.6

[a] BMI = 25–29.9 reflects overweight

[b] PI <12.5 but >11.6 reflects moderate risk for obesity

[c] BMI ≥30 reflects obesity

[d] PI <11.6 reflects high risk for obesity

4.4.3 Survey Data

The survey results were tabulated nationally, for each province, and for Inuit and First Nations (Nutrition Canada, 1973, 1975a-l). The provincial reports display national and provincial one-day (unadjusted) intake distributions by level of nutrient intake (including the contributions from supplements) for each age–sex category. For example, for vitamin C the proportion of each age–sex group with vitamin C intakes falling within 20 mg increments is provided for intakes up to 400 mg/d (i.e. 0 to 20 mg, 20 to 40 mg, …380 to 400 mg), and a final category shows the proportion with intakes above 400 mg. In addition, the 5th, 25th, 50th, 75th, and 95th percentiles of the one-day (unadjusted) intake distributions are shown for each age–sex group. Other tables show the percentages of each age–sex group with one-day intakes classified as *inadequate*, *less than adequate*, and *adequate*. A similar approach was used for PI (i.e. proportions with PI <10, in increments of 0.25 from 10.0 to 14.75, and above 14.75). In addition, the selected percentiles of PI, and the proportions classified at high risk, moderate risk and low risk, were tablulated for groups aged 20 or above.

Data available from the Nutrition Canada Survey also include mean nutrient intakes for each age–sex group for the national sample and for each of the five regions (Atlantic, Quebec, Ontario, Prairies and B.C.) (Nutrition Canada, undated). However, measures of variability were not included in the data tabulations.

4.4.4 Comparing to the CCHS 2.2

Those wishing to compare data from the Nutrition Canada Survey to data from the CCHS 2.2 will recognize the differences in the methodology (e.g. methods used to conduct 24-hr recalls), the response rate (76.5% for the CCHS 2.2 versus 46% for the Nutrition Canada Survey), the food supply, and the prevalence of use of vitamin and mineral supplements over the past three decades. Although the Nutrition Canada Survey also used the then-current USDA database with modifications to reflect the Canadian food supply, over the past 30 years the units used to report some nutrients have changed, and the methods to obtain nutrient values have evolved for most nutrients. Furthermore, different age groupings were used in the two surveys, as well as different methods and standards for classifying intakes as adequate or inadequate. Another difference was that the data on height and weight obtained in Nutrition Canada were presented using the PI rather than Body Mass Index, and mean heights and weights were not presented.

Accordingly, in many cases the CCHS 2.2 data would need to be reanalyzed (e.g. using different age groups; calculating the PI) to make comparisons to the Nutrition Canada Survey. In this regard, it should be noted that instead of using Nutrition Canada data on relative weight to compare to the CCHS 2.2, Statistics Canada publications (Tjepkema, 2005; Shields, 2005) made comparisons to data obtained in the 1978 to 1979 Canada Health Survey (Canada Health Survey, 1979), as height and weight data in that survey were measured in kilograms and centimetres, respectively. It should also be noted that the absence of measures of variability for mean nutrient intakes in the Nutrition Canada reports preclude statistical comparisons. For example, mean vitamin C intake for men aged 20 to 39 years in the Nutrition Canada Quebec sample was 127 mg/d (Nutrition Canada, undated), but it will not be possible to determine whether this intake differs significantly from the intake assessed in the CCHS 2.2 without access to the raw data. Finally, the percentiles of the one-day (unadjusted) intake distributions from Nutrition Canada should not be compared to the usual intake percentiles (adjusted to remove within-person variability) from the CCHS 2.2.

4.5 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 US Department of Health and Human Services. NHANES also includes 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 survey content for 1999 to 2004 is available at www.cdc.gov/nchs/data/nhanes/comp3.pdf). Data from these surveys are accessible: for example, data from the 1994 to 1996, 1998 CSFII can be accessed at www.ars.usda.gov/Services/docs.htm?docid=7716. Published tables present mean intakes for age and sex groups cross-tabulated by variables such as race, region, and income.

