

Summary

This report is one of a series designed to provide guidance on the interpretation and uses of Dietary Reference Intakes (DRIs). The term *Dietary Reference Intakes* is relatively new to the field of nutrition and refers to a set of four nutrient-based reference values that can be used for assessing and planning diets and for many other purposes. Specifically, this report provides guidance to nutrition and health professionals for applications of the DRIs in dietary *assessment* of individuals and groups. It also demonstrates that these uses of the DRIs are based on what is reasonable from a statistical as well as nutritional point of view. The report encourages nutritional evaluation from a quantitative perspective and in this regard follows the 1986 National Research Council report on nutrient adequacy by providing the theoretical underpinnings of the various methods discussed. The report emphasizes that dietary assessment of either groups or individuals must be based on an estimate of usual (long-term) intake. In a departure from many of the more traditional analyses, the use of standard deviations to estimate uncertainty is emphasized. It is hoped that this use of standard deviations of estimates of usual intake, nutrient inadequacy, nutrient requirements, or any other parameter of interest will become the norm in nutritional analyses.

Throughout this report the Subcommittee on Interpretation and Uses of Dietary Reference Intakes distinguishes between methods of evaluating the nutrient intakes of individuals (Chapter 3), and methods for evaluating the intakes of groups (Chapters 4–7), as these are two very different applications. A subsequent report will

address appropriate uses of the DRIs for *planning* diets of groups and individuals.

THE CONCEPT OF DIETARY REFERENCE STANDARDS

In 1941, the Food and Nutrition Board first proposed the Recommended Dietary Allowance (RDA) for the U.S. population “to serve as a goal for good nutrition and as a ‘yardstick’ by which to measure progress toward that goal...” (NRC, 1941, p. 1). Even today, the many specific uses and applications of dietary reference standards fall into the two general categories defined implicitly in 1941: diet assessment and planning. Diet assessment applications involve determining the probable adequacy or inadequacy of observed intakes (a yardstick by which to measure progress). Diet planning applications involve using dietary reference standards to develop recommendations for what food intakes should be (as a goal for good nutrition). Obviously, these two general applications are interrelated.

The first dietary standards in Canada were issued by the Canadian Council on Nutrition in 1938. At the time it was stated that the standards were to be used as the basis for evaluating observed diets. In 1942, rather than revise the 1938 standards, the Canadian Council on Nutrition recommended that the 1941 RDAs be applied in Canada. However, by 1945 differences in the approach of the Canadian Daily Recommended Nutrient Intakes (DRNIs) and U.S. standards had become evident. The differences were conceptual and related to the application of the standards to individuals versus application to groups.

The most recent versions of the Canadian (now shortened to Recommended Nutrient Intakes [RNIs]) (Health and Welfare Canada, 1990) and U.S. (NRC, 1989) standards did not differ in the described derivations of the recommended intakes but some differences remained in how intended uses were described.

WHAT ARE DIETARY REFERENCE INTAKES?

The new Dietary Reference Intakes (DRIs) differ from the former Recommended Dietary Allowances (RDAs) and Recommended Nutrient Intakes (RNIs) conceptually. These differences are that: (1) where specific data on safety and efficacy exist, reduction in the risk of chronic degenerative disease is included in the formulation of the recommendation rather than just the absence of signs of deficiency; (2) upper levels of intake are established where data exist regarding risk of adverse health effects; and (3) components

of food that may not meet the traditional concept of a nutrient but are of possible benefit to health will be reviewed, and if sufficient data exist, reference intakes will be established.

Where adequate information is available, each nutrient has a set of DRIs. A nutrient has either an Estimated Average Requirement (EAR) and an RDA, or an Adequate Intake (AI). When an EAR for the nutrient cannot be determined (and therefore, neither can the RDA), then an AI is set for the nutrient. In addition, many nutrients have a Tolerable Upper Intake Level (UL). A brief definition of each of the DRIs is presented in Box S-1.

Like the former RDAs and RNIs, each DRI refers to the average daily nutrient intake of apparently healthy individuals over time. The amount of intake may vary substantially from day to day without ill effect in most cases.

