# Consensus Workshop on Dietary Assessment: Nutrition Monitoring and Tracking the Year 2000 Objectives

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# PREFACE

The purpose of the Consensus Workshop on Dietary Assessment: Nutrition Monitoring and Tracking the Year 2000 Objectives was to develop consensus statements and recommendations on the selection and uses of dietary methods, and interpretation of the data, focusing on data needs for nutrition monitoring and Year 2000 nutrition objectives. Consensus is an ambitious goal, and in many discussions solid and comprehensive consensus was not achieved. There are few disagreements over the optimal methods for dietary assessment in theory, however, the real constraints of resources render the selection of the optimal dietary method uncertain. In spite of the difficulties of discussing the topics in the abstract, participants developed conclusions and recommendations for each topic in the workshop discussions. The recommendations for each topic were finalized and expanded (where necessary to fill in gaps) in order to produce a more comprehensive report. In some cases, additional meetings were held with smaller groups of workshop participants. The participants reviewed iterative drafts of the chapters of the report. The editors gratefully acknowledge the contributions of all of those who participated in the workshop and reviewed drafts of the report. The editors also acknowledge the significant contributions of the authors of the background papers that are included in the report.

Included in this report are the workshop discussions, the recommendations resulting from the workshop, the background papers, and the topics and issues requiring further research. These recommendations serve to improve the direction and comparability of dietary data for national nutrition monitoring and for tracking selected Year 2000 objectives on diet. Further research will provide additional information to build upon the framework of these recommendations to meet future data needs for dietary information. Continued collaboration will improve communication across the various disciplines and Federal agencies working in this area.

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# INTRODUCTION

The Consensus Workshop on Dietary Assessment: Nutrition Monitoring and Tracking the Year 2000 Objectives was held in Richmond, Virginia on February 21-23, 1993. The workshop was sponsored by the National Center for Health Statistics, Centers for Disease Control and Prevention (NCHS/CDC), in collaboration with other Federal agencies, to address dietary assessment methodologies in the National Nutrition Monitoring and Related Research Program (NNMRRP). NCHS has a key role in nutrition monitoring through conducting national surveys of the nutritional and health status of the U.S. population. As part of the Federal government's Ten-Year Comprehensive Plan for the NNMRRP, NCHS also has lead responsibility to develop a core set of standardized nutritional status indicators that are coordinated with those for the Year 2000 objectives, and to develop appropriate interpretive criteria for the general population and subgroups of the population. The standardized assessment of diet, including the development of dietary indicators, is a critical component of this core nutritional status package. In addition, improved coordination and linkage of dietary methods used at the national level to methods used at State and local levels is necessary. Comparable dietary data collection methods are needed for nutrition monitoring and for tracking progress toward reaching certain Year 2000 health objectives at national, State, and local levels. The specific workshop objectives were:

1) To establish consensus on the selection, use, and interpretation of dietary methods used for nutrition monitoring surveys and surveillance systems for the nutrition monitoring objectives addressed at the workshop.

2) To establish dietary methods appropriate for State/local use that are comparable with national dietary methods.

3) To recommend dietary methods for monitoring selected Year 2000 objectives (1):

   *Pertinent Year 2000 objectives:*

   *2.5 dietary fat intake*
   *2.6 fruit and vegetable intake*
   *2.8 calcium intake*
   *4.6, 4.7 alcohol risk reduction*

4) To develop strategies for implementation of the workshop recommendations.

A steering committee was formed to plan the framework and structure of the workshop. The committee was composed of representatives from various Federal agencies that are involved in objectives of the Ten-Year Comprehensive Plan for the NNMRRP which deal with dietary methodology. The following are the specific objectives from the Ten-Year Comprehensive Plan for the NNMRRP that provided the focus for the steering committee (2):

V-A-1.1
Coordinate the planning for coverage, tracking, and reporting of findings from surveys and surveillance systems that collect nutrition and related health data in the NNMRRP to monitor the Year 2000 Health Objectives; coordinate the development of standardized nutrition and related health indicators with those established for the Year 2000 Objectives, as appropriate; release remaining Hispanic HANES nutrition data tapes for public use and publish nutrition-related information from Hispanic HANES.

V-B-2.3
Identify ways to increase comparability within a dietary method such as the 24-hour recall, food record or food frequency, to improve the quality and usefulness of data; and implement recommended changes including food coding, probing techniques, proxy-reporting, and portion size estimation in order to standardize data collection by method.

V-B-2.5
Establish a consensus and biennially publish key standardized dietary status indicators to be included as a part of the NNMRRP surveys that collect food and nutrient consumption data, and implement recommendations in appropriate surveys.

V-C-2.2
Develop and evaluate procedures for determining usual intakes of food and nutrients from surveys employing 24-hour recall measures of dietary intake.

The workshop was attended by 61 participants from universities, industry, State Departments of Health, and Federal agencies involved in the NNMRRP (see Workshop Participants List in Appendix C). The participants represented multiple disciplines including nutrition, epidemiology, cognitive psychology, public health, and statistics. Not only did the participants contribute expertise from their areas of specialty, but also their experience as users or as providers of nutrition monitoring survey data.

The workshop framework was small group discussions followed by large plenary sessions where reports were heard from each of the small groups (see Workshop Agenda in Appendix A). This allowed for unreserved dialogue and detailed exchange of ideas that were then incorporated into the overall discussion. This design enabled the addition of discussions that were not a part of the original agenda.

The workshop began with working group discussions on general issues related to dietary methods in the context of the Nutrition Monitoring Program (NNMRRP). The groups were provided with a framework of questions on dietary assessment to foster discussion and to provide direction. Two particular issues were addressed in "special topic" groups: statistical estimation of usual intake distributions and cognitive aspects of dietary recall. On the second day of the workshop, working group discussions addressed the assessment of intake of specific foods or food components related to the specified Year 2000 objectives.

Background papers were requested from a number of the participants, and served as a springboard for discussions for a number of the working groups. The purpose of these papers was to outline the issues surrounding the topic from the perspective of the author. These papers are included in Section III. Also, Thompson and Byers shared a draft version of the Dietary Assessment Resource Manual (3) with participants. This manual provides an overview of dietary assessment methodologies. A framework of questions related to the different discussion topics was also provided to each group to foster discussion and to provide direction (see Workshop Questions in Appendix B).

In the working group discussions on general issues related to dietary methods, one question addressed the examination of diet-health relationships. Due to time limitations, this topic was discussed in very few of the working groups. However, many participants emphasized the need for a dialogue between representatives from Federal agencies that conduct national nutrition surveys and academic and State researchers who use national survey data. Indeed, Woteki et al. noted the increasing importance of national surveys, such as the NHANES, in analyses of nutritional status and health and disease (4).

Section II, "Review of Brief Indicators of Dietary Status," is a paper that was contracted after the workshop. This paper reviews selected indicators of diet and dietary components including those that were the focus of this workshop: alcohol intake, calcium intake, fat intake, and fruit and vegetable intake. This paper addresses the often-requested need from States and localities for brief methods for assessing dietary status that are less costly than more precise/comprehensive methods.

Finally, the readers should note that since the workshop was held in February, 1993, revisions to the Year 2000 objectives have been proposed which expand upon some of the objectives. Once the revisions are finalized they will be published in 1995. In order to maintain the frame of reference of the workshop, the Year 2000 objectives which were addressed at the workshop are presented without revisions, as they were discussed at the workshop.

The audience for this report is wide-ranging, including those who conduct national surveys and those who use national dietary survey data; those who conduct State or local level surveys, especially if comparison to national data is a goal; and those who use State or local level survey data.

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# SECTION I
# RECOMMENDATIONS FROM WORKING GROUPS

# CHAPTER 1
# DIETARY INTAKE ASSESSMENT OF POPULATIONS

The working group discussions on general issues related to dietary intake assessment revealed common themes or generic "analytic uses" of dietary intake data collected in the nutrition monitoring surveys:

- estimate average food and/or nutrient intake for a population;
- estimate the distribution (percentiles) of food and/or nutrient intake for a population;
- estimate the proportion of a population above or below a recommended level of food and/or nutrient intake;
- determine which population subgroups are above or below recommended levels, or are at "high risk" levels of food and/or nutrient intake;
- determine trends in average food and/or nutrient intake; and
- determine trends in the distributions of food and/or nutrient intake.

These "analytic uses" correspond to some of the "general areas" identified by the ad hoc Expert Panel convened by the Life Sciences Research Office (LSRO) for the report Guidelines for Use of Dietary Intake Data (1). These general areas included:

- prevalence of consumption of particular levels of foods or food components;
- comparison of intakes of different groups within the U.S. population;
- time trends in consumption of foods or food components;
- relationship of intake of a food or food component to a given health outcome.

It was noted that the food composition data base used for nutrient and food components is as critical as the data collection method. One of the primary measurement component areas in the Nutrition Monitoring Program is food composition and nutrient data bases. It is necessary to assess the adequacy and accuracy of the food composition data base. Adequacy must be addressed with regard to characterizing food components related to diet and health, including nutrients and non-nutrient/physiologically active components (e.g., caffeine, additives, fat substitutes, contaminants, and toxins). In addition, survey food composition data bases must reflect trends in foods fortified and the levels of fortification (e.g., calcium-fortified juices and breads), so that nutrient intake estimates capture consumer shifts in consumption of fortified foods. This is important for policy and programmatic uses of the data, for example, in estimating

calcium intakes for the Year 2000 Objective 2.8 and for evaluating food fortification proposals. Adequacy and accuracy must also be addressed in the other components of dietary intake assessment: the data collection system, the food coding system, data editing, and the statistical methods used to produce the final estimates of interest. Issues of under-reporting, non-response bias, and failure to include nutrient intake from supplements can affect the final estimates of intake. In addition, modifications to the assessment components mentioned above can, in turn, affect these sources of measurement error.

Working groups also stressed the need to consider related objectives in the Nutrition Monitoring Program when discussing dietary intake assessment. The groups emphasized the need to assess knowledge, attitudes, behavior and skills that affect dietary choices and ultimately dietary intake.

The consensus from the working group discussions, was that multiple 24-hour recalls are best suited for most nutrition monitoring needs. However, infrequent or seasonal consumption of foods, such as alcoholic beverages or fresh fruits and vegetables, may be difficult to assess using 24-hour recalls. To address these situations, the combination of a food frequency or food list method with multiple 24-hour recalls was considered in some of the working groups and has been recommended elsewhere (2,3).

In the closing plenary session of the workshop, participants developed a list of overall consensus statements (Figure 1). These statements were culled from the previous days' discussions and are the conclusions, recommendations, and areas identified for further discussion and research. Some of these statements emerged from working group discussions of a specific Year 2000 objective, while others came from the plenary discussion that followed the working group discussions of general issues related to dietary intake assessment. These statements have implications for topics that were not addressed in the discussions. For example, in addition to determining exactly which foods should be counted as fruits and as vegetables, one must also determine which foods should be counted as grain products when measuring that part of the objective (a recommended number of servings of grain products is also a part of Year 2000 Objective 2.6). That is, should cookies, cakes, and doughnuts be counted as servings of grain products?

**Figure 1**
**Overall Consensus Statements**

**The optimal method for estimating nutrient intake is multiple, non-consecutive, 24-hour recalls.**

**However, no one method suits all purposes.**

**Only one measurement is needed to estimate mean nutrient intake of a population, but more than one measurement is needed to estimate the distribution of nutrient intakes.**

**Estimation of usual intake should include statistical adjustment for intraindividual variation.**

**It is important to assess the accuracy and adequacy of the nutrient composition data base.**

**Methods should be developed to allow comparisons of State data with national data.**

**The Year 2000 objectives need clarification so that appropriate measures can be developed, that is, the underlying assumptions should be specified.**

**Fruits and vegetables must be defined. (Objective 2.6)**

**Other food sources of calcium in addition to dairy foods should also be tracked. (Objective 2.8)**

**Closer collaboration and linkage should be encouraged between the Nutrition Monitoring Program and alcohol research efforts.**

Some working groups suggested that at least two 24-hour recalls would be optimal for nutrient intake estimation, given the large variation in intake from day-to-day. This variation, called within-person or intraindividual variation, has been studied in relation to between-person (interindividual) variation (4-6). The number of recalls needed should be determined after considering the analytic goals/purpose of the study (2). Statistical methods which adjust for this variation and allow estimates of usual intake from multiple 24-hour recalls are discussed in the chapter titled, "Statistical Estimation of Usual Intake" and in the background paper titled, "Statistical Issues in Estimating Usual Intake From 24-Hour Recall or Frequency Data".

Given the optimum of multiple 24-hour recalls, the working groups acknowledged the need to develop other dietary methods or combinations of methods, to meet budgetary, time, and other constraints. This may apply to national and State level estimates, or for specific subgroups of the population.

The following paragraphs provide a background to the recommendations for dietary data collection methods, and describe areas for further research and discussion in NNMRRP. Table 1 identifies surveys and studies that have collected dietary intake data, and briefly describes the methods that were used.

Dietary intake data is used in relation to a broad range of goals within the Nutrition Monitoring Program. The scope of nutrition monitoring includes measuring consumption of specific foods such as vegetables or fish, as well as measuring intake of specific nutrients such as calcium or fat, for which subgroups within or all of the population may be at risk of inadequate or excessive intakes. Measuring total nutrient intake should include food intake and intake from dietary supplements. In addition, researchers need to assess food and nutrient intake relative to nutritional status measures (e.g., iron intake estimates relative to iron status measures) and relative to identified recommendations, for example the Dietary Guidelines for Americans and the Year 2000 Health Objectives for the Nation (7,8).