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 CCHS 2.2). The first 24-hr recall is conducted in person, whereas the second is conducted by telephone. Public use data files from 2001 to 2002 have recently been released from NHANES and are available for researchers to analyze (www.cdc.gov/nchs/about/major/nhanes/datalink.htm). The dietary data are also available in tabular form (www.ars.usda.gov/SP2UserFiles/Place/12355000/pdf/usualintaketables2001-02.pdf). These data will be the most appropriate for comparison (with appropriate caution) to the CCHS 2.2. The 2001-02 tables from *What We Eat in America* present the mean, SEM, and percentiles of the usual nutrient intake distributions from food sources for the total population and for the DRI age–sex groups. For nutrients with an EAR, the tables also present the proportions with usual intakes below the EAR (and the standard error of that estimate), whereas for nutrients with an AI, the proportions with intakes above the AI (and the standard error) are provided. The report does not include the prevalence of intakes above the UL, and also does not report usual nutrient intake distributions from food and supplements combined.

Relative body weight may also be compared between the CCHS 2.2 data and US data. In this regard, it is important to recall that for children up to 18 years of age, different BMI cut-offs are used to classify children's weight status in the US than in the CCHS 2.2 (see Section 1.2.10.)

4.6 Food Statistics

The Agriculture Division of Statistics Canada produces data on the estimated amounts of food available for consumption in Canada. These data are published in *Food Statistics* (available at www.statcan.ca:8096/bsolc/english/bsolc?catno=21-020-X&CHROPG=1) and are also available as a component of Canada Food Stats, a CD-ROM product (www.statcan.ca/english/ads/23F0001XCB/). They provide a valuable source of data on trends in food availability, and demonstrate changes over time in the Canadian food supply. For example, they show that total fruit availability (expressed as fresh equivalent weight) has increased by 16.5 kg per capita between 1993 and 2003.

The primary data are food disappearance data, which reflect the per capita amounts of food available for consumption during a given calendar year. These data are calculated by first estimating the total supply for a particular food commodity (e.g. apricots, cheddar cheese) during the year. The total supply is the sum of the food held in storage on January 1 of the year, all food produced in Canada that year, and all food imported to Canada. The net supply is then calculated by subtracting any amount remaining in storage on December 31 of the year, all exports of the food, amounts used in manufacturing (e.g. for processing, seed, animal feed, and industrial use), and amounts wasted at the industrial level. The net supply is then divided by the Canadian population at July 1 to obtain per capita food *availability* (or disappearance) data.

Traditionally, the waste factors have attempted to account for losses during processing or storage, but do not account for waste at the retail or consumer levels, or for unconsumed food. Recently, Statistics Canada has attempted to estimate actual per capita *consumption* by applying new waste factors to food availability data that account for these additional losses. These new waste factors are estimates, and were developed in the US; it is not known whether they accurately reflect the Canadian context. Thus, Statistics Canada states that the resulting data on estimated food consumption should be considered experimental, and therefore used with caution.

Estimates of nutrient availability (and estimated consumption) have also been generated from the food availability and estimated food consumption data. These are derived by applying nutritional equivalent factors to the amounts of the food commodity. Again, estimated nutrient consumption data derived in this way are considered experimental and should be used with caution.

Comparison of the CCHS 2.2 nutrient intake data to the estimated nutrient availability or consumption data from *Food Statistics* is not recommended. There are different errors associated with these two different types of data (e.g. 24-hr recall data may underestimate intakes; nutrient availability data overestimate intakes). Furthermore, the only comparison that can be made is mean estimated consumption (or availability) at the per capita level, which has relatively little biological meaning. First, differing nutrient requirements and intakes by age and sex cannot be considered. Second, as discussed in Chapter 2, the mean intake of a population group provides no information on the distribution of intakes; rather it is the usual intake distribution that permits insights into the prevalence of inadequate nutrient intakes.

