
NUTRIENT ADEQUACY

Assessment Using
Food Consumption
Surveys

Subcommittee on Criteria for Dietary Evaluation
Coordinating Committee on Evaluation of
Food Consumption Surveys
Food and Nutrition Board
Commission on Life Sciences
National Research Council

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Preface

At the request of the U.S. Department of Agriculture (USDA), the National Research Council undertook a study of the criteria used to evaluate data on dietary intake. This study was performed by a subcommittee of the Coordinating Committee on Evaluation of Food Consumption Surveys. In January 1984, the subcommittee was formed to develop criteria for the use of survey data in the evaluation of dietary adequacy, paying particular attention to applications to data from the Nationwide Food Consumption Survey. During the course of its study, the subcommittee examined information on levels and variability of human nutrient requirements, survey methodology, and the reliability of food composition data.

Estimates of the proportion of the population with inadequate dietary intake have provided the impetus for food assistance programs and other efforts to improve the diet of the U.S. public. Increasingly, policymakers, scientists, and others interested in health maintenance recognize the need to improve the utilization of data on dietary intake and other information to monitor the U.S. population's nutritional status.

The proportion of the population at risk for inadequate nutrient intake can be estimated from survey data on dietary intake, even though the nutritional status of individuals can only be analyzed according to probabilities. The subcommittee in its deliberations developed an approach to dietary analysis that is based on these probabilities and takes into account the inherent variability of nutrient intake by individuals over time and of nutrients in the same foods.

Chapter 1 is a summary of the report. The history of dietary surveys is recounted in Chapter 2 along with a description of the committee's task and its approach to the study. In Chapter 3, the

basis of dietary evaluation and its relationship to the recommended dietary allowances are discussed. The method of estimating usual dietary intake from survey data is described in Chapter 4. In Chapter 5, the recommended approach to dietary analysis is presented with examples. Chapter 6 deals with the application of the method in analysis of excessive intake and the utility of nutrient energy ratios. The impact of technical error on the analysis of dietary intake data is discussed in Chapter 7. Chapter 8 presents the results of confidence interval calculations. Chapter 9 is a summary of the subcommittee's recommendations. Additional details of the analyses described in the text are included in the appendices.

The committee gratefully acknowledges Susan Welsh, Betty Peterkin, and Robert L. Rizek of the USDA Human Nutrition Information Service (HNIS) for their interest and support; Bruce Gray, also of HNIS, for his preliminary analysis of the USDA data set; and Wayne Wolf and Joanne Holden of the Nutrient Composition Laboratory, USDA Beltsville Human Nutrition Center, for the reanalysis of their earlier work.

The subcommittee commends the able and dedicated assistance of the Food and Nutrition Board staff under the direction of Sushma Palmer, including staff officers Stephanie C. Crocco (prior to July 1984) and Virginia Hight Laukaran (beginning August 1984), and senior secretaries Sylvia Glasser and Tujuana M. Albritton. It is also grateful for the editorial assistance of Frances M. Peter and Judith Grumstrup-Scott.

A handwritten signature in dark ink, appearing to read "L. J. Filer, Jr.", with a stylized, cursive script.

L. J. FILER, JR.
Chairman
Subcommittee on Criteria
for Dietary Evaluation

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Executive Summary

Since 1936 the U.S. Department of Agriculture (USDA) has been responsible for conducting periodic surveys of food consumption. Currently, the agency's Nationwide Food Consumption Survey (NFCS), a large study of the food consumption patterns in the United States, includes information on individual dietary intake, which serves as a basis for determining the magnitude of inadequate nutrition in the general population. To ensure that the estimates of inadequacy are based on scientifically valid parameters, the USDA asked the National Research Council to develop criteria for the use of survey data in this effort. As a result of this request, the Subcommittee on Criteria for Dietary Evaluation was formed within the Food and Nutrition Board of the Research Council's Commission on Life Sciences.