The uses of dietary intake data in the Nutrition Monitoring Program include: assessment and monitoring, regulatory uses, epidemiologic research, and commercial uses (3,9,10). The recommendations in this report are made with the understanding that the primary uses of the dietary data are for assessment and monitoring, and for program and policy planning, including regulatory use.

## TABLE 1. SURVEYS/STUDIES OF THE NNMRRP THAT COLLECT DIETARY INTAKE DATA

| SURVEY/STUDY | AGENCY | METHOD | MODE |
|---|---|---|---|
| Adult Day Care Program Study (1992) | USDA/FNS | one day observation and dietary recall | observation; for meals not observed, an in-person interview or, when necessary, a proxy telephone interview |
| Behavioral Risk Factor Surveillance System (continuously since 1993) | HHS/CDC/ NCCDPHP | modified food frequency modules specific for fat and for fruit and vegetable consumption | telephone interview |
| Continuing Survey of Food Intakes by Individuals (1994-96) | USDA/ARS | two 24-hour recalls (in 1989-91 CSFII one 24-hour recall and 2 days of food diary were collected) | in-person interview |
| 5 A Day Baseline Survey (1991) | HHS/NIH/ NCI | modified food frequency specific for fruit and vegetable consumption | telephone interview |
| Nationwide Food Consumption Survey (1987-88) | USDA/HNIS | one 24-hour recall and two-day diet record for each household member (household component measures household food use by list-aided recall of foods eaten or discarded during the past seven days) | in-person interview |
| Navajo Health and Nutrition Survey (1992) | HHS/IHS | 24-hour recall and food frequency | in-person interview |
| National Health Interview Survey on Cancer Epidemiology and Cancer Control (1987, 1992) | HHS/CDC/ NCHS and HHS/NIH/ NCI | semiquantitative food frequency | in-person interview |

**TABLE 1. SURVEYS/STUDIES OF THE NNMRRP THAT COLLECT DIETARY INTAKE DATA, CONTINUED**

| SURVEY/STUDY | AGENCY | METHOD | MODE |
|---|---|---|---|
| Third National Health and Nutrition Examination Survey (1988-94) | HHS/CDC/ NCHS | 24-hour recall (second and third recalls on subsample of persons 50 years and older) and qualitative, 60-item food frequency for persons 12 years and older | automated, in-person 24-hour recall (telephone interview for second and third recalls), and in-person interview for food frequency |
| Nutritional Evaluation of Military Feeding Systems and Military Populations | DOD/ USARIEM | different methods are used depending on the topic and study design; example of these methods are: semiquantitative food frequency (NCI Diet History Questionnaire), food record, and visual estimation | food frequencies and food records are self-administered with review by a nutritionist |
| School Nutrition Dietary Assessment Study (1992) | USDA/FNS | 24-hour recall | in-person interview with parent and child |
| WIC Evaluation Study (1983) | USDA/FNS | two 24-hour recalls and a one-week food expenditures diary | in-person interview and food expenditures questions; one-week diary with debriefing interview |
| Youth Risk Behavior Surveillance System (1993) | HHS/CDC/ NCCDPHP | minimal eating practices and dietary behaviors questions | self-administered questionnaire in schools |

One of the overall objectives of the Ten-Year Comprehensive Plan is "to use comparable methods of data collection and reporting of results" (11). The workshop established the need for a clear vision of comparability of dietary intake methodology in the Nutrition Monitoring Program. Beaton (12) provides an eloquent example of what must underlie such a vision:

> We contend that (1) dietary intake cannot be estimated without error (and never will be), (2) collection and analysis of dietary data is essential if we are to pursue questions about the relationships between food use and health, and (3) a very serious limitation at present is not the errors in dietary data but rather our failure to appreciate the nature of these errors, how they differ with choice of methodology of data collection, and what impact they have in specific strategies of data analysis.

There is a need for a uniform approach in selecting a method for assessing dietary intake in the surveys and surveillance systems of the Nutrition Monitoring Program. There are previous, government-sponsored publications which have emphasized this, for example, in 1982 the National Research Council's Recommendations for Survey Data; in 1986 the LSRO Report, Guidelines for Use of Dietary Intake Data; also in 1986, Nutrition Monitoring in the United States: A Progress Report from the Joint Nutrition Monitoring Evaluation Committee; and in 1989, Nutrition Monitoring in the United States: An Update Report on Nutrition Monitoring (1, 13-15).

These publications address the subject of comparability of analysis and interpretation of dietary intake data within the Nutrition Monitoring Program. This need is difficult to address, given the complex, varying, and sometimes conflicting needs for dietary intake data. As was stated in the Overall Consensus Statements (Figure 1) from the workshop, "no one method suits all purposes." In some cases budget constraints, study or survey design, or some other factor precludes the use of an optimal method. In spite of this, it is important to apply the same process in selecting a dietary method. As part of the selection process one should carefully consider the study or survey purposes, the analytic plans for the data, and the study or survey design and population. The decision-making process involves weighing many factors, and some factors carry more weight than others.

An document often requested is a set of recommendations for selecting dietary methods for specific analytic purposes. This report provides guidance in how to determine which dietary method is best-suited for the study or survey purpose. However, the assumptions made and measurement error associated with specific methods must be acknowledged. Advantages and disadvantages of all methods should be carefully considered, and the limitations of the method must be accepted when conducting analyses and interpreting results. While it may be appealing to use a decision tree or matrix to aid in selecting a method, one should carefully consider all of the factors in the study or survey, and critically examine existing reviews of dietary methods when selecting a dietary method.

A checklist of items to consider in selecting a dietary method was developed to guide researchers in determining which dietary method to use in a study or survey (Table 2). This should be applicable at a national, State, or local level.

## TABLE 2. ISSUES IN SELECTING A DIETARY INTAKE METHOD

**Purpose**

| | |
|---|---|
| Dietary Component of Interest | Food(s) or food group(s) |
| | Nutrient intake (from foods and supplements) |
| | Supplements (including vitamin/mineral and other dietary supplements) |
| | Non-nutrient food component(s), such as caffeine, additives |
| Temporal Pattern of Interest | Usual or chronic |
| | Acute |
| Why is diet of interest? What is the intended purpose for the data? (see general analytic uses on p.6) | Mean intake of a particular food, nutrient or food component |
| | Comparison of intakes of different groups |
| | Proportion of population above or below a recommended standard level of food or nutrient intake |
| | To assess trends in the mean or distribution of food and/or nutrient intakes |
| | To associate intake of food(s) and/or nutrient(s) to health or disease |

**Population Characteristics**

| | |
|---|---|
| Geopolitical unit | National sample |
| | State sample |
| | Regional sample |
| | Reservations or other geographical areas |
| Demographic characteristics | Age/Birthdate |
| | Gender (Sex) |
| | Income |

TABLE 2. ISSUES IN SELECTING A DIETARY INTAKE METHOD, CONTINUED

| | | |
|---|---|---|
| **Population Characteristics, continued** | Demographic characteristics, continued | Race/ ethnicity |
| | Education | Cognitive Skills |
| | | Literacy Skills |
| | Ethnic diversity | Primary language other than English |
| | | Cultural sensitivities |
| | | Food patterns |
| | Physiologic differences | Pregnancy, lactation, pre-/post-menopausal state, illness |
| **Operational/ Administrative Constraints** | Resources | Staff/personnel required |
| | | Computer resources/ capability for automation |

The LSRO report, Guidelines for Use of Dietary Intake Data, addresses the appropriate uses of dietary intake methods and suggests that the researcher ask two questions: 1) What does the method purport to measure? and 2) Does the method suit the purpose of the study (1). Issues related to the use of recently developed brief dietary indicators are discussed separately in the Section titled, "Brief Indicators of Dietary Status". Dietary assessment methods have been extensively reviewed. The following are suggested as resources:

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## CHAPTER 2
## STATISTICAL ESTIMATION OF USUAL INTAKE[1]

Whether statistical adjustment to dietary intake data collected from 24-hour recalls is necessary to provide estimates of usual intake depends on the information needed. That is, the question or purpose determines which statistical estimates are needed. The mean does not require adjustment, whereas estimates of the distribution of intakes, such as percentiles or the proportion above or below a cut-point, may require adjustment.

The number of 24-hour recalls per study participant needed depends on the statistical properties of the dietary component or nutrient to be investigated. In general, at least two independent observations are needed from a sample of individuals. If multiple observations are made on a subsample of the total sample, the subsample should be selected randomly. Initial and replicate recalls days, if possible, also should be selected randomly. The size needed for the subsample depends on intraindividual variability.

The method of correction employed, and the raw, uncorrected data need to be clearly presented; that is, a description should be reported of exactly how the point estimate is produced.

The following methods of adjustment were reviewed by the working group ---

- The National Academy of Science (NAS) method is described in detail in the 1986 National Academy of Sciences' report, Nutrient Adequacy: Assessment Using Food Consumption Surveys (1). The group concluded that this method may have serious problems for highly skewed nutrients.

- Using four days of intake data for women 19-50 years old, from the 1985 Continuing Survey of Food Intakes by Individuals, the Iowa State University (ISU) researchers have developed an adjustment for the NAS method which corrects for bias that is incurred when reversing the nonlinear transformation step in the NAS method.

- Iowa State University researchers have further expanded on the NAS bias-adjusted method. The ISU method includes an additional

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[1] See background paper titled, "Statistical issues in estimating usual intake from 24-hour recall or frequency data: A working report for the consensus workshop on dietary assessment" in a later section of this report.

transformation step and also accounts for the presence of heterogeneous within-individual variances in intakes.[2]

The NAS bias-adjusted method and ISU method produce similar results, and appear in simulation, under certain assumptions, to work well for calcium, energy, and fat, in which distributions are somewhat skewed but do not exhibit large within-individual variation. In addition, the ISU method appears in simulation, under certain assumptions, to work well for vitamin A, vitamin C, protein, and iron, for which intake distributions are very skewed and exhibit large within-individual variation.

The NAS stratum-adjusted method, which was developed by the Health Protection Branch of the Department of Health and Welfare, Canada for use in the 1990 Nova Scotia Nutrition Survey, was also reviewed(2):

- Normality tests were carried out on standardized residuals after removing the effects of survey design variables. This included assessment and adjustment for outliers.

- The intra- and interindividual variances were estimated within each stratum and were pooled across strata within homogeneous variances. These variance estimates were used in the NAS procedure to adjust nutrient distributions in each stratum. The above analyses were carried out on the scale which best approximated a normal distribution.

- Nutrient distributions for which analyses were carried out on a transformed scale, were transformed back to derive the adjusted response on the original scale.

The method was validated by comparing distributions generated by the adjustment method with distributions derived from average intake from repeated recall data in Nova Scotia for several dietary variables (protein, fat, saturated fat, polyunsaturated fat, carbohydrate, cholesterol, fiber and energy). Excellent agreement between the two sets of distributions was obtained for each variable investigated.

Comparison of the ISU method with the NAS stratum-adjusted method, using the Nova Scotia Survey data, showed excellent agreement between the two

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[2] A manuscript describing the ISU method has been accepted, pending revision, by the Journal of the American Statistical Association, and software is being developed.

procedures. While in most cases there will be little difference in estimates provided by the two approaches for nutrients with intake distributions which are approximately normal and homogeneous, in cases with highly skewed intake distributions, unusual consumption patterns, and other non-ideal situations, all procedures will require further research.

In conclusion, there was no consensus in the working group as to the generally best method of adjustment available at this time. Further research taking into consideration the practical issues associated with 24-hour recall data collection will be necessary to resolve this issue.

Time constraints precluded discussion of other statistical issues in dietary intake assessment, however, the working group noted that statistical properties of data from different measures (e.g., 24-hour recall, food frequency) deserve additional study.

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1. National Research Council, Commission on Life Sciences, Food and Nutrition Board, Coordinating Committee on Evaluation of Food Consumption Surveys, Subcommittee on Criteria for Dietary Evaluation. Nutrient Adequacy: Assessment Using Food Consumption Surveys. Washington: National Academy Press. 1986.

2. Karpinski KF, Nargundkar MS. Nova Scotia Nutrition Survey Methodology Report. Food Directorate Technical Document No. 451311-0010. Ottawa: Health Canada. February, 1992.

## CHAPTER 3
## COGNITIVE ISSUES IN DIETARY RECALL[1]

The cognitive working group was charged with examining cognitive issues related to memory for foods and portion sizes. Based on their knowledge of cognition and dietary methodology, they were asked to recommend strategies or techniques for improving performance on 24-hour dietary recalls, food frequency questionnaires, and portion size estimation. Many issues were addressed and a number of recommendations were made. By-in-large, though, the group felt that more research needed to be conducted in this area.

### I. Registering information in memory

Memory for events can develop either as a result of intentional or incidental learning of information related to the event. When an individual deliberately or intentionally tries to commit material to memory, the process is defined as intentional learning. On the other hand, when a person learns material without conscious effort or intent to do so, the process is called incidental learning (1).