Notes

5. Conclusions and Next Steps

The 2004 CCHS Cycle 2.2 presents an opportunity to examine the food and nutrient intakes of Canadians and the relationship between diet and a wide range of health correlates. This guide was created to be a reference—to bring together information needed to understand data summaries (such as tables) and to provide a basis of information for those planning to perform analyses. It is complemented by a variety of Statistics Canada's CCHS 2.2 resource documents which are also of broad interest, but are particularly necessary for those planning to undertake their own data analyses.

Learning and research opportunities are being organized to support the users of the CCHS 2.2 data, 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 CCHS 2.2, is recognised and will be addressed. The INMD is promoting research through a special Request for Applications initiative launched in June 2005. The opportunity for informal learning and sharing will be possible through a CCHS 2.2 User Group. This is being organized through Health Canada to address the ongoing research and data analysis issues of interested parties.

A series of reports based on the CCHS 2.2 data will be released by Health Canada. The first of these is a report on food security to be released in 2006. A compendium of data tables on the nutrient intakes and food patterns of Canadians is also planned. Please consult www.hc-sc.gc.ca/fn-an/surveill/nutrition/index_e.html to obtain the most up-to-date information and to find out about learning opportunities and report releases.

Notes

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Notes

Notes

Appendix 1: Dietary Reference Intakes

Equations to Estimate Energy Requirements

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]) + PAx { (26.7 x weight [kg]) + (903 x height [m]) } + 20
9-18 years	EER = 88.5 – (61.9 x age [y]) + PAx { (26.7 x weight [kg]) + (903 x height [m]) } + 25
Girls 3-8 years	EER = 135.3 – (30.8 x age [y]) + PAx { (10.0 x weight [kg]) + (934 x height [m]) } + 20
9-18 years	EER = 135.3 – (30.8 x age [y]) + PAx { (10.0 x weight [kg]) + (934 x height [m]) } + 25
Adults 19 years or older Estimated Energy Requirement (kcal/day) = Total Energy Expenditure	
Men	EER = 662 – (9.53 x age [y]) + PAx { (15.91 x weight [kg]) + (539.6 x height [m]) }
Women	EER = 354 – (6.91 x age [y]) + PAx { (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 2005

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 to <1.4)	**Low Active** (PAL 1.4 to <1.6)	**Active** (PAL 1.6 to <1.9)	**Very Active** (PAL 1.9 to <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 (e.g. 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 2005

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		IU/day		mg/day			μg/day	
	EAR	RDA/AI	UL[3]	EAR	RDA/AI	UL[3]	AI[4]	UL	AI[4]	UL	EAR	RDA/AI	UL[6]	AI	UL[7]
Infants															
0-6 mo	ND	400*	600	ND	1333*	2000	5*	25	200*	1000	ND	4*	ND	2.0*	ND
7-12 mo	ND	500*	600	ND	1667*	2000	5*	25	200*	1000	ND	5*	ND	2.5*	ND
Children															
1-3 y	210	300	600	700	1000	2000	5*	50	200*	2000	5	6	200	30*	ND
4-8 y	275	400	900	917	1333	3000	5*	50	200*	2000	6	7	300	55*	ND
Males															
9-13 y	445	600	1700	1483	2000	5667	5*	50	200*	2000	9	11	600	60*	ND
14-18 y	630	900	2800	2100	3000	9333	5*	50	200*	2000	12	15	800	75*	ND
19-30 y	625	900	3000	2083	3000	10000	5*	50	200*	2000	12	15	1000	120*	ND
31-50 y	625	900	3000	2083	3000	10000	5*	50	200*	2000	12	15	1000	120*	ND
51-70 y	625	900	3000	2083	3000	10000	10*	50	400*	2000	12	15	1000	120*	ND
>70 y	625	900	3000	2083	3000	10000	15*	50	600*	2000	12	15	1000	120*	ND
Females															
9-13 y	420	600	1700	1400	2000	5667	5*	50	200*	2000	9	11	600	60*	ND
14-18 y	485	700	2800	1617	2333	9333	5*	50	200*	2000	12	15	800	75*	ND
19-30 y	500	700	3000	1667	2333	10000	5*	50	200*	2000	12	15	1000	90*	ND
31-50 y	500	700	3000	1667	2333	10000	5*	50	200*	2000	12	15	1000	90*	ND
51-70 y	500	700	3000	1667	2333	10000	10*	50	400*	2000	12	15	1000	90*	ND
>70 y	500	700	3000	1667	2333	10000	15*	50	600*	2000	12	15	1000	90*	ND
Pregnancy															
≤18 y	530	750	2800	1767	2500	9333	5*	50	200*	2000	12	15	800	75*	ND
19-30 y	550	770	3000	1833	2567	10000	5*	50	200*	2000	12	15	1000	90*	ND
31-50 y	550	770	3000	1833	2567	10000	5*	50	200*	2000	12	15	1000	90*	ND
Lactation															
≤18 y	885	1200	2800	2950	4000	9333	5*	50	200*	2000	16	19	800	75*	ND
19-30 y	900	1300	3000	3000	4333	10000	5*	50	200*	2000	16	19	1000	90*	ND
31-50 y	900	1300	3000	3000	4333	10000	5*	50	200*	2000	16	19	1000	90*	ND