The chosen criterion of nutritional adequacy or adverse effect on which the DRI is based is different for each nutrient and is identified in the DRI nutrient reports. In some cases the criterion for a nutrient may differ for individuals at different life stages. In developing recommendations, emphasis is placed on the reasons underlying the particular criterion of adequacy used to establish the requirement for each nutrient. This requirement is typically presented as a single number for various life stage and gender groups rather than as multiple endpoints even if the criterion of adequacy for the end-

Box S-1 Dietary Reference Intakes

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 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): a 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 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 increases.

point differs. A more detailed discussion of the origin and framework of the DRIs is presented in Appendix A. Recommended intakes for the nutrients examined to date are presented at the end of this book.

The introduction of multiple dietary reference intakes—the EAR, RDA, AI, and UL—requires that applications for each be carefully developed and clearly explained. Box S-2 provides a brief introduction to appropriate uses of the DRIs for assessment, but it lacks the detail needed for their application (see Chapters 3–7).

Various professionals applying the former RDAs and RNIs—nutrition researchers, policy makers, nutrition educators, epidemiologists, and many others—may need guidance in using and interpreting

Box S-2 Uses of DRIs for Assessing Intakes of Individuals and Groups

For an Individual

EAR: use to examine the probability that usual intake is inadequate.

RDA: usual intake at or above this level has a low probability of inadequacy.

AI: usual intake at or above this level has a low probability of inadequacy.

UL: usual intake above this level may place an individual at risk of adverse effects from excessive nutrient intake.

EAR = Estimated Average Requirement
RDA = Recommended Dietary Allowance
AI = Adequate Intake
UL = Tolerable Upper Intake Level

For a Group

EAR: use to estimate the prevalence of inadequate intakes within a group.

RDA: do not use to assess intakes of groups.

AI: mean usual intake at or above this level implies a low prevalence of inadequate intakes.^a

UL: use to estimate the percentage of the population at potential risk of adverse effects from excessive nutrient intake.

^aWhen the AI for a nutrient is not based on mean intakes of healthy populations, this assessment is made with less confidence.

the new DRI values. This report is aimed at meeting this need as well as providing the theoretical background and statistical justification for application of the DRIs in the area of dietary assessment.

USING DRIs TO ASSESS NUTRIENT INTAKES OF INDIVIDUALS

It can be appropriate to compare intakes of individuals with specific Dietary Reference Intakes (DRIs), even though dietary intake data alone cannot be used to ascertain an individual's nutritional status. Dietary assessment is one component of a nutritional status assessment, provided that accurate dietary intake data are collected, the correct DRI is selected for the assessment, and the results are interpreted appropriately. Ideally, intake data are combined with clinical, biochemical, and anthropometric information to provide a valid assessment of an individual's nutritional status.

Using the EAR to Assess Individuals

Assessing individual diets for apparent nutrient adequacy addresses the following question, Given an individual's observed intakes on a small number of days, is that individual's usual nutrient intake adequate or not? Comparing an individual's intake to his or her requirement for a nutrient is difficult because: (1) a given individual's actual *requirement* is not known; and (2) it is seldom possible to measure an individual's long-term *usual intake* of the nutrient due to day-to-day variation in intake and intake measurement errors. Theoretically, the probability of inadequacy can be calculated for an individual's usual nutrient intake using the EAR and standard deviation of requirement. However, since an individual's usual intake is almost never known, a statistical approach is suggested in Chapter 3 and Appendix B that allows an evaluation of *observed intake* and an estimation of the confidence one has that usual intake is above (or below) an individual's requirement, based on the observed intake. This approach is based on the following assumptions:

- The Estimated Average Requirement (EAR) is the best estimate of an individual's requirement.
- There is person-to-person variation in the requirement. The standard deviation of the requirement is an indicator of how much the individual's requirement for a nutrient can deviate from the median requirement (EAR) in the population.
- Mean observed intake of an individual is the best estimate of an

individual's usual intake.

- There is day-to-day variation in intake for an individual. The within-person standard deviation of intakes is an indicator of how much observed intake may deviate from usual intake.

Inferences about the adequacy of an individual's diet can be made by looking at the difference between observed intake and the median requirement. If this difference is large and positive, that is, if observed intake is much greater than the median requirement, then it is likely that an individual's intake is adequate. Conversely, if the difference is large and negative, that is, observed intake is much less than the median requirement, then it is likely that an individual's intake is not adequate. In between there is considerable uncertainty about the adequacy of the individual's intake.