The cognitive working group assumed that 24-hour dietary recalls and food frequency questionnaires relied on incidental learning of information about one's dietary intake. However, if one is "monitoring" his/her dietary intake or is otherwise consciously aware of his/her diet, information about foods eaten may be intentionally acquired or learned. In situations where a 24-hour recall plus two days of food records are collected, information about dietary intake may be acquired incidentally and intentionally, respectively. This raises questions about the appropriateness of combining or averaging data from both dietary methods in a single survey since each method may rely upon a different learning style and the types of errors produced may be different from each other.

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[1] See background paper titled, "Cognitive issues in two dietary survey methods" in a later section of this report.

## II. Memory for foods: 24-hour dietary recall

A. General comments

1. Reasons for errors

   a. Forgetting
   b. The respondent fails to understand the level of detail that the interviewer wants.

2. It is important to get a complete recall---every food needs to be recorded so that food and nutrient calculations are meaningful.

3. The validity of 24-hour recalls needs to be further investigated.

B. Strategies discussed to improve recall of foods

1. Prior notification of a dietary recall

   The working group pointed out that one might notify respondents a few days before administering a 24-hour recall. Then the respondents could prepare for the dietary recall by using any strategies that would help them better remember their dietary intakes. Some examples are consciously "monitoring" their intake, keeping food records, or looking at labels, to name a few. These strategies probably involve intentional learning. People might recall the foods they ate more accurately and completely when they use these strategies. The potential trade-off with prior notification is that the a person might alter what he/she eats, and the recall might not represent what he/she customarily consumes. More research needs to be conducted on this topic.

2. Cuing strategies

   The cognitive working group recommended that some type of cuing strategy be used with 24-hour recalls and food frequency questionnaires to prompt recall of dietary intake. Two cuing strategies that were mentioned were use of lists of foods and temporal patterns.

   Food lists could be shown to respondents to prompt recall of foods eaten the previous day. This method relies upon recognition. That is, matching items on the list with a previous experience when the

food was consumed that is stored in memory. The list could be administered after the initial recall, and might consist of commonly eaten foods (e.g., 100 foods) or commonly forgotten foods. Upon seeing the name of the food on a list a person might be reminded about a food he/she ate but forgot to report. More research needs to be conducted on this topic.

Another cuing strategy that is frequently used is time periods during the day. Often morning, mid-morning, noon, etc., are used as cues on 24-hour dietary recalls. Typically, the interviewer moves chronologically forward in time, although it is not known if this is the best approach. More research needs to be conducted on this topic.

3. Multiple passes through the day

Another technique which the cognitive group recommended using with 24-hour dietary recalls was performing multiple passes through the day. With this approach the interviewer asks the respondent several different times to search his/her memory for the requested information. The belief is that the more attempts the respondent makes trying to retrieve information, the more successful he/she will be.

A key element of the multiple pass approach is to use multiple, alternate sets of cues or retrieval probes. As a general rule, the more cues or probes an interviewer uses and the more they are different from one another, the more likely he/she will be in eliciting the requested information from the respondent. While one type of retrieval cue may not be successful in activating a person's memory for certain information, a different type of cue may be more successful. Some examples of multiple cuing strategies that are already being used include: referring to the time of day, asking respondents about their activities throughout the day, asking respondents about categories of foods, and showing respondents food lists.

The NCHS has used a multiple pass approach in previous NHANES surveys, and has also used it in NHANES III (2). USDA is using a multiple pass approach in the Continuing Survey of Food Intakes by Individuals, 1994-96. The USDA method is described below (3).

*1st pass through the day*: The respondent uses any recall strategy he/she wishes to use to remember the foods and beverages he/she

consumed the previous day. The interviewer does not interrupt the respondent during this free recall process.

*2nd pass through the day*: Next the interviewer goes back over the items reported during the free recall, probing for more detailed information about the foods. This pass is designed to discover any additions to the foods and beverages, such as cream in coffee, and anything the respondent forgot to report during the initial recall. Reviewing the items reported and asking about additions is intended to stimulate additional recall.

*3rd pass through the day*: The interviewer again reviews the list of foods reported, asking about eating occasions and about any additional foods or beverages that were forgotten.

The group felt that more research needed to be conducted on the multiple pass approach. The following questions were raised about using multiple passes and need to be answered:

- How many passes should one make through a day? There needs to be a cost/benefit analysis on the number of passes.
- What types of cues should one use with each pass? Should one pass be chronologically forward through the day and another backwards in order to elicit different retrieval cues? Should recognition, perhaps from a food list, be part of the last pass?

C. Defaults

Often respondents do not provide enough descriptive information about the foods they have consumed (e.g., type of fat used to prepare a food). To collect more detailed information requires a substantial amount of effort on the part of the interviewer. Default values are often used when not enough descriptive information is provided. The group recommended that in order to minimize errors, the default values should be as specific as possible for the source of the food (e.g., school lunch values for foods consumed at school meal programs).

D. Summary and Recommendations

1. The group identified a number of strategies that may improve 24-hour recall data including prior notification of a recall, cuing strategies (food lists and temporal patterns were two that were mentioned), and multiple passes through a day. The group concluded

that little data were available on these strategies and that this area needed more research.

2. There needs to be a cost-benefit analysis of the time, cost, and respondent burden for using multiple cues.

3. More research needs to be conducted on the number of passes through a day that should be used on a multiple-pass approach.

4. More research needs to be conducted on the validity of 24-hour dietary recalls.

## III. Memory for foods: Food Frequency Questionnaires

A. General comments

1. A food frequency questionnaire (FFQ) has merit as a qualitative measure of intake. Its role as a quantitative measure of intake was not resolved.

2. There are many unknown or unresolved issues about the cognitive strategies respondents employ to answer FFQs. Also, there are many factors that have not been studied that appear to influence responses. The points listed below are all important and need to be addressed, but the group thought that there was not enough information at present to make specific recommendations. More research needs to be conducted on this topic.

B. Points raised concerning cognition and food frequency questionnaires

1. Cues/probes

There were unresolved questions about the best probes to use in improving responses. For example, would it help to ask someone to think about all the situations in which he/she eats chicken before asking the person to report how frequently he/she eats chicken?

2. Specificity of food lists

Food lists need to be specific. Food lists cease to be helpful to the respondent when they are not meaningful to him/her. Are the names on the list appropriate in terms of age, ethnicity, and region for the

subpopulation being interviewed? One participant noted that food lists should be sufficiently comprehensive to capture the foods respondents are eating, while at the same time fulfilling the purpose for the FFQ.

3. Grouping versus listing foods separately

Some data indicate that the more fruit and vegetable groups there are listed on a FFQ, the higher the number of counts of fruits and vegetables eaten. In contrast, using a broad category name may not be a sufficient cue to elicit retrieval of specific foods within that category. For instance, if "dark green or yellow vegetables" is the only name listed on the questionnaire, it may not be enough of a cue to help the respondent remember all the different types of these vegetables he/she has consumed.

4. Order of foods listed on the FFQ

It is known that the order of the questions may influence the types of answers that respondents give. Early responses (e.g., number of servings and serving size) may influence later ones, but no data were available on this point. Responses for foods listed at the end of a questionnaire might be more biased or erroneous that those listed earlier. For instance, there may be a relationship between the order in which foods are listed on a FFQ and the respondent's level of fatigue or motivation to complete the questionnaire. One participant suggested that investigators could use interactive computer systems that would enable them to use randomly ordered lists.

5. Response scale

In general, people are known to be sensitive to response scale categories. The group knew of little, if any, work on the impact of the frequency categories used on the actual responses. For instance, what are the advantages of providing the frequency categories on the FFQ (e.g., How many times in a day, week, or month do you eat...?) versus giving open-ended categories (e.g., "How often do you eat...?"). Closed- and open-ended questions such as these may elicit different and often contradictory results.

6. General versus specific memories of diet

When asked to recall their diet over an extended period of time, respondents are more likely to report their routine or typical diet

than they are to report the specifics of what they ate. That is, respondents rely more on general knowledge of their diet and less on specific memories of their dietary intake as the duration increases between the time foods are consumed and the time of the recall (4).

7. Reference period

The reference period is the time interval during which the respondent is asked to recall all the foods and beverages he/she has consumed. This interval may be one or more days, a week, a month, a year or even longer periods of time.

The accuracy of frequency estimates of foods consumed diminishes as the amount of time increases since the reference period (4).

The cognitive working group raised a number of questions about this topic. What is the optimal length of the reference period? Is shorter better? What is the shortest amount of time one can use and still capture variability of intake across time? The answers to these questions may differ from one group of respondents to the next.

The cognitive group assumed that it might be difficult to assess usual intake if the reference period cuts across time periods in which real differences in intake occur. That is, when individuals make changes in their usual intakes.

It is not clear whether people really use the reference period they are asked to use in formulating their answers. For instance, instead of thinking about their intake over the past 30 days, a respondent may think about last month. These two may not be the same time periods. One suggestion was to try to get respondents to think in terms of seasons and then respond. Some data on the season in which the FFQ was administered suggest that the present time period is an important reference point in questioning.

Another suggestion was that interviewers use a shorter reference period, but interview the same people multiple times during a year. For example, if one is collecting data on diet-disease relationships.

8. Food frequency judgments

When one adds across all the items an individual consumes, a person overestimates the frequency with which he/she consumes foods. The group was not certain whether this was true on an item-by-item

basis. The frequency for some foods, such as desserts or alcohol, may actually be underestimated.

The strategies used for coming up with answers vary within people, from one food to the next, and vary between people.

People are thought to calibrate to themselves on a relative basis. Smith (4, 5) found that although subjects could not give accurate estimates of the absolute frequency with which foods were consumed, they were able to give "reasonable estimates of the relative frequency with which they ate various foods." That is, their estimates for items eaten more frequently were higher than those for items eaten less frequently. However, peoples' responses about how frequently they consume a food varies enough from the actual frequency that the ordinal relationship across people does not reflect the true ordinal relationship.

9. Rates versus counts

Is it easier or better for respondents to report rates (e.g., "I eat 3 eggs per week") or counts (e.g., "I eat 12 eggs in a month")? One participant reported that some research indicates that rates are better for frequently consumed foods like bread or juice, and counts may be better for infrequently consumed foods. Another participant thought that people could perform counts for a month.

10. Portion size estimates on food frequency questionnaires

The cognitive group disagreed about how accurately individuals could estimate portion sizes on FFQs. Some research suggests that people do not maintain stable representations of the portion sizes of foods they eat (4). Other data show that people select the middle category on the questionnaire. Questions were raised about ranking people based on default portion size values and about the distribution of intake data.

11. Validity and reliability

The group raised questions about the approaches used to assess validity of food frequency questionnaires. It was a suggested that FFQs be validated based on foods consumed. The group noted that instead of testing validity, researchers have been calibrating FFQs against other dietary methods (e.g., multiple 24-hour recalls or food records).

A question was also raised about the reliability of FFQs.

12. Defaults

Defaults are a source of problems and can lead to very distorted results. The defaults used may not be appropriate for every member of the group being studied.

C. Summary and Recommendations

1. While the cognitive working group did not reach closure about specific recommendations for administering FFQs, they identified many factors that potentially may influence performance on FFQs. More research needs to be conducted on each of these factors and how they affect responses on FFQs.

2. New technologies for administering FFQs need to be developed and tested.

## IV. Portion size issues

The cognitive group was only able to conduct a partial discussion of portion size issues.

A. General comments

1. People have difficulty recognizing sameness versus differences in quantities of foods.

2. People have difficulty estimating quantities of foods. However, it may not be difficult to estimate quantities of foods that come in defined units (e.g., a slice of bread, one egg, or a can of soda).

3. The cognitive working group was not united on how accurately individuals could estimate portion sizes. People may underestimate the portion sizes of some foods, but may also overestimate the amounts for other foods.

B. Recommendations

1. More research needs to be conducted on portion size issues.

2. For 24-hour recalls collected/conducted *in the home*--respondent's eating utensils should be used. As necessary, measure amounts while one is in the household.

3. For 24-hour recalls not collected/conducted *in the home*--use mugs, plates, bowls, glasses, and measuring utensils in the interview.

## V. Additional comments

A. There was a recommendation that an objective to assess behaviors that underlie food consumption be added to the list of the Ten-Year Comprehensive Plan Nutrition Monitoring objectives. This objective should emphasize the importance of monitoring eating environments (i.e., where people eat) for tracking behavior change.

B. There was a recommendation that researchers take into consideration situations that may disrupt a respondent's "typical intake". For example, events/diseases may lead to a disruption of a "typical diet". These situations may have profound influences on food and nutrient intake at particular time periods.

## References

1. Searleman A and Herrmann D. Memory from a broader perspective. New York: McGraw-Hill, Inc. 1994.

2. Westat, Inc. NHANES III dietary interviewer's manual, prepared for the National Center for Health Statistics. Westat, Inc: Rockville, MD. Revised September 1992, by the Nutrition Coordinating Center, University of Minnesota.

3. DeMaio TJ, Ciochetto S and Davis WL. Research on the Continuing Survey of Food Intakes by Individuals. Proceedings of the Section on Survey Research Methods, volume II. Alexandria: American Statistical Association. 1993:1021-25.

4. Smith AF. Cognitive processes in long-term dietary recall. National Center for Health Statistics. Vital Health Stat 6(4). Hyattsville: Public Health Service. 1991.

5. Smith AF. Cognitive psychological issues of relevance to the validity of dietary reports. Eur J Clin Nutr 1993;47(suppl):S6-S18.