The subcommittee was charged by the USDA with establishing criteria reflecting the degree of risk associated with intakes of the following nutrients: ascorbic acid; vitamins A, B₆, and B₁₂; calcium; folacin; iron; magnesium; riboflavin; niacin; phosphorus; thiamin; zinc; food energy; and protein. The agency also requested that criteria be established for the evaluation of the proportion of dietary intake derived from protein, fats, and carbohydrates as well as from total energy (caloric) intake. During the course of its study, the study group examined efforts of the USDA and others in the scientific community to assess the nutrient adequacy of diets in the U.S. population and considered the analytic methods used in the past. Data from the most recent NFCS survey were provided to the subcommittee to permit empirical testing of different approaches for dietary evaluation.

USDA food assistance programs and other nutrition-related projects are based in part on estimates of inadequate nutrient intake derived from the NFCS. These estimates are also of interest to nutrition policymakers outside the USDA, scientists, and others who wish to identify population groups at risk of developing nutrient deficiency and to learn the determinants of unsatisfactory dietary intake for the country as a whole and for specific population groups. Although estimates based on dietary intake data are useful for examining adequacy of nutrient intake in a population or subpopulation, and may be useful in identifying individuals at relative risk of developing nutrient deficiency, they cannot be used alone to determine the nutritional status of individuals or population groups. For these purposes, biomedical and clinical measures are necessary.

The Recommended Dietary Allowances (RDAs) are often used as the basis for determining whether nutrient intake is adequate. They are standards for nutrient intake designed to meet the nutrient needs of virtually all healthy individuals in the United States. Because there is variation in nutrient needs among people despite similar physiological characteristics, margins of safety are built into the RDAs for many nutrients. Therefore, most people who receive less than the RDA for a specific nutrient will nevertheless meet their own nutrient requirement. For a number of years, a fixed cutoff point, such as two-thirds or three-fourths of the RDA, has been used by analysts to estimate the prevalence of inadequate intake for specific nutrients.

The subcommittee considered the merits of this type of analysis and concluded that it may lead to imprecise estimates, partly because it does not consider fully the variability in requirements among individuals. Consequently, some persons who are meeting their nutrient requirement may be judged by this method to have inadequate intake while some with inadequate intake will not be identified. A different approach based on the probability that a specific intake is inadequate to meet an individual's requirement was identified by the subcommittee, and guidelines were developed for interpreting the resulting estimates. Although the new approach is not difficult, it requires some familiarity with basic statistical theory. In this probability approach, estimates of average requirements and variability (i.e., the standard deviation) for

the nutrient are used along with the shape of the distribution (e.g., normal or skewed) as the criteria for judging adequacy of dietary intake. The approach also requires information on the distribution of usual intakes among individuals examined in the survey. Dietary data from the NFCS are derived from interviews to determine the foods respondents have eaten for 3 days. Because the intake of an individual varies over time, it is necessary to adjust the distribution of dietary data in order to estimate the distribution of usual dietary intakes. The subcommittee also recognized that the analysis of nutrient intake adequacy may be constrained by systematic errors such as underreporting or overreporting of food intake and lack of information on the mean and shape of the requirement distribution for many nutrients.

The subcommittee believes that the prevalence of inadequate intake can be estimated for many nutrients and food components by using the probability approach. Empirical tests of the approach were made using intake data for iron, protein, vitamin A, and vitamin C in men and women and for thiamin in men. These data, from the 1977-1978 NFCS, were provided to the subcommittee by the USDA. The probability approach is not indicated for some nutrients, especially energy, as will be discussed below.

The overriding constraints in the application and interpretation of the probability approach are the limitations, validity, and reliability of estimates of mean nutrient requirements and survey data on dietary intake. At present, direct estimates of mean nutrient requirements are not available for most nutrients. Thus, the proposal to undertake probability analysis of dietary intake calls for the assignment of a higher priority to the development of the knowledge base on mean nutrient requirements and to improvement of the data on dietary intake by the collection of least two independent (i.e., nonconsecutive) observations for the same individuals. The subcommittee suggests that priority be assigned to the development of improved estimates of mean nutrient requirement for nutrients that a substantial proportion of the population is consuming at levels less than the RDA.