For practical purposes, many users of the DRIs may find it useful to consider that observed intakes below the EAR very likely need to be improved (because the probability of adequacy is 50 percent or less), and those between the EAR and the Recommended Dietary Allowance (RDA) probably need to be improved (because the probability of adequacy is less than 97 to 98 percent). Only if intakes have been observed for a large number of days and are at or above the RDA, or observed intakes for fewer days are well above the RDA, should one have a high level of confidence that the intake is adequate. It is hoped that computer software will be developed that will determine these probabilities (as described in Appendix B), thus offering more objective alternatives when individual intakes are evaluated.

Using the AI to Assess Individuals

Some nutrients have an Adequate Intake (AI) because the evidence was not sufficient to establish an EAR and thus an RDA for the nutrient in question. The approach described above for the EAR cannot be used for nutrients that have an AI. However, a statistically based hypothesis testing procedure for comparing observed intake to the AI may be used. This is a simple *z*-test, which is constructed using the standard deviation of daily intake of the nutrient.

What conclusions can be drawn about the adequacy of individual intakes for nutrients with AIs? First, if an individual's usual intake equals or exceeds the AI, it can be concluded that the diet is almost certainly adequate. If, however, their intake falls below the AI, no quantitative (or qualitative) estimate can be made of the probability of nutrient inadequacy. Professional judgment, based on additional

types of information about the individual, should be exercised when interpreting intakes below the AI.

Using the UL to Assess Individuals

Assessing individual diets for risk of adverse effects from excessive intake addresses the question, Given an individual's observed intake on a small number of days, is that individual's usual nutrient intake so high that it poses a risk of adverse health effects? The answer is obtained by comparing usual intake to the Tolerable Upper Intake Level (UL). A hypothesis test similar to the one proposed above for the AI can be used to decide whether usual intake is below the UL. For some nutrients, the intake to be considered is from supplements, fortificants, and medications only, while for other nutrients one may need to consider intake from food as well.

The UL is set at the highest level that is likely to pose no risk of adverse health effects for almost all individuals in the general population, including sensitive individuals; but it is not possible to know who is most sensitive. If usual intake exceeds the UL, it may pose a risk for some healthy individuals. The consequences of nutrient excess are much more severe for some nutrients than for others, and for some nutrients the consequences may be irreversible.

The Bottom Line: Assessing Individual Diets

In all cases the individual's true requirement and usual intake can only be approximated. Thus, assessment of dietary adequacy for an individual is imprecise and must be interpreted cautiously in combination with other types of information about the individual.

USING DRIs TO ASSESS NUTRIENT INTAKES OF GROUPS

What proportion of the group has a usual intake of a nutrient that is less than their requirement for the same nutrient? This is one of the most basic questions that can be asked about nutritional needs of a group, and is critically important from a public health perspective. Clearly, the implications are different if 30 versus 3 percent of individuals are estimated to be inadequate. Another basic question is, What proportion of the group has a usual intake of a nutrient so high that it places them at risk of adverse health effects?

The assessment of intake of groups requires obtaining accurate data on intake, selecting the appropriate Dietary Reference Intakes (DRIs), adjusting intake distributions for within-person variability

and survey-related effects, and interpreting the results appropriately. Assessment of groups for the adequacy of intake also involves choosing between two methods: (1) the probability approach or (2) the Estimated Average Requirement (EAR) cut-point method. Both are presented in detail in Chapter 4.

Individuals in a group vary both in the amounts of a nutrient they consume and in their requirements for the nutrient. If information were available on both the usual intakes and the requirements of all individuals in a group, determining the proportion of the group with intakes less than their requirements would be straightforward. One would simply observe how many individuals had inadequate intakes. Unfortunately, collecting such data is impractical. Therefore, rather than actually observing prevalence of inadequate intakes in the group, it can only be approximated by using other methods.

Using the EAR to Assess Groups

Regardless of the method chosen to actually estimate the prevalence of inadequacy, the EAR is the appropriate DRI to use when assessing the adequacy of group intakes. To demonstrate the pivotal importance of the EAR in assessing groups, the probability approach and the EAR cut-point method are described briefly below.