# CHAPTER 4
# ASSESSMENT OF ALCOHOL INTAKE

## Overall recommendations

The working group strongly recommends more basic methods research and validation studies. Cognitive testing of the specific questions used to collect alcohol intake data *must* be done.

Greater consistency between national surveys on alcohol consumption and nutrition surveys is needed, and a formal liaison between organizations conducting such surveys is recommended. More immediately, ways should be sought to coordinate nutrition monitoring surveys, that are being planned, with the 1994 National Alcohol Survey.

The working group agreed that it is not appropriate to monitor the Year 2000 Objective 4.8 using survey data. The standard established for this objective is alcohol sales data. However, trends in alcohol intake estimates from survey data could be compared and contrasted with trends in per capita consumption of alcohol.

## Recommended definitions

The working group noted that in alcohol research, the definition of intoxication experiences in study and survey questionnaires varies widely. The Year 2000 Objective 4.7 defines "recent occasions of heavy drinking" as "five or more drinks on one occasion during the previous two-week period," while the Dietary Guidelines for Americans (1) recommends that alcoholic beverages be consumed in moderation (that is, no more than one drink a day for women, and no more than two drinks a day for men). Hilton's discussion of assessment of alcohol intake outlines the rationale for different recommendations for different population subgroups.[1]

The group modified the definition used in the Year 2000 Objective 4.7: Recent heavy drinking was defined as five or more drinks on at least one occasion (in the previous two week period).

The ambiguity in the term "drinking occasion" was a source of concern for the working group, especially when one drinking occasion is defined as approximately

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[1] See background paper titled, "The Measurement of Alcohol Consumption" in a later section of this report.

one day. A *drinking occasion* was defined as any sequence of drinks uninterrupted by an hour. Two drinking occasions are distinguished by a separation of one hour or more. However, the working group did not have access to the definition of a drinking occasion from the Monitoring the Future survey (2). Person-specific definitions of drinking occasion could be made using 24-hour recall information. If the data include information on the timing of eating and drinking occasions, then the variability in the population of duration and number of drinking occasions per day could be examined.

Following the definitions used in the Dietary Guidelines for Americans, a *standard drink* was defined as one containing 0.5 ounces of ethanol alcohol (1). This was further defined as any one of the following:

- one 12 ounce bottle/can of beer;
- one 5 ounces glass of wine;
- one mixed drink containing 1.5 ounces of liquor. (The group recommended asking about *liquor* rather than *hard liquor.*)

## Specific recommendations

Although a four week reporting period was suggested, the working group did not reach consensus on a recommended reference period. The group suggests maintaining the reference period in a given survey for comparability against previous surveys.

It was recommended that interviewers ask about consumption per drinking occasion. The recommended approach for asking about consumption was the graduated frequency approach by beverage type, starting at one drink and increasing by single drinks until five drinks, then grouped as 5-7 drinks and 8+ drinks (a matrix of 21 items).

The working group noted that the choice of a global question about all types of alcohol or beverage-specific questions, should be made based on the purpose of the survey or study. To obtain amount or volume information, asking questions by beverage type (beer, wine, liquor) was recommended.

When differentiating individual versus group estimates, the working group decided that individual estimates are optimal for monitoring and research. Individual-level estimates allow researchers to investigate of associations between alcohol intake and health status measurements, for example, investigating the relationship between alcohol intake and high density lipoprotein cholesterol.

The working group discussed the utility of asking about the location of consumption. They decided that it is of value for many research questions, but does not have general utility for assessing the Year 2000 objectives. However, context-specific questions are useful as "cues" for memory of drinking experiences, and may give better consumption estimates.

The working group agreed that it is suboptimal to ask one question about consumption of alcohol of any type instead of asking beverage-specific questions. The following question provides only an index of heavy drinking:

> During the past two weeks, how often have you had 5 or more drinks of alcohol of any type on any one occasion?

In summary, the working group agreed upon the following specific method for assessing intake of alcohol:

> A graduated frequency approach, by beverage type, beginning at 1 drink and increasing in single drink units to 5 drinks, then collapsing into categories 5-7, and 8+ drinks. Again, in order to make full use of the responses, the following question should be asked (where appropriate): When you drink eight or more drinks, how many do you usually have?

## References

1. U.S. Department of Agriculture and U.S. Department of Health and Human Services. Nutrition and your health: Dietary guidelines for Americans. 3rd ed. Washington: the Departments, 1990.

2. Monitoring the Future Study (High School Senior Survey), Alcohol, Drug Abuse, and Mental Health Administration, Public Health Service, U.S. Department of Health and Human Services, Rockville, MD.

# CHAPTER 5
# ASSESSMENT OF CALCIUM INTAKE[1]

*Healthy People 2000 Objective* 2.8, is designed to increase calcium intake (1). The objective states:

> Increase calcium intake so at least 50 percent of youth 12 through 24 years of age and 50 percent of pregnant and lactating women consume 3 or more servings daily of foods rich in calcium, and at least 50 percent of people 25 years of age and older consume 2 or more servings daily.
>
> *Note: The number of servings of foods rich in calcium is based on milk and milk products. One cup of skim milk or its equivalent in calcium (302 mg) is considered a serving.* The number of servings in this objective will generally provide approximately three-fourths of the 1989 Recommended Dietary Allowance (RDA) of calcium. The RDA is 1200 mg for people 12 through 24 years of age, 800 mg for people 25 years of age and older, and 1200 mg for pregnant and lactating women.

## Background

Low calcium intake has been linked with increased risk for osteoporosis, hypertension, and colon cancer (2). When examining the relationships between calcium and these diseases, intakes from food sources, dietary supplements, and water should be measured. In addition, it may be important to measure other factors that may influence calcium absorption, metabolism, and excretion, including vitamin D, protein, fat and fatty acids, fiber, alcohol, caffeine, sodium, antacids and certain drugs. Nevertheless, examining the diet-disease relationships is beyond the scope of this objective.

The Year 2000 objective focuses on increasing dietary calcium intake, particularly among certain subgroups of the population that have special needs for calcium based on the extra demands of growth and milk production, and the age-related decrease in calcium absorption. Low calcium intake is thought to be an important risk factor in the development of osteoporosis. There is also special concern about the adequacy of calcium intakes of individuals with incomes below the poverty level (1).

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[1] See background paper titled, "Assessment of calcium intake" in a later section of this report.

Objective 2.8 encourages consuming foods rich in calcium as a way to increase calcium intake. Emphasis is placed on dairy products since they provide more than half of the calcium in the U.S. diet, and they typically constitute the difference between inadequate and adequate intakes of calcium. This objective also supports use of lower fat forms of dairy products (1).

## Recommendations

### Measuring calcium intake

1. In evaluating progress toward the Year 2000 calcium objective, national surveys should measure all foods and beverages consumed, not just dairy products or other high-calcium foods. Ideally, States and localities should also measure total food and beverage intakes. There are several reasons for this recommendation. Some segments of the population may not consume dairy products or high-calcium foods. By collecting all foods and beverages consumed, poorer sources of calcium can be included in the calculations. Breads and cereals are examples of poorer sources of calcium. Collectively, these poorer food sources may contribute a considerable amount of calcium to the diet. Another reason is that cultural or ethnic foods, which may otherwise be overlooked but may contribute to calcium intake, can be counted. In assessing progress toward the objective, calcium intakes can be reported for dairy products and other calcium-rich foods in addition to reporting total food and beverage intakes. (See below)

2. Collect brand names of food products. Probe to find out whether foods are calcium-fortified.

3. Information on calcium content of dietary supplements may be collected, but should be reported separately from the calculations assessing progress toward the Year 2000 objective, since the objective focuses solely on food sources of calcium.

4. States and localities often do not have the time and resources to collect total food and beverage intakes. When this is not possible, they should use a targeted food frequency questionnaire. Federal agencies should develop a list of dairy products and other calcium-rich foods, including food mixtures that are rich in calcium, from national data that everyone can use to measure Objective 2.8. For example, data from 24-hour dietary recalls from the National Health and Nutrition Examination Survey or the Continuing Survey of Food Intakes by Individuals can be used to construct this list.

Portion sizes should be provided for each food or beverage on the list. In addition, the amount in terms of a serving based on the definition specified in the Year 2000 objective should also be listed. According to the objective "...a serving is

considered to be one cup of skim milk or its equivalent in calcium (302 mg)." The list might resemble the examples below:

1 cup skim milk (1 serving)
1 ounce cheddar cheese (2/3 serving)

States or localities should use this list to construct a targeted food frequency questionnaire that they can administer. Federal agencies should also use this list either to construct a targeted food frequency, or to analyze these foods separately from the rest of the foods on the 24-hour recalls. If everyone uses the same list of foods then States and localities can compare their data with those from national surveys.

## Method for measuring calcium intake

1. In order to measure progress toward the Year 2000 calcium objective, collect 24-hour dietary recalls to assess total food and beverage intakes. States and localities should also collect 24-hour dietary recalls if possible. Collect a minimum of two recalls, at least on a representative subsample of the population.

2. When States and localities cannot collect 24-hour recalls, they should use the targeted food frequency questionnaire. As indicated above, Federal agencies should develop a list of dairy products and other foods rich in calcium from national data. States or localities can use this list to construct a food frequency they can administer. They may want to supplement this list with foods that are frequently consumed by population groups in their specific regions. For comparison purposes, though, the supplemental list of foods should be reported separately from the foods on the standardized list.

Besides measuring total calcium intake from foods and beverages, Federal agencies should use this list either as a targeted food frequency, or select these foods from the dietary recalls and analyze them separately from the other foods. In this way States and localities that choose to use the food frequency can compare their data with results from national surveys.

## Reporting calcium intake

1. *For 24-hour recalls*: Convert intakes from multiple 24-hour dietary recalls into mean nutrient intakes (milligrams of calcium per day). Then report the percent of people meeting or exceeding the minimum goal set in Objective 2.8, that is, three-fourths of the 1989 Recommended Dietary Allowance for calcium.

2. *For food lists*: The serving sizes that accompany the food list can be used to calculate the total number of servings of diary products or calcium-rich foods a person has consumed. Then the number of servings can be compared to the Year 2000 objective.

If Federal agencies choose to analyze these foods separately from the rest of the foods on the 24-hour recalls, they first need to convert the respondents' portion sizes into servings based on the Year 2000 objective. For instance, one cup of skim milk would be one serving of a food rich in calcium. Then the number of servings can be tabulated as above.

## Administering the instruments

1. Preferably the 24-hour recall and food frequency questionnaire should be administered face-to-face, however, a telephone interview is an acceptable alternative.

2. Use portion size aides to help respondents judge amounts.

## Population characteristics

Population-specific probes need to be developed and evaluated, including ones for various racial/ethnic groups.

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1. U.S. Department of Health and Human Services. Healthy people 2000: National health promotion and disease prevention objectives. Washington: Public Health Service. 1990.

2. National Research Council. Diet and health: Implications for reducing chronic disease risk. Washington: National Academy Press. 1989.

## CHAPTER 6
## ASSESSMENT OF FAT INTAKE[1]

The assessment of fat intake in the population and monitoring changes in fat intake over time are high-priority public health nutrition topics. Total fat intake has been shown to be related to the risk of cardiovascular disease and certain types of cancer, with emphases on reducing the intake of total fat and saturated fat, and improving the ratio of polyunsaturated fat to saturated fat (1-4). Total fat and saturated fat intakes are typically expressed as the percentage of total energy rather than as absolute intakes, such as in the Dietary Guidelines for Americans (5) and Healthy People 2000 (3). The working group addressed the following objective:

> *Year 2000 Objective 2.5* - Reduce dietary fat intake to an average of 30 percent of calories or less and average saturated fat intake to less than 10 percent of calories among people ages 2 and older. (Baseline 36 percent of calories from total fat and 13 percent from saturated fat for people aged 20 through 74 in 1976-80 (NHANES II); 36 percent and 13 percent for women aged 19 through 50 in 1985 (CSFII).)

*The consensus recommendation was that multiple 24-hour dietary recalls be used for assessing fat intake.* The working group made the following recommendations for collecting 24-hour recalls:

- to monitor fat intake in the population, researchers must consider both the mean intake and the proportion of the population above or below a recommended level (such as the percent of the population below 10 percent of calories from saturated fat);
- one 24-hour recall per individual is needed to estimate the mean fat intake for the population and subgroups;
- more than one 24-hour recall, i.e., nonconsecutive, independent 24-hour dietary recalls, is needed, on *at least* a subsample of individuals, to assess the distribution of fat intake in the population (for further information on how the subsample should be selected, see the recommendations chapter titled, "Statistical Estimation of Usual Intake");

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[1] See background paper titled, "Assessment of fat intake" in a later section of this report.

- dietary information should be collected across all days of the week to estimate the fat intake in the population.

The recommended fat assessment protocol is:

1. Use multiple 24-hour dietary recalls (multiple-pass approach) with appropriate retrieval cues (for further information see background paper titled, "Cognitive Issues in Dietary Recall") (7-9).

2. The first 24-hour recall interview should be face-to-face; there are positive training effects for subsequent interviews if the first one is face-to-face.

3. The followup 24-hour recall should be at least 3 days after the first one to maximize the probability of independence. A face-to-face interview is preferable for the second 24-hour recall, but a telephone interview is acceptable (6-8).

4. Respondents should be selected in a representative manner corresponding to the sample design specifications. Recalls should be evenly distributed by day of the week, week of the month, and month of the year, since intake may vary by weekday versus weekend day, by season, and by week in the month depending on access to food in the household (9-12).