In the meantime, the subcommittee believes that the use of the probability approach will both stimulate and guide efforts to improve the validity and reliability of nutrient requirement estimates by permitting examination of the

implications of different requirement estimates for a population, given current levels of dietary intake. There is now a need for further empirical testing of the proposed approach to determine the applicability of the method and to establish directions for further research.

MAJOR CONCLUSIONS

- The prevalence of inadequate intake can be estimated for many nutrients by the probability approach described in this report. For others, however, the method cannot be applied until research leads to a better understanding of both the average nutrient requirement and its variability, which are needed in probability analysis, and an improvement in the reliability of food composition data. These estimates are important in identifying determinants of inadequate intake, identifying possible interventions, and designing them for maximal efficiency. They are dependent on more comprehensive surveys to validate dietary analyses through biochemical and clinical measurements, such as are currently done in the National Health and Nutrition Examination Survey (NHANES) of the National Center for Health Statistics (NCHS).

- A basic statistical assumption of independence between requirement and intake is necessary for the probability approach. Thus, this method cannot be used meaningfully when the level of dietary intake and the required intake are correlated, as for dietary energy (calories), which most people in prosperous nations with low requirements consume at low levels. After reviewing the work of Lörstad (1971), however, the subcommittee concluded that this is not a problem.

- There is a need for continuing studies to improve research methods and thus data on dietary intake, which are essential for analysis regardless of the approach used. There is also a need for continuing attention to the validity of food composition data and research to improve such data.

- After examining the methods with which dietary intake data and reference data on the nutrient composition of foods are collected and conducting several types of analysis to determine the impact of random error, error due to the sampling technique, and systematic biases on the estimates of adequacy, the subcommittee concluded that such errors diminish the accuracy but do not necessarily destroy the utility of

estimates of the prevalence of inadequate intake. The subcommittee believes that sensitivity testing is needed to assist in determining which factors have the greatest effect on prevalence estimates and hence should be given priority for research to improve the approach.

MAJOR RECOMMENDATIONS

- Nutrient requirements based on multiple criteria of adequacy should be developed and applied. For a given nutrient, one might focus on the intake adequate to prevent clinical deficiency, to maintain functional integrity of metabolic systems, and to maintain tissue stores. This would permit multitiered population assessments.

If the probability approach is adopted, the following suggestions should be considered when planning for future NFCS surveys:

- Changes may be advisable in the design of food intake data collection. For example, the number of 1-day food intake observations per subject might be reduced; it would be preferable to use the same data collection methods for each day of intake data; and it might be desirable to avoid sampling on adjacent days and to continue to sample on representative days of the week. These changes should be made only after full consideration of all the uses of the data and of the integration of survey planning for all these purposes.

- Methods to reduce, or take into account, respondent or interviewer bias should be developed to improve the accuracy of food intake data.

- Continuing research on food intake methods and the design of sampling strategies is recommended.

- Research should be conducted to determine the magnitude of any correlation between dietary intake and nutrient requirement.

- The subcommittee also recommends a number of actions that should be considered in order to improve the reference tables on nutrient composition of foods. These recommendations, which are presented in Chapter 9, relate to documentation and analysis when data are missing, increases in sam-

ple size for nutrient composition analyses, and improvements in sampling methods.

- The design selected for future surveys should take into account all important uses of the survey data. The subcommittee's attention has been directed to one particular type of use. Other purposes may impose additional design demands on data collection approaches. The subcommittee believes that agencies responsible for the design and conduct of national or regional surveys would benefit from conducting analyses analogous to those discussed in this report, including full statistical consideration of the implication of design decisions on the precision and reliability of data analyses.

- It is imperative that future surveys include questions on intake of dietary supplements as well as of foods.