The Probability Approach

The probability approach is a statistical method that combines the distributions of requirements and intakes in the group to produce an estimate of the expected proportion of individuals at risk for inadequacy (NRC, 1986). For this method to perform well, little or no correlation should exist between intakes and requirements in the group. The concept is simple: at very low intakes the risk of inadequacy is high, whereas at very high intakes the risk of inadequacy is negligible. In fact, with information about the distribution of requirements in the group (median, variance, and shape), a value for risk of inadequacy can be attached to each intake level. Because there is a range of usual intakes in a group, the prevalence of inadequacy—the average group risk—is estimated as the weighted average of the risks at each possible intake level. Thus, the probability approach combines the two distributions: the requirement distribution which provides the risk of inadequacy at each intake level, and the usual intake distribution which provides the intake levels for the group and the frequency of each.

To compute the risk to attach to each intake level, one needs to know the EAR (the median) of the requirement distribution as well as its variance and its shape. Without an EAR, the probability approach cannot be used to estimate the prevalence of inadequacy.

The EAR Cut-Point Method

With some additional assumptions, a simpler version of the probability approach can be applied with essentially the same success. The EAR cut-point method can be used if no correlation exists between intakes and requirements (as in the probability approach above), if the distribution of requirements can be assumed to be symmetrical around the EAR, and if the variance of intakes is greater than the variance of requirements. Table S-1 indicates whether these conditions have been met for nutrients for which DRIs have been determined at the time of publication.

The EAR cut-point method is simpler because rather than estimating the risk of inadequacy for each individual's intake level, one simply counts how many individuals in the group of interest have usual intakes that are below the EAR. That proportion is the estimate of the proportion of individuals in the group with inadequate intakes. (For a theoretical justification of this simplified cut-point method, see Chapter 4 or Appendixes C and D.)

Adjusting Intake Distributions

Regardless of the method chosen to assess prevalence of inadequate nutrient intakes in a group of individuals, information is required about the distribution of usual intakes of the nutrient in the group. The distribution of those usual intakes in the group is referred to as the *usual intake distribution* or the *adjusted intake distribution*. Adjustments to the distribution of observed intakes are needed to partially remove the day-to-day variability in intakes (within-person variation). The resulting estimated usual intake distribution of a dietary component should then better reflect the individual-to-individual variation of intakes of that component within the group.

Usual intake distributions can be estimated by statistically adjusting the distribution of intake of each individual in the group. This general approach was proposed by NRC (1986) and was further developed by Nusser et al. (1996). To adjust intake distributions, it is necessary to have at least two independent days of dietary intake data for a representative subsample of individuals in the group (or at least three days when data are collected over consecutive days).

TABLE S-1 Summary of Dietary Reference Intakes (DRIs) for Nutrients and Assumptions Necessary to Apply the Estimated Average Requirement (EAR) Cut-Point Method for Assessing the Prevalence of Inadequacy for Groups

Nutrient	Established DRIs ^a				Meets the Requirement if Variance of Intake is Greater than Variance of Requirement
	EAR	RDA	AI	UL	
Magnesium	+	+		+	Yes
Phosphorus	+	+		+	Yes
Selenium	+	+		+	Yes
Thiamin	+	+			Yes
Riboflavin	+	+			Yes
Niacin	+	+		+	Yes
Vitamin B ₆	+	+		+	Yes
Folate	+	+		+	Yes
Vitamin B ₁₂	+	+			Yes
Vitamin C	+	+		+	Yes
Vitamin E	+	+		+	Yes
Calcium			+	+	
Fluoride			+	+	
Biotin			+		
Choline			+	+	
Vitamin D			+	+	
Pantothenic Acid			+		

^a RDA = Recommended Dietary Allowance; AI = Adequate Intake, cannot be used with the cut-point method; UL = Tolerable Upper Intake Level.

^b Due to little information on the variance of requirements, published DRIs have assumed a coefficient of variation (CV) of 10 percent unless data for a specific nutrient demonstrate a greater variability. Variance of intake, as calculated from the 1994–1996

If intake distributions are not properly adjusted both for within-person variation and survey-related effects such as interview method and interview sequence, the prevalence of nutrient inadequacy will be incorrectly estimated no matter which of the methods discussed earlier is chosen. If only one day of intake data is available for each individual in the sample, it may still be possible to adjust the observed intake distribution by using an estimate of within-person variation in intakes estimated from other data sets.