5. Data collection in the respondent's home potentially can improve dietary information since interviewers can be trained to check brand names and label information, and portion sizes using actual household eating utensils. (Note: Survey data from NFCS 1987-88 and CSFII 1989-91 have been collected to indicate how respondents estimate the quantities consumed, e.g., from package weight, measured in a household bowl or cup, etc. Following further analyses, these survey data will provide information useful for improving the collection of portion sizes in dietary surveys.)

6. The optimal mode for administration of the 24-hour recall is an automated data collection system to reduce errors and to standardize probing, and to capture specific details necessary for accurate fat estimates. An acceptable alternative is comparable data collection on paper, but may be slower and more costly (13).

7. Specific probes and attention to fat-containing foods, ethnic and regional dishes, particular foods such as fish oils, respondents' use of terms such as "lite", "low-fat", "fat-free", and "low cholesterol" should be included.

8. Probes at the end of the 24-hour recall for frequently forgotten foods and beverages should be included, especially since alcoholic beverages and soft drinks provide calories and can seriously affect the calculation of total energy from fat if not accurately captured in the 24-hour recall; the list should be general and open-ended so as not to bias the reporting of specific foods and beverages.

9. Optimally, a standard set of 3-dimensional measurement aids should be used to estimate portion sizes. However, it was noted that further research was needed in order to recommend a standard set of measurement aids. It was also noted that there needed to be comparable 2-dimensional measurement aids for use when administrating a 24-hour recall by telephone.

Dietary recalls have the advantage of accommodating all population groups because all foods reported can be captured (compared to other dietary methods such as food frequency food lists), and literacy is not required to participate in the 24-hour recall. Dietary data collection methods other than 24-hour recalls (or food records) are not appropriate for assessing quantitative levels of fat intake in the population over time (e.g., the percent of calories from fat) because information is needed on:

- total energy (calories)
- specific types of fat
- sources of fat including condiments, spreads, and additions to vegetables and salads
- food preparation methods
- brand name information
- related dietary practices, such as whether fat is trimmed from meats and whether skin is removed from poultry
- products containing fat-substitutes
- serving sizes

Food frequency lists and behavioral questions such as removing skin from poultry may be useful for assessing relative fat intake in a general or qualitative manner (see the paper titled, "Brief Indicators of Dietary Status"). However, food frequency methods are not appropriate as a population monitoring tool for quantifying fat intake over time, which requires comparability of the dietary method and the food composition data base over time, and generalizability to the general population.

It is also important to use a time-related food composition data base system so that changes in intake represent actual changes in food consumption rather than artifacts of nutrient data bases (14). This is especially important for assessing

trends in fat intake since many reduced-fat, no-fat, and fat-substitute food items are rapidly entering the marketplace. A time-related food composition data base allows one to recalculate nutrients at any point in time using improved or updated food composition data.

Additional discussion points put forth by the working group:

- Accuracy in fat assessment improves accuracy in total energy intake estimates.

- Food frequencies are subject to inaccuracy and lack specificity regarding foods and ingredients added to other foods, e.g., butter added to popcorn, needed to assess fat intake.

- Absolute values calculated using food frequencies bear little resemblance to absolute values calculated using other dietary methods.

- Most food frequency questionnaires do not allow the determination of the impact of new low-fat foods on total dietary intake, unless the food list is very long, very specific, and brand-name specific. Such a food frequency would be too long to administer in a timely manner.

- It is not desirable to impute serving sizes (i.e., deriving portion size information from food frequencies where no measurement aids were used is not useful for quantifying fat intake).

- Food frequencies are enormously sensitive to underlying assumptions. For assessing fat intake, absolute values and the distribution of fat intake in the population are needed, making food frequency instruments undesirable.

- Questions on trimming fat from meats, removing poultry skin, and consuming fast food should be evaluated for use as fat-related behavior questions (see the Section titled, "Brief Indicators of Dietary Status").

- To interpret dietary intake, diet should be considered in the context of the "whole" person and other attributes such as physical activity, smoking, and obesity.

The following recommendations on dietary assessment are especially important to improve national estimates of fat intake:

- Make available a time-related food composition data base that includes brand-specific information needed for accurately assessing fat intake;

sufficient detail must be captured for commonly consumed sources of fat, in both the data collection and in the food composition data base to accurately assess fat intake.

- Improve currently available software and computer programs for easier data processing of detailed information collected by 24-hour recalls, including information on foods, foods eaten together, recipes, and food preparation.

- Improve linkages between dietary data collection software, processing data bases, and food composition data bases, to facilitate data management and processing to meet diverse data needs in a timely manner.

## Research Needs

- Further research is needed on the mode of administration (e.g., what are the effects of telephone administration) and the multiple-pass approach method of collecting 24-hour recalls.

- Further research is needed on the use of food models and measurement aids to estimate portion size in the general population and with specific subgroups. (Research is in progress on telephone dietary recall methodology at NCHS.)

- National dietary survey data should be analyzed to define foods indicative of or contributing to a high-fat intake. These indicator foods may have utility as relative measures of fat intake for use as a surveillance tool for assessing changes in dietary fat behavior.

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# CHAPTER 7
# ASSESSMENT OF FRUIT AND VEGETABLE INTAKE[1]

The Year 2000 Objective 2.6 related to fruits and vegetables is stated as follows (1):

> Increase complex carbohydrate and fiber-containing foods in the diets of adults to five or more daily servings for vegetables (including legumes) and fruits, and to 6 or more daily servings for grain products.

The objective to consume 5 or more servings of fruits and vegetables per day was based on the Dietary Guidelines for Americans which contain the recommendation to eat 2 to 4 servings of fruit and 3 to 5 servings of vegetables per day (2,3). That recommendation, in turn, was based on the USDA food guide developed in the early 1980's (4,5). It has since been depicted graphically in the Food Guide Pyramid (6).

The theoretical underpinning of the USDA food guide was that all foods should be counted toward one or more of the major groups and/or the fats, sweets, and alcohol group. The recommendations for the major food groups assured nutrient adequacy and sufficient intakes of complex carbohydrate and fiber, while the limitations on fats, sweets, and alcohol controlled the intake of these constituents and maintained energy balance (4,5). The philosophy was that dietary guidance "should allow as much flexibility as possible in selecting foods to meet nutritional objectives"; therefore, "individual food preferences should be accommodated by allowing for choice among food sources of fat, added sweeteners, and sodium" (5). Thus, it was recognized that fruits are fruits and vegetables are vegetables, whether or not they have added fat or sugar.

## Definition of fruits and vegetables

Considering the origins of the objective, whenever it is monitored, the definition of fruits and vegetables should include all foods which are considered to be fruits and vegetables according to the Dietary Guidelines for Americans (3), the Food Guide Pyramid (6), and/or supporting documentation (4,5). For example, sweet corn should be considered a vegetable, but popcorn, which is considered to be a grain in those publications, should not. Fruits and vegetables consumed as part of a few foods--fruits eaten as part of jams and fruit candy, and vegetables eaten as part of condiments, pickles, and potato chips--are excluded for purposes of monitoring the

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[1] See background paper titled, "Assessment of fruit and vegetable intake" in a later section of this report.

objective because the Food Guide Pyramid brochure suggests that such foods are not considered fruits and vegetables (6). Nonetheless, it is important to track these miscellaneous forms of fruits and vegetables to see changes in the relative proportion of fruits and vegetables eaten in such forms.

Because the Dietary Guidelines recommend limiting the intake of fat and increasing fiber (3) and because part of the justification for the health objective is that fruits and vegetables are "good sources of ... fiber" and are "generally low in fat" (1), the consumption of fruits and vegetables should be partitioned to provide even minimal information on fat and fiber content. Whenever fruits and vegetables are monitored, the total intake should be partitioned (at a minimum) according to the following scheme which separates foods by categories of use:

- fruit juice (including that in sweetened beverages)
- fruit, (including that from mixtures and that with sugar added, but excluding that in jellies)
- vegetables, without fat added (including vegetable juice)
- vegetables with fat added (including fried vegetables)
- vegetables eaten as part of mixed dishes (containing ingredients other than fat or other vegetables)
- miscellaneous (including fruits eaten as part of jams and fruit candy; and vegetables eaten as part of condiments, pickles, and potato chips)

The sum total of all of the above categories of use, excluding miscellaneous, should constitute the definition of "fruits and vegetables" for monitoring the objective. In order to assess variety in intake, the sum total of all fruits and vegetables monitored in relation to the objective should also be divided (at a minimum) according to the following subgroups which are based primarily on their nutrient content:

- citrus, melon, and berries
- other fruit
- dark green, deep yellow vegetables
- starchy vegetables, including dried beans and peas
- other vegetables

In either scheme, further subgroups could be added, but these major classifications should consistently be used to allow for comparisons across studies. See Detailed Notes at the end of this chapter for guidelines how individual foods should be classified according to these schemes.

This total accounting of fruit and vegetable intakes will allow tracking of all of the ways that fruits and vegetables are consumed, while the partitioning will provide

the ability to look at various subsets of use. Nonetheless, the plan to monitor all forms of fruits and vegetables should not imply an endorsement of all currently consumed forms.

In order to operationalize fruit and vegetable intake this way, the aggregation/disaggregation process (e.g., separating fruits and vegetables from other ingredients of food mixtures) is critical, because only the weight of the fruit/vegetable portion should be counted, not the weight of other ingredients. Nutrition monitoring at the national level is now sufficiently sophisticated to capture most of this information. The primary dietary intake surveys collect data via 24-hour recalls which provide the most detailed data available on food consumption. The Food Grouping System (7) (see Detailed Notes at the end of this chapter), being developed at the USDA, will allow food mixtures to be separated into their component ingredients. For example, the amount of vegetables in soups and on sandwiches can be estimated and ascribed some portion of a serving.

## Serving Sizes

Servings sizes should correspond to those provided in the Dietary Guidelines for Americans (3) and the Food Guide Pyramid (6): 3/4 cup of juice, 1 cup of raw leafy vegetables, 1 medium piece of fruit (such as an apple or banana), 1/4 cup of dried fruit, and 1/2 cup of cooked or sliced fruits or vegetables for all persons over the age of three. For children ages two to three, serving sizes should be two-thirds the size of adult serving sizes (5).

It is acknowledged that cultural differences exist with regard to serving sizes. For example, in some cultures, vegetables may be consumed more frequently in smaller quantities or as part of mixed dishes. However, this concern can be addressed by counting all uses of fruits and vegetables, however large or small, and dividing by the serving size to obtain the fraction of a serving from the particular food.

## Time Frame of Interest/ Seasonal Variation

The time frame of interest is "usual" (i.e., normal or long-run average), current (i.e., present or contemporary) intake, as this is the time frame implied in the objective. Seasonal variation of intake necessitates sampling over the year or, minimally, in summer and winter.

## Types of Estimates Needed

Both quantitative and qualitative data are needed for monitoring the objective. The mean number of servings and the proportion of persons meeting the objective

are examples of quantitative data. Qualitative data are needed, for example, to distinguish between high and low fat choices. The subgroup scheme described above shows the level of qualitative data needed.

Estimates are needed for groups of people, rather than individual level estimates. However, sufficient information must be available from each individual to provide reasonable estimates of the distribution of intakes for the group.

Optimal Method to Measure Objective

As for other dietary components, the optimal method for measuring the intake of fruits and vegetables is multiple, nonconsecutive 24-hour recalls. In practical terms, this would be at least two days of intake per individual, though the theoretical optimum number of days might be much greater. While there is some concern that 24-hour recalls suffer from under-reporting, interviewing and probing methods are continually being improved to recover more information from the respondent.

It is understood that the collection of multiple 24-hour recall data is not always possible, especially at the State and local levels. Thus, it would be beneficial if abbreviated methods (such as the battery of questions asked on the Behavioral Risk Factor Surveillance System) could be calibrated with multiple 24-hour recall data. However, such calibrations would need to be made for each different subpopulation for which the abbreviated method will be used. For additional information on this topic see the paper titled, "Brief Indicators of Dietary Status".

Food supply data, if used appropriately, can be useful in assessing trends in intake. Survey data cannot be used for trends yet because the methods outlined here have not been used before and the changing methodology precludes an assessment of trends. Methods used for determining food supply data have remained basically the same over the years. Food supply data provide information on population *use* of various products, rather than *consumption* per se, but because the discrepancy between use and consumption (e.g., the amount of waste) is estimated to be relatively constant, they can provide an indication of trends in consumption over time.

Food frequency data may also be useful. While much less exacting than 24-hour recall data, they address food usage over a much longer period of time than multiple recalls. Therefore, they may be useful in assessing usual intake, in determining variety of fruits and vegetables consumed, and in identifying true non-consumers.

## Specific Population Subgroups

While the objective, as stated, only refers to the general population of adults, estimates for other groups are also of interest. It is important to monitor the intakes of children and adolescents as well and, among adults, to monitor intakes of young adults versus older adults. In addition, estimates for different subgroups of the population, defined by gender, race/ethnicity, income, and education are important for targeting nutrition education messages.

## Administration Methods

No single administration method is preferred.

## Portion Size Estimation Aids

No consensus was reached on this issue.