Source: IOM 1997, 2000a, 2000b

This table presents Estimated Average Requirements (EARs), Recommended Dietary Allowances (RDAs), Adequate Intakes (AIs) followed by an asterisk (*) and Tolerable Upper Intake Levels (ULs).

ND = Not Determinable.

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 AI values are based on the absence of adequate exposure to sunlight.

5 EAR and RDA/AI as alpha-tocopherol (2*R*-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 (NE)**			**mg/day**		
	EAR	RDA/AI	UL	EAR	RDA/AI	UL[9]	EAR	RDA/AI	UL[9]	EAR	RDA/AI	UL[11]	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), Recommended Dietary Allowances (RDAs), Adequate Intakes (AIs) followed by an asterisk (*) and Tolerable Upper Intake Levels (ULs).
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), Recommended Dietary Allowances (RDAs), Adequate Intakes (AIs) followed by an asterisk (*) and Tolerable Upper Intake Levels (ULs).

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 400 µg 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	AI	UL	AI	UL[17]	EAR	RDA/AI	UL	AI	UL	EAR	RDA/AI	UL
Infants																
0-6 mo	ND	ND	ND	ND	210*	ND	0.2*	ND	ND	200*	ND	0.01*	0.7	ND	110*	ND
7-12 mo	ND	ND	ND	ND	270*	ND	5.5*	ND	ND	220*	ND	0.5*	0.9	ND	130*	ND
Children																
1-3 y	ND	ND	ND	3	500*	2500	11*	ND	260	340	1000	0.7*	1.3	65	90	200
4-8 y	ND	ND	ND	6	800*	2500	15*	ND	340	440	3000	1*	2.2	65	90	300
Males																
9-13 y	ND	ND	ND	11	1300*	2500	25*	ND	540	700	5000	2*	10	73	120	600
14-18 y	ND	ND	ND	17	1300*	2500	35*	ND	685	890	8000	3*	10	95	150	900
19-30 y	ND	ND	ND	20	1000*	2500	35*	ND	700	900	10000	4*	10	95	150	1100
31-50 y	ND	ND	ND	20	1000*	2500	35*	ND	700	900	10000	4*	10	95	150	1100
51-70 y	ND	ND	ND	20	1200*	2500	30*	ND	700	900	10000	4*	10	95	150	1100
>70 y	ND	ND	ND	20	1200*	2500	30*	ND	700	900	10000	4*	10	95	150	1100
Females																
9-13 y	ND	ND	ND	11	1300*	2500	21*	ND	540	700	5000	2*	10	73	120	600
14-18 y	ND	ND	ND	17	1300*	2500	24*	ND	685	890	8000	3*	10	95	150	900
19-30 y	ND	ND	ND	20	1000*	2500	25*	ND	700	900	10000	3*	10	95	150	1100
31-50 y	ND	ND	ND	20	1000*	2500	25*	ND	700	900	10000	3*	10	95	150	1100
51-70 y	ND	ND	ND	20	1200*	2500	20*	ND	700	900	10000	3*	10	95	150	1100
>70 y	ND	ND	ND	20	1200*	2500	20*	ND	700	900	10000	3*	10	95	150	1100
Pregnancy																
≤18 y	ND	ND	ND	17	1300*	2500	29*	ND	785	1000	8000	3*	10	160	220	900
19-30 y	ND	ND	ND	20	1000*	2500	30*	ND	800	1000	10000	3*	10	160	220	1100
31-50 y	ND	ND	ND	20	1000*	2500	30*	ND	800	1000	10000	3*	10	160	220	1100
Lactation																
≤18 y	ND	ND	ND	17	1300*	2500	44*	ND	985	1300	8000	3*	10	209	290	900
19-30 y	ND	ND	ND	20	1000*	2500	44*	ND	1000	1300	10000	3*	10	209	290	1100
31-50 y	ND	ND	ND	20	1000*	2500	45*	ND	1000	1300	10000	3*	10	209	290	1100