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Meets the Assumptions of the Cut-Point Method

Variance of Intake is Greater than Variance of Requirement ^b	Requirement Distributions Symmetrical ^c	Intake and Requirement Independent or Have Low Correlation	Coefficient of Variance of the Requirement Estimate ^d (%)
Yes	Assumed	Yes	10
Yes	Assumed	Yes	10
Yes	Assumed	Yes	10
Yes	Assumed	Yes	10
Yes	Assumed	Yes	10
Yes	Assumed	Yes	15
Yes	Assumed	Yes	10
Yes	Assumed	Yes	10
Yes	Assumed	Yes	10
Yes	Assumed	Yes	10
Yes	Assumed	Yes	10

Continuing Survey of Food Intake by Individuals, indicates that for all nutrients intake variance is well above the assumed requirement variance.

^cData to determine the shape of requirement distributions are lacking for most nutrients; therefore, symmetry is assumed unless there are adequate data indicating otherwise.

^dThe CV of the requirement estimate is needed for the probability approach.

Using the RDA Is Inappropriate for Assessing Groups

The Recommended Dietary Allowance (RDA), by definition, is an intake level that exceeds the requirements of 97 to 98 percent of all individuals when requirements in the group have a normal distribution. Thus, the RDA should not be used as a cut-point for assessing nutrient intakes of groups because a serious overestimation of the proportion of the group at risk of inadequacy would result.

Using the Mean Intake Is Inappropriate for Assessing Groups

Mean or median intake seldom, if ever, can be used to assess nutrient adequacy of group diets. In the past, nutrient intake data have frequently been evaluated by comparing mean intakes with RDAs. In particular, studies that found mean intakes equal to or exceeding the RDA often concluded that group diets were adequate and conformed to recognized nutritional standards. However, this is inappropriate because the prevalence of inadequacy depends on the shape and variation of the usual intake distribution, not on mean intake. Indeed, for most nutrients, group mean intake must exceed the RDA for there to be an acceptably low prevalence of inadequate intakes. Moreover, the greater the variability in usual intake relative to the variability in requirement, the greater the mean usual intake must be relative to the RDA to ensure that only a small proportion of the group has inadequate intake. If group mean intake equals the RDA, there will be a substantial proportion of the group with usual intake less than requirement. Chapter 4 provides more detail on issues related to comparing mean intakes to the DRIs. Even stronger caution is needed when comparing group mean intakes with the EAR. If mean intake equals the EAR, it is likely that a very high proportion of the population will have inadequate usual intake. In fact, roughly half of the population is expected to have intakes less than their requirement (except for energy).

Using the AI to Assess Groups

When the AI represents the group mean intake of an apparently healthy group (or groups) of people, similar groups with mean intakes at or above the AI can be assumed to have a low prevalence of inadequate intakes for the defined criteria of nutritional status. For AIs that were either experimentally derived or developed from a combination of experimental and intake data, a similar assessment can be made, but with less confidence. Each AI is described in terms of its derivation and selected criterion of adequacy in the individual nutrient panel reports (IOM, 1997, 1998b, 2000). When mean intakes of groups are below the AI it is not possible to make any assumptions about the extent of intake inadequacy. It is not appropriate to try to estimate an EAR from an AI.

Using the UL to Assess Groups

The Tolerable Upper Intake Level (UL) is the appropriate DRI to use to assess the risk of adverse health effects from excessive nutrient intake. As intake increases above the UL, the potential for risk of adverse health effects increases.

Depending on the nutrient, the UL assessment requires accurate information on usual daily intake from all sources, or from supplements, fortificants, and medications only. Usual intake distributions will allow determination of the fraction of the population exceeding the UL. This fraction may be at risk of adverse health effects.

Difficulties arise in attempts to quantify the risk (likelihood) of adverse health effects in the general population from daily nutrient intakes exceeding the UL. The use of uncertainty factors to arrive at the UL reflects inaccuracies in reported nutrient intake data, uncertainties in the dose-response data on adverse health effects, extrapolation of data from animal experiments, severity of the adverse effect, and variation in individual susceptibility. As more accurate data from human studies become available, predicting the magnitude of the risk associated with intakes exceeding the UL may become possible. For now it is advisable to use the UL as a cutoff for safe intake.