## Analytic Issues

Two nonconsecutive 24-hour recalls are needed for each person in order to obtain a reasonable estimate of the distribution of intakes or, for example, the proportion of persons meeting the objective. Without multiple intakes per person, it is not possible to obtain appropriate estimates, and the proportions of persons with high and with low intakes will be overestimated.

## Special Considerations

Even with the use of detailed recalls or records and the ability to disaggregate food mixtures, there are some limitations to reporting fruit and vegetable intakes. First, the data are limited when typical recipes are used for the survey. For example, all reports of mashed potatoes, unless further specified, are assumed to have a specific proportion of potatoes, milk, fat, and salt; variation in the way mashed potatoes are prepared is not considered. Secondly, respondents may not know how their food has been prepared, such as whether or not fat has been added. Finally, because of limitations in how food consumption data are coded, it may not be possible to identify whether fat was added to a food just prior to consumption. For example, if butter is coded as a separate food item in a meal, it may not be clear whether the butter was added to the vegetable or to another item in the meal. Systems have been developed by NCHS and ARS for tracking which foods are eaten in combination if they were reported separately on the food intake record. Refinements are recommended in data coding to further identify foods eaten in combination in a meal.

The decisions made for this consensus statement were specifically directed toward monitoring the Year 2000 health objective related to fruit and vegetable intake. The working group did not consider the appropriateness of the methods for other purposes, such as monitoring consumption in relation to food safety, and this statement does not preclude using other definitions of fruits and vegetables for dietary guidance or meal planning purposes.

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## Detailed Notes

I. Examples of how different types of foods should be classified according to the way fruits and vegetables are used. These types could also be used as further subdivisions by which fruit and vegetable intake data could be reported:

### Fruit juice

- 100 percent fruit juice
- Fruit juice consumed as part of sweetened juice or other juice-containing beverage
- Juice, not specified (NS) regarding sugar

### Fruit

- Fruit, without added sugar or fat
- Fruit with added sugar
- Fruit, with added fat (e.g., in salad, with dressing or fried)
- Fruit, NS regarding sugar or syrup
- As part of a yeast bread or quick bread
- As part of a grain-based dessert (cake, cookie, sweet roll, pastry)
- As part of a cereal (e.g., bran flakes with raisins)
- As part of milk-based product, such as fruit-flavored yogurt

### Vegetables, without fat added

- Cooked vegetable(s), not fried and without added fat
- Cooked vegetable(s), NS regarding added fat
- Cooked vegetables with added sugar, without fat
- Raw vegetables, without added fat (including salads with non-fat dressing)
- As part of tomato sauce or salsa
- Vegetable juice

### Vegetables with fat

- Cooked vegetable(s), with added fat
- Vegetable(s), fried
- As part of vegetable-based salad with fat-containing dressing
- As potato (or other) chip

Vegetables eaten as part of mixed dishes

- As part of vegetable-based soup
- As part of vegetable-based mixture which contains non-vegetable ingredients or sauce
- As part of a sandwich
- As part of a meat-based mixture, such as salad or stew
- As part of meat-based frozen meal
- As part of meat-based soup
- As part of meat-based tomato sauce or as part of a meat dish with a tomato-based sauce
- As flavoring for meat or as part of a non-tomato-based sauce on meat
- As part of pizza
- As part of a pasta- or rice-based dish or stuffing, without tomato sauce
- As part of rice or noodle soup
- As part of a pasta- or rice-based dish, with tomato sauce
- As part of turnover, dumpling, eggroll, burrito, taco
- As part of an omelette or other egg dish
- As part of milk-based product

Miscellaneous

- As part of a condiment or flavoring
- As part of fruit-flavored candy
- As part of chocolate-covered fruit or candied fruit

II. Examples of how individual foods should be classified according to fruit and vegetable subgroups:

Citrus, melon, and berries

- Orange and other citrus juices
- Oranges, grapefruit, lemon, other citrus fruit
- Cantaloupe, watermelon, honeydew, other melons
- Strawberries, blueberries, other berries

Other fruit

- Apple juice, grape juice, other non-citrus fruit juices
- Apples
- Bananas, plantains
- Peaches, pears, grapes, other non-citrus fruit

Dark green, deep yellow vegetables

- Carrots
- Broccoli
- Spinach, mustard greens, other green leafy vegetables
- Sweet potatoes
- Other dark green, deep yellow vegetables

Starchy vegetables, including dried beans and peas

- Potatoes (white)
- Dried beans and peas
- Corn
- Other starchy vegetables

Other vegetables

- Tomatoes
- Green beans
- Cauliflower
- Lettuce
- Other non-starchy, non-dark green/deep yellow vegetables

III. Ethnic minorities with different eating patterns may use foods differently. For example, plantains are grouped with fruits in the Food Guide Pyramid, but used as starchy vegetables by some Hispanics. Breadfruit is grouped with starchy vegetables in the Food Guide Pyramid, but used more like a staple grain product by some Hawaiian cultures. For consistency across researchers who are monitoring progress toward the Year 2000 objective, specific food items should be counted in groups/subgroups in a consistent manner. However, when examining diets of cultural subpopulations with differing food use patterns, these different patterns should be considered in interpreting the findings.

Only the fruit and/or vegetable portion of a mixed food (such as a casserole) or other food (such as a bread) should be counted toward the health objective. Other ingredients of such foods (such as flour, milk, fat or sugar) do not contribute to the number of servings of fruits and vegetables.

The Food Grouping System (FGS) is a modular system under development that will link foods reported in USDA's food consumption surveys to recipes for those foods, separate each food into its ingredients, and regroup its ingredients by selected characteristics for analysis. The system can be used to estimate consumption of specific foods, ingredients, or agricultural commodities (7).

## SECTION II
## BRIEF INDICATORS OF DIETARY STATUS

by Frances J. Cronin, Ph.D., R.D.

### Introduction

### Background

At the Consensus Workshop on Dietary Assessment: Monitoring and Tracking the Year 2000 Objectives, State representatives emphasized the need for Federal guidance on selection and use of dietary methods appropriate for States, including recently developed brief indicators of dietary status. This need also was voiced at the October 1991 State and Local Input Meeting on the National Nutrition Monitoring and Related Research Plan (1). The meeting was sponsored by the National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP), Centers for Disease Control (CDC) to solicit opinion from representatives of State and local organizations and also private industry on their needs for nutrition monitoring data.

### Purpose

This Section reviews brief indicators of dietary assessment and identifies their strengths and limitations. As used here, brief dietary indicators refer to short dietary assessment instruments (approximately 20 or fewer questions) that measure intake of certain foods or food groups and that assess dietary behaviors associated with certain food intake patterns. The review is based on existing literature and relevant public documents and is generally limited to those for which adequate published information was available on the methods used in development and validation. Comparability to national data sources and indicators appropriate to national surveys is also addressed.

### State and Local NNMRRP Objectives and Activities

Besides the objectives related to the measurement and research components in the Ten-Year Comprehensive Plan for the National Nutrition Monitoring and Related Research Program (NNMRRP)(2), there are three objectives and a series of activities to enhance State and local capacity to monitor nutritional status and dietary practices. These will be designed in a way that coordinates with and complements the national nutrition surveys. A State monitoring structure is an essential part of NNMRRP (2).

The State and local objectives in the NNMRRP Ten-Year Plan (2) are:

- To develop and strengthen State and local capacity for continuous and coordinated nutrition monitoring data collection that complements national nutrition surveys (2). State and local data are needed to detect emerging nutrition issues, to monitor trends in nutrition-related health problems, to plan and evaluate nutrition interventions, to measure the quality of nutrition services, and to assess the effectiveness of food assistance and other programs.

- To improve methodologies to enhance comparability of NNMRRP data across Federal, State, and local levels (2). Activities related to this objective include the development of core indicators, standard methodologies, and interpretive criteria. These must be consistent across States and localities and be comparable to national nutrition surveys.

- To improve the quality of State and local nutrition monitoring data (2). This will require periodic training in the collection, analysis and use of nutrition monitoring data. In addition, periodic evaluations of the State and local monitoring systems are important to assure that State and local needs are met.

States' and Localities' Perceived Needs for Nutrition Monitoring Data

The data needs of States and localities are varied. This stems from the number of different organizations and groups with different needs for national nutrition monitoring data. While a comprehensive survey of the nutrition monitoring needs has not been done, efforts have been made to solicit opinion on the needs for dietary intake data from data users (1,3-6).

Of particular importance to many State and local agencies and organizations is their ability to measure both baseline data and progress toward the nutrition objectives presented in Healthy People 2000 (7) and Healthy Communities 2000: Model Standards (8). The nutrition objectives (7,9) related to food, nutrient and alcohol intake are:

- 2.5 Reduce dietary fat to an average of 30 percent of calories or less and average saturated fat intake to less than 10 percent of calories among people aged 2 years and older.

- 2.6 Increase complex carbohydrate and fiber-containing foods in the diets of adults to 5 or more daily servings for vegetables (including legumes) and fruits, and to 6 or more servings for grain products.

- 2.8 Increase calcium intake so at least 50 percent of youth aged 12 to 24 and 50 percent of pregnant and lactating women consume 3 or more servings of foods rich in calcium, and at least 50 percent of people aged 25 and older consume 2 or more servings daily.

- 4.6 Reduce the proportion of young people, who have used alcohol, marijuana, and cocaine in the past month to 12.6 for 12-17 year-olds and 29.0 for 18-19 year olds.

- 4.7 Reduce the proportion of high school seniors and college students engaging in recent occasions of heavy drinking of alcoholic beverages to no more than 28 percent of high school seniors and 32 percent of college students.

The second major area important to State and local agencies was measures of food sufficiency and food security, particularly the identification of groups within the population at risk for poor nutritional status.

Although, information on the general population is also of interest, data users emphasized the need for data from national surveys that is or can be localized. While data subdivided by region and urbanization are useful, data by state and areas within states are most useful. Users want to be able to compare data from their state or locality with data from other states and with national data estimates.

Data are also needed on subgroups of the population. Subgroups of interest included low income groups, racial and ethnic groups, institutionalized populations, homeless persons, elderly, pregnant and lactating women, infants, pre-school and school-age children.

Finally, data users want timely data in a form that is easy for them to use. The definition of ease of use depends on the user. Some users want the data to be analyzed and the results translated into information that they can use immediately. Other users want the data in a form that they can use to do their own data analyses and summaries.

## Considerations in Selecting Brief Indicators of Dietary Status

### Definition

As previously defined, brief indicators of dietary status are short dietary intake assessment instruments that measure an individual's intake of specific foods or food groups, often using food frequency-type questions. The instrument also may include an assessment of dietary behaviors associated with the intake of specific

foods or food groups. While the instrument is self-contained, it can be part of a larger questionnaire.

## Advantages and Disadvantages of the Food Frequency Method in Brief Indicators of Dietary Intake

Questionnaires that ask about the frequency of consumption of selected foods over a specified period are often used as brief dietary indicators. These are similar in design to qualitative food frequency methods that are often used in epidemiological studies.

The purpose of food frequencies is to obtain information on usual food intake over an extended period (for example, the last three months or the last year) to assess diet and disease relationships. Respondents are asked to report the number of times each food or food group on a checklist was eaten during a specified period. The lists vary in the number of foods included and specificity of the description (for example, fruits versus apples or oranges)(10,11). While food frequency questionnaires may be designed to obtain information on all or most of the food consumed, in this paper food frequencies refer only to those that are brief indicators targeted to obtain information of specific food items, such as alcohol, or food groups (for example, fruits and vegetables).

Sometimes average or median serving sizes are assigned to foods in food frequencies to obtain a measure of amounts. However, imputed portion sizes do not accurately represent serving sizes of all consumers. Quantitative food frequency methods that require recording of the usual amount eaten are used in some studies (10,11).

Food frequencies can be an appropriate measure to obtain information on specific foods or food groups. However, they are severely limited in their ability to make estimates at specific percentiles of the population (12-14). Therefore, the method is not appropriate in cases where precise estimates are necessary.

The respondent burden for a food frequency is light to moderate depending on the number of foods and whether quantitative information is requested (10,15). Response rates are usually high. Literacy is not required unless the food list is self-administered. While the checklist can be translated into other languages or administered by a bilingual interviewer, care must be taken so that the translation is consistent with the particular food information wanted.

Food frequencies are designed to obtain usual intake over a period of time. However, many individuals have difficulty in reporting their intake within a specific period. Often, current intake interferes with past recall (16). Many

respondents also have difficulty in averaging the intake of some foods, particularly seasonal foods.

## Considerations in Selecting Brief Indicators for Use

In selecting a brief indicator, many factors must be considered. First, the purpose or use of the data must be defined. If the purpose is to identify the existence of a problem such as high fat intake, less comprehensive data is required than for other purposes such as program planning (17). For example, the association between fat intake and coronary heart disease is well established in the scientific literature. Thus, the only information required to identify that a problem exists is that some portion of the population of interest has a high fat intake. Information on why the problem exists is not required.

The data required for planning programs and directing resources are broader in scope and more specific in detail than data required to identify problems (17). Information is required about the determinants of the behavior to be measured, and more detailed knowledge of sociodemographic factors and information about the availability, use and effects of programs. When possible, surveys designed to determine needs for planning programs and directing resources should include indicators that will be useful for program and policy evaluation. Measures should supply information on the current state of the population of interest and have the capacity to detect the changes that occur during the intervention.