Source: IOM 1997, 2000b

This table presents Estimated Average Requirements (EARs), Recommended Dietary Allowances (RDAs), Adequate Intakes (AIs) followed by an asterisk (*) and Tolerable Upper Intake Levels (ULs).

ND = Not Determinable.

[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, 2000b
This table presents Estimated Average Requirements (EARs), Recommended Dietary Allowances (RDAs), Adequate Intakes (AIs) followed by an asterisk (*) and Tolerable Upper Intake Levels (ULs).
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 or 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, 2000b, 2004

This table presents Estimated Average Requirements (EARs), Recommended Dietary Allowances (RDAs), Adequate Intakes (AIs) followed by an asterisk (*) and Tolerable Upper Intake Levels (ULs).

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 2004, 2005

This table presents Estimated Average Requirements (EARs), Recommended Dietary Allowances (RDAs), Adequate Intakes (AIs) followed by an asterisk (*) and Tolerable Upper Intake Levels (ULs).

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 complementary 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.

Acceptable Macronutrient Distribution Ranges (AMDR)

	Total Carbohydrate	Total Protein	Total Fat	n-6 polyunsaturated fatty acids (linoleic acid)	n-3 polyunsaturated fatty acids (α-linolenic acid)
Males and Females [34]	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

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.

Protein Quality Scoring Pattern (age 1 year and older)

Amino Acid	Recommended pattern
	mg/g protein
Histidine	18
Isoleucine	25
Leucine	55
Lysine	51
Methionine + Cysteine	25
Phenylalanine + Tyrosine	47
Threonine	27
Tryptophan	7
Valine	32

Reference amino acid pattern for use in evaluating the quality of food proteins using the protein digestibility corrected amino acid score (PDCAAS). Based on Estimated Average Requirements both for indispensable amino acids and for total protein for 1- to 3-year-old children.

Source: IOM 2005

Physical Activity Recommendation

To prevent weight gain and accrue additional health benefits of physical activity, **60 minutes of daily moderate intensity activity** is recommended in addition to the activities required by a sedentary lifestyle. This amount of physical activity leads to an "active" lifestyle.

Appendix 2: Criteria Used to Set EERs, EARs, AIs and ULs

Table A2.1 Criteria used to set EERs, EARs, AIs and ULs

	Reference Standard	Criterion used to set EER, EAR or AI in adults	Adverse effect used to set UL[1, 2] in adults
Energy	EER	Energy expenditure	N/A
Carbohydrate	EAR	Brain glucose utilization	N/A
Total fibre	AI	Intake level shown to provide greatest protection against coronary heart disease (14 g/1000 kcal) x median energy intake (kcal/d)	N/A
n-6 Polyunsaturates (linoleic acid)	AI	Median intake of linoleic acid from CSFII	N/A
n-3 Polyunsaturates (α-linolenic acid)	AI	Median intake of α-linolenic acid from CSFII	N/A
Protein	EAR	Nitrogen equilibrium	N/A
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])
Thiamin	EAR	Erythrocyte transketolase activity, urinary thiamine excretion	N/A
Riboflavin	EAR	Erythrocyte glutathione reductase activity coefficient and urinary riboflavin excretion	N/A
Niacin	EAR	Urinary excretion of niacin metabolites	Flushing (UL applies only to supplemental or synthetic forms)
Vitamin B_6	EAR	Plasma 5'-pyridoxal phosphate value of at least 20 nmol/L	Sensory neuropathy