Applications in Group Assessment

The evaluation of dietary survey data merits special attention. This includes three major components: describing the dietary survey data, estimating the prevalence of inadequate or excessive intake, and evaluating differences among subgroups in intake. These applications are discussed in Chapter 7 and summarized in Table S-2.

Bottom Line: Assessing Group Intakes

Dietary assessment at the group level typically involves comparing usual nutrient intakes with nutrient requirements to assess the prevalence of nutrient inadequacy. The preferred outcome measure used to assess the prevalence of inadequate nutrient intake is the percentage of a group with usual intake less than the EAR. For nutrients with an AI, the best that can be done is to look at mean and median intake relative to the AI. However, when mean intakes of groups are less than the AI, nothing can be inferred about the prevalence of inadequacy. To estimate the proportion of the population at risk of excessive intake, the outcome measure is the per-

TABLE S-2 Applications: Evaluating Dietary Survey Data

Measures	Nutrients	Comments
<i>What are the characteristics of the distribution of usual nutrient intake?</i>		
Mean usual nutrient intake	All nutrients under consideration	Mean nu
Median usual nutrient intake		
Percentiles of usual nutrient intake distribution		
<i>What proportion of the population has inadequate usual nutrient intake?</i>		
Percentage with usual intake less than the Estimated Average Requirement (EAR)	Vitamins: thiamin, riboflavin, niacin, B ₆ , folate, B ₁₂ , C, and E Elements: phosphorus, magnesium, selenium	This mea intake This mea and ch
<i>What proportion of the population is at potential risk of adverse effects?</i>		
Percentage with usual intake greater than the Tolerable Upper Intake Level (UL)	Vitamins: niacin, B ₆ , folate, choline, C, D, and E Elements: calcium, phosphorus, magnesium, fluoride, selenium	There cu and bi adverse
<i>Are there differences in nutrient intakes and differences in nutrient adequacy for different subgroups of the population?</i>		
Mean usual nutrient intake for subgroups	All nutrients under consideration	Conduct adjuste
Median usual nutrient intake for subgroups		Regressio adequa
Percentiles of the usual nutrient intake distribution for subgroups		
Percentage with usual intake less than the EAR for subgroups	Vitamins: thiamin, riboflavin, niacin, B ₆ , folate, B ₁₂ , C, and E Elements: phosphorus, magnesium, selenium	Statistica subgro This mea intake This mea acid, b
Percentage with usual intake greater than the UL for subgroups	Vitamins: niacin, B ₆ , folate, choline, C, D, and E Elements: calcium, phosphorus, magnesium, fluoride, selenium	Statistica subgro This mea (thiam

 Comments

Mean nutrient intake should not be used to assess nutrient adequacy

This measure is not appropriate for food energy, given the correlation between intake and requirement

This measure is not appropriate for calcium, vitamin D, pantothenic acid, biotin, and choline, since they currently do not have an EAR

There currently is no UL for thiamin, riboflavin, vitamin B₁₂, pantothenic acid, and biotin, thus no conclusion can be drawn regarding potential risk of adverse effects.

Conduct multiple regression analyses of nutrient intakes; compare regression-adjusted mean intake for the different subgroups

Regression-adjusted mean nutrient intake should not be used to assess nutrient adequacy

Statistical tests of significance can be used to determine if the differences across subgroups in percentages less than the EAR are statistically significant

This measure is not appropriate for food energy, given the correlation between intake and requirement

This measure is not appropriate for calcium, vitamin D, fluoride, pantothenic acid, biotin, and choline, since they currently do not have an EAR

Statistical tests of significance can be used to determine if the differences across subgroups in percentages greater than the UL are statistically significant

This measure is not appropriate for nutrients for which a UL has not been set (thiamin, riboflavin, vitamin B₁₂, pantothenic acid, and biotin)

centage of the population or group with usual intakes exceeding the UL.

MINIMIZING POTENTIAL ERRORS IN ASSESSING INTAKES

Users of the Dietary Reference Intakes (DRIs) have many opportunities to increase the accuracy of dietary assessments by ensuring that the dietary data are complete, portions are correctly specified, and food composition data are accurate, and by selecting appropriate methodologies and plans for sampling group intakes.