Information needed for evaluation of programs and policies are usually more narrowly focused than information needed for problem identification and program planning (17). The data needed for evaluation depends in part on the information available when the policies or programs were implemented and on the expected effects of the program. The time-oriented aspect of monitoring for program and policy evaluation requires the selection of indicators that can measure differences over time. Finally, in selecting an indicator and other measures, feasibility must be a priority consideration.

## Sampling Considerations

The purpose of the survey, the type of characteristics to be measured, and the nature of the population to be studied is key to deciding both the sampling method and the sample size (15,17,18). Sometimes, the purpose may be to identify the magnitude (prevalence) of a problem. In other cases, the goal may be to identify the determinants of a problem and/or the characteristics of the population at risk. Unfortunately, often the need for data may include knowing the prevalence of the problem and the determinants of the problem and characteristics of the population at risk (17). Thus, decisions are required concerning the relative importance of the parameters to be measured.

*Sample Design.* There are many procedures available to select samples. The procedure most commonly used is probability sampling (17,18). This method requires that each element in a population have a known and non-zero chance of being selected. It requires rigorous use of sampling procedures throughout the sample selection process. The method does not make assumptions about the population, and randomization is used to ensure unbiased selection of sample units. Probability sampling allows inferences and estimates of reliability of survey results based on data from the survey.

Often costs or other constraints make using a probability sample unrealistic. In these instances non-probability methods may be employed (17). These methods require the judgement of an expert to make inferences about the population. Convenience sampling and purposive selection of "representative" units are included. The reliability of non-probability methods can only be assessed by using a model specified by an expert. Randomization may be used at some points in the sample selection process, but at some point during the selection of sample units, non-statistical criteria are used.

The purpose of the survey dictates the sample design (17). Prevalence estimates are required to establish the magnitude of a problem. This requires a probability sample of the population of interest. However, if the objective is to determine characteristics within a population, then non-probability sampling can be appropriate. It must be reasonable to assume that the factor of interest is associated with other characteristics, in the same way in the general population as in the subgroup of interest. For example, if the relationship between consumption of fruit and sociodemographic characteristics is the same in a sample of the general population and in the subgroup of interest, non-probability sampling may be appropriate. However, if the relationship is different, then non-probability sampling of subgroups will produce biases.

*Sample Size.* Just as with method of sample selection, sample size is key to obtaining worthwhile results (19). The failure to obtain an adequate sample can cause a failure to detect important effects and/or relationships and lead to misleading or wrong conclusions. There are many methods for estimating sample size requirements (15), and these estimates will vary depending on the method chosen, the degree of precision required and the tolerance for error. The procedures for deciding required sample sizes are complex and consultation with experts are recommended. Several references provide an overview of the procedures involved (19,20).

Finally, the availability of funds may require compromises in sample design and sample size. These should be recognized in advance and decisions made so that valid and reliable data can be obtained. Sample size and design decisions made

before the study dictate the conclusions that can be drawn when the survey is completed.

## Difficult-to-Sample Populations

Difficult-to-sample populations are subgroups that contain few individuals or subgroups that are difficult to identify, locate, enumerate or interview (17). Many of these subgroups are subject to nutritional risks. Examples include pregnant women (few relative to the total population), migrant workers (difficult to locate), homeless individuals (difficult to locate and difficult to enumerate), and substance abusers (difficult to identify and difficult to interview). These and other difficult-to-sample subgroups are seldom covered adequately in surveys whose sampling unit is based on the household or individuals in households.

Conducting dietary surveys of difficult-to-sample populations requires unusual sampling frames. This will result in trade-offs between adherence to probability sampling procedures and considerations of cost, error and feasibility. As discussed, use of sampling methodologies other than probability sampling will result in information that is less reliable and less defensible statistically, but is useful for some purposes.

## Statistical Considerations

Measurement qualities include validity/calibration, reliability, and sensitivity and specificity. These qualities are essential considerations in the selection of a survey instrument (21).

*Validity and Calibration.* The terms validity and calibration are used to discuss studies that compare one method of dietary assessment with another. Although each term has its own meaning, currently these terms are often used interchangeably in the studies to which they are applied (22). Validity is the ability of an instrument or a test to measure what it intends to measure. Although observational studies and laboratory measures are used, generally the validity of an instrument is assessed in terms of its correlation with a more established method (20). For example, a food frequency instrument might be compared to the results of multiple days of food records or 24-hour recalls on the same individual. Several researchers have pointed to problems related to some assumptions used in this type of validation (13,14).

The difficulty of obtaining a true measure of dietary intake is well documented. Although there are no true measures of food consumption, a weighed-food record has long been considered the most accurate method (15). However, recent research calls this assumption into serious question (23,24). Mertz and colleagues found 81 percent of the respondents under-reported food, and thus their calorie

needs, by around 18 percent. Whether the respondents changed their food habits and ate less than their usual intake, failed to report items actually eaten, or under-reported portion sizes, was not determined.

Calibration studies also use the information obtained by comparing the results from a new method of dietary assessment with more established methods on the same individuals. The purpose is to compare and/or correct the new method so that it more nearly reflects the relationship between the diet measure and the true diet (22). To be useful, calibration studies must have a large enough sample to estimate the relationship between the study instrument and the reference method with reasonable precision. Use of a sub-sample of the population of the study for which the instrument is being calibrated can provide information to "correct" the data gathered in the larger study, has been suggested (25). Adjustments require the strong assumption that the reference method is unbiased (20), which, as noted above, may not be true.

Careful review of validation/calibration studies is essential before selecting a brief indicator of dietary status. Of importance is the similarity of the population used to validate/calibrate the instrument to the population to be studied. A study to validate a brief indicator of fruit and vegetable intake found differences related to ethnicity (26).

*Reliability.* The reliability of an instrument is consistency of results on the same subject, repeatedly. For dietary intake surveys, reliability is studied by the administration of followup questionnaires to the same subjects. Several factors may affect the comparability of estimates (11). These include the respondent's ability to estimate past frequency and the amount consumed, a dietary change during the interval, inadequate instructions to the respondent, and "error-proneness" of the questionnaire.

In contrast to validity studies, reliability is more easily tested. However, the first assessment may influence subsequent assessments. Thus, the interval between repeated measures should not be too short. Similarity, if the period between the repeated measures is too long, recall can be difficult due to a memory problem.

*Sensitivity and Specificity.* When the instrument is designed to screen individuals for a particular condition or trait, then the sensitivity and specificity of the measure must be addressed (21). Sensitivity is used to characterize the incidence of true positive results obtained when a measure is applied to individuals known to have the characteristic (17). Specificity is used to characterize the incidence of true negatives found when a measure is applied to individuals known not to have the characteristic. Since for any indicator sensitivity and specificity are inversely related, decreasing one will increase the other. Thus, the performance of an indicator must by judged considering both sensitivity and specificity. A cut-off

value to maximize sensitivity will cause the test to be less specific. Judgement is required to decide the degree to which false positive and false negatives can be tolerated.

## Operational Criteria

Operationally, it must be feasible to conduct the dietary assessment measures as part of a larger survey or independently. The following are issues that need to be considered in the development of and/or the selection of measures to be used.

*Consistency of Results Across Sociodemographic Groups.* A number of factors may limit the comparability of results across various sociodemographic groups unless care is taken in selection of the method. Many factors can interfere with a respondent's ability to complete an instrument. These include literacy level, the language and the ethnicity of the respondent.

Individuals with limited literacy skills may not be able to participate, if the method selected requires reading and responding to written questions and/or instructions (15). Currently, estimates of illiteracy, functional incompetency and marginal competency in American adults ranges from .05 to 50 percent depending on how literacy is defined (27). Questionnaires with columns, check boxes to be marked and lines to be completed are very complex documents. Many individuals, who can read simple prose, have difficulty with these types of documents. Use of interviewers can alleviate this problem. However, even with interviews some examination of printed materials may be required. Training of interviewers to consistently handle these situations is essential for consistent results across sociodemographic groups (15).

Language barriers are frequently encountered in surveys, particularly among some subgroups. Often, the questionnaire can be translated into the language of the respondents. However, care must be taken that the items of interest are translated appropriately for the particular language group. A translation that may be appropriate for one group that speaks a particular language may not be understood the same way by others who speak the same language (28).

Special modifications of the survey instrument may be required where the study population is composed of individuals with strong ethnic identity (20,29). Use of interviewers of the same ethnic or cultural group is preferable so that the dietary information is appropriately expressed (30). Some foods that are very dissimilar may be called by the same name or similar foods may be called different names (28).

In addition the use of standard food lists to obtain food frequency information from individuals with a strong ethnic identity may be inappropriate (20,29). Many members of ethnic groups consume both foods that are typical of the rest of the population and foods that are specific to their own group. If comparisons across ethnic groups are important, then an instrument validated for use with the ethnic group of interest should be selected. It may be appropriate to develop a different instrument to measure the construct of interest (29).

*Comparability With Existing National Surveys or Surveillance Systems.* The importance of comparability of data across dietary intake surveys has been emphasized by several groups (1,2,31). Many factors can interfere with the capability of comparing the results from one survey with those of another. These include consistency in method, mode of administration, choice of nutrient composition data base/computer software, consistency in the questionnaires, and population descriptors. Clearly the method used to determine dietary intake – food record, 24-hour recall, food frequency, diet history – impacts on the results. It may be less obvious that other factors also influence the comparability of results.

The mode of administration of the survey instrument is just one factor. Food frequencies have been administered by telephone, mail, and in-person interviews. A review of the limited research suggests that, while considerable agreement was found between telephone and in person interviews, the agreement was not perfect (20,32).

The mode of administration affects cost and response rate. Mail and telephone surveys are less costly than face to face interviews. Response rates are higher for telephone and in-person interviews than mail surveys. However, some segments of the population do not have telephones or will not answer their phones under some circumstances. Alternative methods should be employed to reach these individuals. Finally, obtaining information on serving sizes is difficult during phone interviews, unless portion size estimating aides are provided to the respondents in advance (20).

Analysis of nutrient intake requires an adequate and appropriate nutrient data base. Many factors are involved in determining both the quality of the nutrient data for foods and its appropriateness for a particular use (18,20,33). Nutrient data bases must be updated regularly. Changes in nutrient values of foods occur for two reasons. These changes can be due to real changes that occur in the nutrient content of a food, and to improvements in the quality of nutrient data (31,34,35). Because nutrient data bases differ, use of data bases from different sources or different versions of the same data base will affect comparability of nutrient data intake estimates.

The way that a question is asked will affect the response. Some dietary intake studies rely on a respondent's or a surrogate's ability to recall foods and beverages consumed. The way questions are asked affects responses. Researchers have found that when foods high in fat are grouped together instead of asked about individually, frequency of consumption is lower (36). In addition, many respondents reported never consuming the foods. The use of probes can help respondents to recall food intake (37). However, unless the use of probes by interviewers are standardized, the results could be inconsistent from respondent to respondent.

Perceived acceptability of some foods over others is another factor that affects responses. Some foods are viewed by some individuals as "good" or "bad." Respondents may be reluctant to report eating certain kinds of foods, or they may under- or over-report intake depending on the perceived healthfulness of the food. Conducting interviews in private and training of interviewers to refrain from either negative or positive reactions may encourage accurate reporting (20).

Consistency in questions is also important for population descriptors, such as income, education, and race and ethnicity. A recent report from the Interagency Board for Nutrition Monitoring and Related Research (IBNMRR) recommended specific questions for use in NNMRRP surveys and surveillance activities (38). Use of these descriptors should be considered, if comparisons with national surveys is planned.

Finally, it is generally recognized that previous questions may influence responses. For example, questions related to food sufficiency may be influenced by questions related to participation in Federal or local food programs. Besides using consistent questions, it may be important to try to order questions similarly to those used in the survey to which the results are to be compared.

*Ease of Incorporation of Brief Indicators into National Surveys and Surveillance Systems.* The National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention annually conducts the State-based Behavioral Risk Factor Surveillance System (BRFSS) to assess the prevalence of personal health practices related to the leading causes of death. Beginning in 1990, optional modules for the assessment of dietary fat and fruit and vegetable consumption were added (39). Questions about alcohol intake have always been included. Data from participating states can be combined and states can compare data from their state to the "national data." However, while useful for some purposes, the combined state data is not a national probability sample.

As noted previously, one of the major purposes is to compare results to those obtained from the large nationally representative surveys such as HHS's National Health and Nutrition Examination Surveys (NHANES) and USDA's Continuing

Survey of Food Intakes by Individuals (CSFII). If the brief indicators are included as part of these larger surveys, it will be possible to compare local and state with data from a nationally representative sample.

Besides data on food and nutrient intake, national surveys contain additional measures in areas such as health status, diet health and knowledge, and food expenditures. If brief indicators of dietary intake were included in the larger surveys, then the indicators could be linked to other data of interest. Analysis could provide information on the association of the brief indicators with other measures of health, nutrition and dietary status included in those surveys. This would provide useful information to users of the brief indicators in other surveys or surveillance. However, because national surveys are large and complex, brief indicators that are compatible with current items, have a small respondent burden, are compatible with the survey methodology and/or are of wide interest are more likely to be included in national surveys.

*Availability of Interpretive Criteria.* To be useful, a measure of dietary intake must have meaning. Brief indicators of dietary intake generally only give a partial picture. Thus they are most useful when neither completeness nor quantitative accuracy is required. For example, a brief indicator might be used to separate individuals into groups based on their intake of a specific nutrient such as fat or a specific food group such a fruit. This allows education or treatment efforts to be concentrated on those with the greatest need. However, unless the indicator has been calibrated with other complete measures of dietary intake, the inferences from the intake data are unclear. In addition, comparisons with other groups and the larger population are not possible. Therefore, indicators that will be most useful are those for which comparisons can be made with other groups, and with the population as a whole.