	Reference Standard	Criterion used to set EER, EAR or AI in adults	Adverse effect used to set UL[1,2] in adults
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)
Pantothenic Acid	AI	Pantothenic acid intake sufficient to replace urinary excretion	N/A
Vitamin B_{12}	EAR	Maintenance of hematological status and normal serum vitamin B_{12} values	N/A
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
Vitamin C	EAR	Near-maximal neutrophil ascorbate concentration with minimal urinary ascorbate excretion (to provide antioxidant protection)	Osmotic diarrhea
Vitamin D	AI	Serum 25(OH)D levels	Hypercalcemia
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 α-tocopherol obtained from supplements and/or fortified foods)
Vitamin K	AI	Dietary intake of healthy individuals	N/A
Calcium	AI	Desirable calcium retention/ calcium balance	Milk-alkali syndrome
Chromium	AI	Estimated mean intakes based on chromium content of 'balanced diets' per 1,000 kcal, and average energy intake	N/A
Copper	EAR	Plasma copper, serum ceruoplasmin, platelet copper, and red cell superoxide dismutase activity	Liver damage
Fluoride	AI	Caries prevention	Skeletal fluorosis
Iodine	EAR	Thyroid iodine accumulation and turnover	Serum thyrotropin concentrations

	Reference Standard	Criterion used to set EER, EAR or AI in adults	Adverse effect used to set UL[1,2] in adults
Iron	EAR	Factorial modelling to replace losses and to allow for growth	Gastrointestinal distress
Magnesium	EAR	Magnesium balance	Diarrhea (UL applies only to supplemental magnesium)
Manganese	AI	Median intakes from the US Food and Drug Administration Total Diet Study	Manganese neurotoxicity
Molybdenum	EAR	Molybdenum balance	Impaired reproduction and growth in animals
Phosphorus	EAR	Serum inorganic phosphorus concentration	Elevated serum inorganic phosphorus concentration
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)
Zinc	EAR	Factorial analysis of zinc losses and needs for growth	Reduced copper status (reduced red blood cell copper-zinc superoxide dismutase activity)

[1] Unless otherwise specified, the UL represents total intake from food, water, and supplements.

[2] Due to the lack of suitable data, ULs could not be established for several nutrients, indicated by (N/A). In the absence of a UL, extra caution may be warranted in consuming intakes above recommended levels.

Sources: IOM, 1997, 1998a, 2000a, 2000b, 2002, 2004, 2005

Notes

Appendix 3: The Probability Method for Assessing Group Prevalence of Inadequacy

In population nutrition surveys such as the CCHS 2.2, 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 2.2.1). 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 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 it would be classified as inadequate, whereas another man with a usual nutrient intake of 9 mg/d