When assessing the dietary adequacy of populations, having accurate information on the distribution of usual (habitual) intakes based on accurate and quantitative food intake information for each individual is necessary. Thus, the use of semi-quantitative food-frequency questionnaires is seldom appropriate for assessing the adequacy of dietary intake of groups.

Physiological measures are helpful when assessing the dietary status of individuals or of groups of people. They can be used to supplement or confirm estimates of inadequacy based on dietary data.

Despite the occurrence of unavoidable errors, it is worthwhile to compare high-quality intake data with accurate requirement data for assessing intakes. At a minimum, such a comparison identifies nutrients likely to be either under- or overconsumed by the individual or the group of interest.

RECOMMENDATIONS FOR RESEARCH TO ENHANCE USE OF THE DRIs

In several parts of this report, only some very general guidelines for applying the Dietary Reference Intakes (DRIs) in dietary assessment are provided. It became clear during development of the report that much research is still needed in this area. By highlighting these areas, it is hoped that there will be a greater chance that research on these topics will be undertaken.

The topics given below are not necessarily in order of priority. Increased knowledge in any of the areas listed would be beneficial in enhancing use of the DRIs for dietary assessment.

Research to Improve Estimates of Nutrient Requirements

Even for nutrients for which an Estimated Average Requirement (EAR) is available, the EARs and Recommended Dietary Allowances (RDAs) are often based on just a few experiments with very small

sample sizes. For nutrients with an Adequate Intake (AI) for age groups older than infants, new research and data that allow replacement of the AIs with EARs and RDAs will greatly aid the assessment of nutrient adequacy. In addition, information on the distribution of requirements is needed so that the appropriate method for assessing the prevalence of inadequacy for groups can be determined (EAR cut-point method vs. full probability approach).

Research should be undertaken to allow Tolerable Upper Intake Levels (ULs) to be set for all nutrients and to generate information on ways to identify and conceptualize the risk of exceeding the UL.

Research to Improve the Quality of Dietary Intake Data

The estimation and amelioration of bias (such as under- or over-reporting of food intake) is a relatively unexplored field. Efforts in the management of bias during data analysis are very preliminary and far from satisfactory at present. This is seen as a high priority area waiting for new initiatives and innovative approaches.

Advances in behavioral research to determine why people under-report food intake would allow development of improved dietary data collection tools that would not trigger this behavior. Such information would also help in the derivation of statistical tools to correct the bias associated with this phenomenon.

Better ways to quantify the intake of supplements are needed. A large proportion of the population in the United States and Canada consumes dietary supplements. Using intakes only from food sources in dietary assessment is certain to result in a faulty estimate of nutrient inadequacy, as well as inaccurate estimates of the percentage of the population with intakes above the UL.

Food composition databases will need to be updated to include the forms and units that are specified by the DRIs. Chemical methodology to facilitate analysis of various forms of certain nutrients (e.g., α -tocopherol vs. γ -tocopherol) may be required for comparison to the DRIs.

Research to Improve Statistical Methods for Using DRIs to Assess Intakes of Groups

Methods for developing standard errors for prevalence estimates should be investigated. Some sources of variance (primarily associated with intake data) can currently be quantified but many (such as those associated with requirement estimates) cannot. Without a standard error estimate, it is not possible to determine if an esti-

mated prevalence of X percent is significantly different from zero or if prevalence estimates for two groups of individuals differ significantly from each other or from zero.

Additional research is needed for applications that assess the nutrient intakes of different subgroups of the population. In particular, further research is needed to apply the methods included in this report to estimate differences in the prevalence of inadequacy between subgroups after controlling for other factors that affect nutrient intake.

Ways to assess the performance of methods to estimate prevalence of inadequacy should be investigated. A detailed investigation of the effect of violating assumptions for the EAR cut-point method discussed in this report is a high research priority. This would best be done using well-designed, well-planned, and well-implemented simulation studies. Results of such studies would permit identification of recommendations as to the best approach to be used in assessments for each nutrient and would provide an estimate of the expected bias in prevalence estimates when the conditions for application of the cut-point method are not ideal.