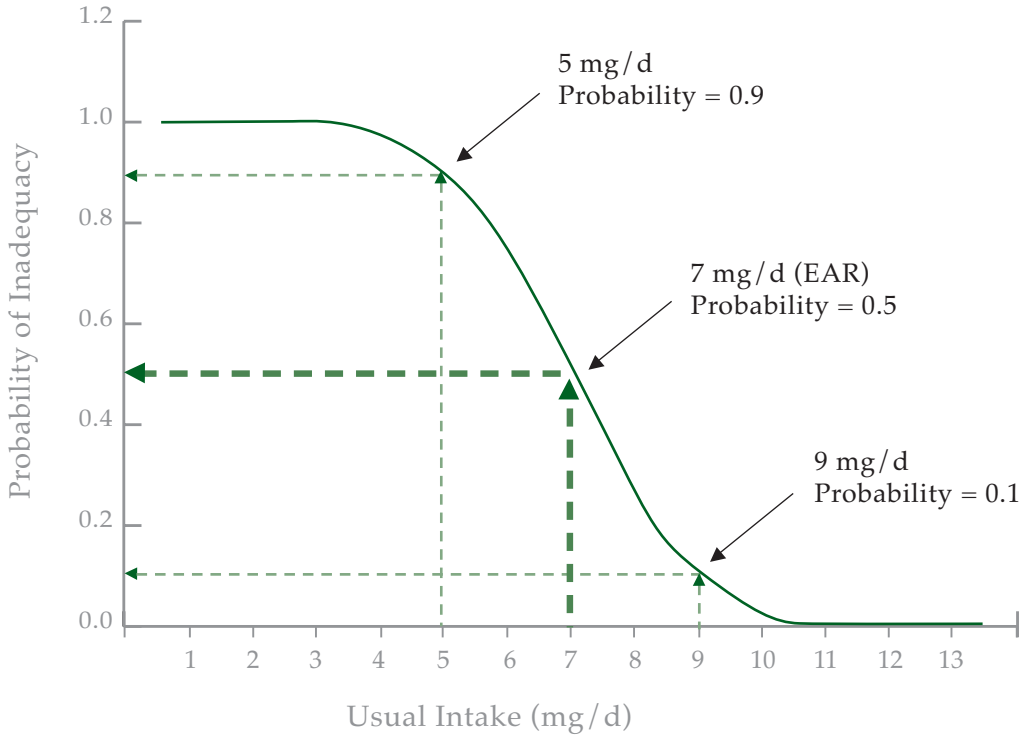
and a requirement of 5 mg/d would exceed his requirement. In practice, however, we almost never know individuals' nutrient requirements. Instead, we may have information on the *distribution of requirements* for a small group of individuals who are similar in age and sex, and who took part in studies 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 A3.1 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.

- 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 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 0, meaning that virtually everyone with a usual intake in this range would meet his or her 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).

Figure A3.1 **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.



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 A3.2 and Table A3.1 illustrate this approach. Figure A3.2 shows the risk curve from Figure A3.1, 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 A3.2, 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 an inadequate intake, one would expect the intakes of 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 the intakes of 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 A3.2 **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.

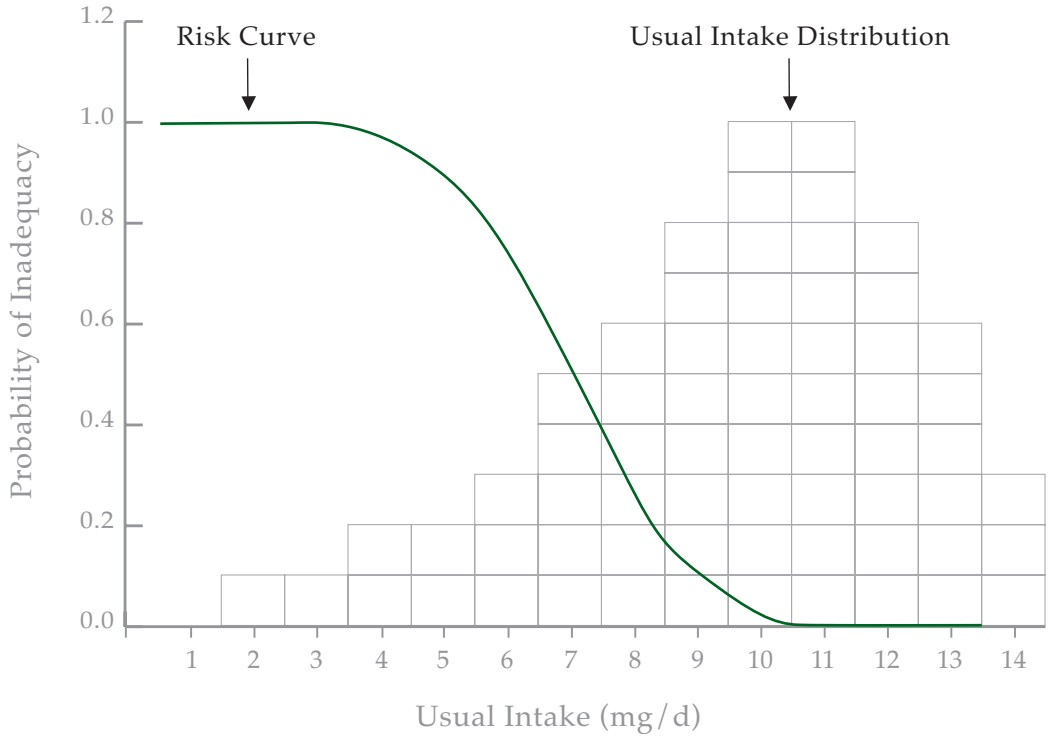


Table A3.1 Example of estimating group prevalence of inadequacy using the probability method

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 = Total (probability x number) / Total number of people = 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.

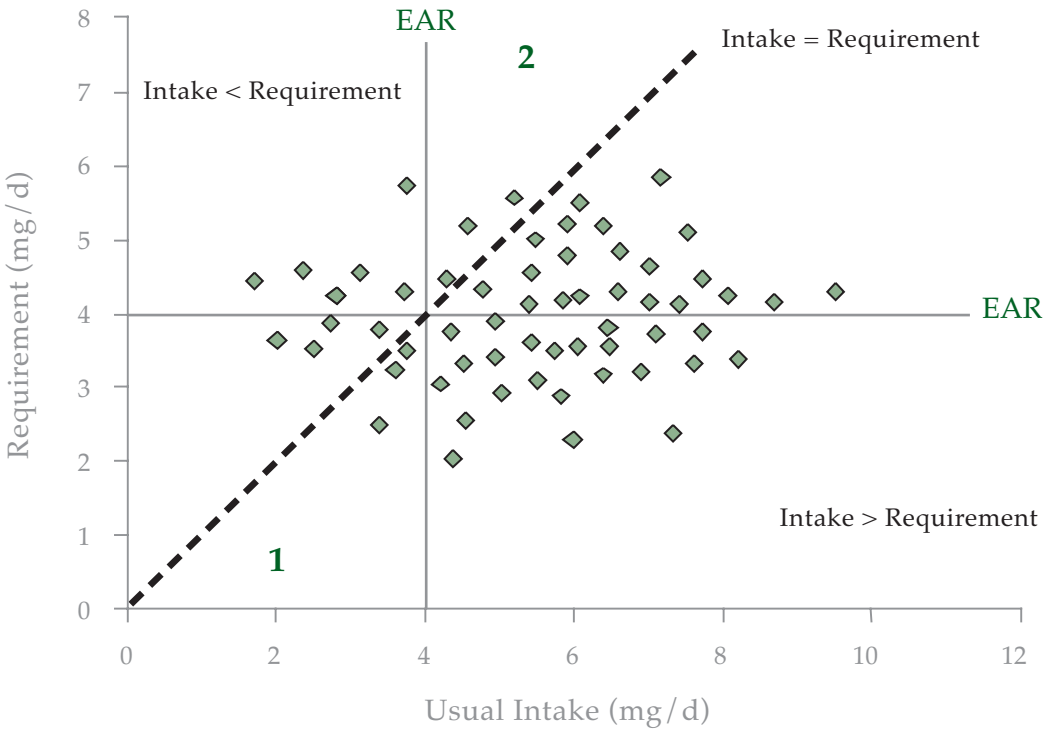
When the conditions outlined above are satisfied, the proportion of the group with intakes below the EAR will approximate the prevalence of inadequacy in the group as determined by the full probability method. The reason this occurs can be described as follows:

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 A3.3. 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 A3.3 **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. 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. ***The requirement distribution is approximately symmetrical.*** In Figure A3.3, 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 A3.1, 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 require 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.

Notes

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