*Reasonable Respondent Burden.* Among other factors, respondent burden can influence response rate, an important source of error in any survey. Non-response can result from refusal to participate in the survey, or from refusal to complete a specific item or items on the questionnaire. Both could be the result of respondent burden. In either case, the lack of data can result in a systematic difference in study findings as compared to the population values of interest (15).

*Cost.* Finally, the amount of money available is often key to deciding the method used to determine dietary intake. All costs need to be considered when making decisions. These include the cost for design of the survey, development and production of the survey instrument, obtaining the sample, data collection (including the cost of interviews if needed, interviewer supervision, mailing costs, telephone costs and so forth), data cleaning and documentation, data analysis and preparation of reports. Costs also include the time of in-house staff who supervise and do other tasks related to the survey. Time spent by in-house staff cannot be

devoted to other essential functions of the organization. Unless all costs are considered before beginning a survey, the results may be compromised and/or the data may not be analyzed in a timely manner.

*Estimation of Portion Size.* While brief indicators are generally not quantitative, sometimes information on serving size is needed. Research suggests that individuals have great difficulty in estimating serving sizes (40), even when food models are used (16).

## Review of Selected Brief Dietary Indicators

### Overview

Several brief dietary indicators have been developed for measuring intake of foods and/or nutrients that can be useful for monitoring progress toward meeting the Year 2000 nutrition objectives. While these measures will not provide point estimates of actual intake, they can provide information on the variability of intake among individuals and their relative rank as compared to others (41). For example, complete food frequencies typically contain 100 or more food items. However, often only 15 to 20 items are required to account for most of the intake of a particular nutrient or food group in the population (41).

The advantages of brief indicators are the lower cost and reduced respondent burden, which makes them an option for many situations where dietary intake information is needed (41). However, their limitations must be understood. Brief indicators are designed to capture information only about foods with large amounts or concentrations of a specific nutrient or foods comprising a specific food group. They are not quantitatively meaningful unless the results are compared to other studies using the same questionnaire. Finally, a brief indicator designed to be used with one population group may not measure intake in other population groups in the same way.

These and other issues will be discussed in relation to brief indicators designed to measure fruit and vegetable intake, fat intake, intake of calcium-rich foods and alcohol, and measures of food sufficiency. Brief indicators, along with other measures of dietary intake, are also discussed in the recently published Dietary Assessment Resource Manual (20). The manual also includes copies of the instrument or lists of foods included in the brief indicators and other measures of dietary intake.

### Fruit and Vegetable Intake

The Year 2000 objectives include an objective to increase intake of fruits and vegetables to five or more servings a day. At the national level, the source of data

for the baseline measure is 24-hour recall from USDA's CSFII 1989-90. Progress toward meeting this objective will be measured with 24-hour recall data from national food consumption surveys (42). Thus, any brief indicator will not provide data that is directly comparable to these national measures. However, brief indicators of fruit and vegetable intake could provide data for state and local policy development, program planning and evaluation of progress.

The National Center for Chronic Disease Prevention and Health Promotion, CDC has developed a six-item fruit and vegetable module for use in the Behavioral Risk Factor Surveillance System (BRFSS) (26). BRFSS is a surveillance system designed to collect data by telephone (using random-digit dialing techniques) within participating states (39,43). The primary purpose is to provide state-specific estimates of health behaviors. All the states use a core questionnaire. In 1990, 16 states also administered the 6-item module (26).

The BRFSS fruit and vegetable module was evaluated by comparing the intakes as measured by the module with more extensive measures of dietary assessment — diet records, food frequencies, and diet records. The populations used for the validation were diverse including middle-aged and older adults in Beaver Dam, Wisconsin; middle-aged and older women throughout Wisconsin; parents of school-age children in Augusta, Georgia; low income Hispanic mothers in Chicago; and older affluent white adults in Arizona. While the dietary intake methods used for comparisons were not standardized, the fruit and vegetable module was administered consistently following the BRFSS procedures. Fruits and vegetables reported on the dietary recalls and record were translated into servings using procedures defined by the authors (26).

Validity was assessed for both the individual fruit and vegetable items in the module and for the total intake of all fruits and vegetables. The mean intakes from the BRFSS module were compared with the means from the more extensive measures. Correlation coefficients between intakes measured by BRFSS and intakes from the other methods were calculated. Finally, Spearman rank order correlation coefficients were used to compare individuals' BRFSS rankings with rankings by the reference methods (26).

The mean number of servings of all fruits and vegetables varied among the groups studied. Mean intakes measured by BRFSS were similar to those measured by recalls and records; however, BRFSS intake estimates were lower than those measured by the extensive food frequencies. The one exception was that affluent white adults in Arizona reported a higher intake on the BRFSS measure. Much of the difference between BRFSS estimates and the reference methods is the lower reported intake of "fruit" (not counting fruit juice) and "other vegetables." These were the two broadest categories in the BRFSS fruit and vegetable module

(26). This finding is consistent with results of the effect of grouping high fat foods into a single question (36).

Correlation coefficients between BRFSS total fruit and vegetable intake and more extensive reference methods ranged from 0.47 to 0.57. Correlation coefficients with food records and recalls, adjusted for intra-individual variation, ranged from 0.36 to 0.66. The BRFSS category "other vegetables" generally showed the smallest correlation with reference methods (26). Low correlations (-0.04 to 0.22) for individual items were found for the Chicago sample composed of low-income Hispanic women. This may suggest that the BRFSS module does not adequately represent foods commonly consumed by Hispanics (26).

Three of the five studies (Beaver Dam, Wisconsin and Augusta, Georgia) had a sample size of over 100. In these studies, there were no consistent differences in correlation coefficients according to age, sex, and education. In Augusta, there were adequate numbers of blacks and whites to allow calculation of correlation coefficients by race. The correlations between BRFSS and the reference food frequency were 0.41 for whites and 0.64 for blacks (26). The three studies were also used to assess the mean fruit and vegetable intake as measured by the reference methods by quartile of BRFSS intake. Except for the upper two quartiles of intake in Augusta study, the mean intake of fruits and vegetables increased consistently across the BRFSS quartiles (26).

The BRFSS fruit and vegetable module had correlations similar in magnitude to other studies comparing more extensive food frequencies with results of diet records and recalls, and it appears to generally rank individuals by intake, appropriately. A concern is the low correlations between the six individual items and diet recalls of low income Hispanic women from Chicago. This suggests that the BRFSS module may not be sensitive to Hispanic foods. Further validation/calibration studies with other ethnic groups and low income populations would be appropriate.

One issue that affects any measure of fruit and vegetable intake is the definition of what counts as a fruit and a vegetable. This issue is discussed in the chapter tiled, "Assessment of Fruit and Vegetable Intake." Users of the BRFSS module should recognize that not all foods that are classified as fruits and vegetables by the Food Guide Pyramid are included in the six items. The question about potatoes specifically excludes fried potatoes and potato chips, but does not exclude other vegetables prepared with fat. In addition, respondents are not asked to include in their estimates, fruits and vegetables that are found in mixtures (for example, pizza, beef stew, apple pie) or used as condiments. The Food Guide Pyramid also allows legumes to be counted as a vegetable, but the consumption of legumes is not included in the BRFSS module. These may cause an

underestimation of total vegetable consumption, as defined by the Food Guide Pyramid, for most individuals.

Despite the limitations, the BRFSS is part of a national surveillance system. Thus, states and localities can compare the results from their area with the aggregated "national" data and with data from other states. The BRFSS system includes key sociodemographic characteristics on respondents, which provides essential information for policy analysis and program planning. Respondent burden is low and the results are easily tabulated and analyzed.

Comparison to nationally representative data has been mentioned previously as a goal of the States. The 5 A Day for Better Health Baseline Study collected data on a nationally representative sample of adults in 1991. This telephone survey included a 33-item food frequency to measure intake of fruits and vegetables (44). A soon to be published study discusses the adjustment of estimated servings per week. Individuals tend to over report fruits and vegetables when many different items are included on the questionnaire (45).

A seven-item assessment instrument for fruit and vegetable intake has been developed by grantees of a series of studies across the country supported by the 5 A Day for Better Health Program. The instrument is designed to provide an indicator of the average number of servings of fruits and vegetables consumed daily, and will be validated as part of the individual 5 A Day research projects. A copy of the instrument is included in Dietary Assessment Resource Manual (20).

The NHANES III (1988-94) food frequency has 18 fruit and vegetable items and one legume item (46). In addition there are two questions in the meat category for mixed dishes and soups containing vegetables. While this expanded food frequency has not been validated, comparison of this data with food intake data from the 24-hour recall in NHANES III is planned by the National Center for Health Statistics (NCHS). In addition, it will provide national estimates subdivided by sex, age and selected ethnic and racial groups that could be compared with state and local estimates.

## Fat Intake

The Year 2000 objectives include an objective to reduce fat intake to an average of 30 percent of calories or less and an average saturated fat intake to less than 10 percent of calories among people aged two and older. At the national level, the source of data for the baseline measure and progress toward meeting this objective will be measured with 24-hour recall data from national food consumption surveys (46).

Measurement of the percent of calories from fat is more complex than the measurement of the intake of specific foods such fruits and vegetables. It requires information not only on the amount of fat and/or saturated fat, but also on the calories consumed. Information is not only needed on the food sources of fat, but also the sources of non-fat calories. Thus, accurately measuring the percent of calories from fat requires information on total intake. If one only wants to categorize individuals into groups by fat intake then only information on the intake of major sources of fat may be required. Byers and others (41) found that 17 items of a 128-item food frequency questionnaire explained 90 percent of the variance in fat intake. However, unless calorie intakes are similar, the grams of fat in the diet may not provide a meaningful ranking.

Block and others (47) developed a 13-item screening tool to identify a group of women whose mean percent of calories from fat intake was high at baseline. The purpose was not to develop accurate estimates of fat intake as a percent of total intake nor to rank or categorize people accurately on that variable. Its purpose was to identify individuals who could be further screened with more precise measures of dietary intake or who might benefit from counseling.

The final 13 food items included in the Block Fat screener are based on a rank order list of the contributors of fat to the diet developed from NHANES II conducted in 1976-80 (47). These items accounted for approximately 60 percent of the total population fat intake. The 13 items are a subset of items found in the 100-item Block Food Frequency Questionnaire (48), now called the Health Habits and History Questionnaire (HHHQ).

Longer lists of foods that accounted for a larger percentage of fat intake and lists of foods that accounted for both fat and calorie intakes were evaluated before the decision was made to use the 13 food items. This evaluation was conducted using data from the 100 item Block questionnaire completed by 150 women aged 45 and older, who were healthy participants in prevention trials or methodological studies. The 13 item list and the other lists tested were subsets of the longer questionnaire (47).

Correlations were calculated between the 100 item questionnaire and the subsets of items from this questionnaire for percent of calories from fat and grams of fat, to decide which of the lists best met the instrument criteria. Although a 43-item and a 33-item screeners correlated reasonably well with the full questionnaire, the researchers decided that those instruments would be too long for a rapid screening tool. Since the correlations between the percent of calories from fat derived from the 100 item Block questionnaire and the grams of fat derived from the subsets of 25 items, 18 items and 13 items were similar, the 13 item subset of high fat foods was selected for further evaluation (47).

The further evaluation of the Block screener used women 101 women aged 45 to 69 years, who were controls in the Women's Health Trial. Ninety-five percent of the women were white and 65 percent had at least one year of college. These women had completed three 4-day food records at six month intervals over one year. At the end of the year they also completed the 100 item Block Questionnaire. The evaluation of the 13-item screener was based on the responses to items from the 100-item questionnaire. Correlations between the grams of fat as estimated by the screener and the percent of calories from fat from the food records were 0.54 and between the grams of fat from the screener and the food records was 0.58. The mean percent of fat for those above the mean on the screener was 40.8 percent compared to 35.1 for those below the mean (47).

Finally, the ability of the screener to classify individuals correctly was evaluated. Sixty-eight percent of participants were correctly classified by the fat screener above or below the median percent of calories from fat based on the two four-day food records (47).

The results of the evaluation showed correlations of 0.54 and 0.58 between grams of fat as measured by the Block screener and percent of fat and grams of fat, respectively, from multiple days of food records. Several factors should be recognized before selecting this measure. First the evaluation study was done on a single subset of the total population, mostly white, highly educated older women. Second, the data were not from the screener administered as a separate questionnaire, but the data used to represent the 13 items of screener were from the 100 item Block Questionnaire.

A modified version of the Block Screening Questionnaire is presented in the Appendix of Dietary Assessment Resource Manual (20). It combines fat and plant food dimensions in a 24-item self-scoring questionnaire. A study submitted for publication found correlations of 0.65 for grams of fat and 0.40 for percent of energy from carbohydrate (20). Dietary analysis software is available, which contains updated nutrient data to use to calculate the fat intake measured by the screener (49).

BRFSS, described earlier, has a dietary fat module, which like the fruit and vegetable module, is optional. The 13 item module was adapted from the 1987 National Health Interview Survey on Cancer Epidemiology and Cancer Control. It is similar to the Block Screening Questionnaire (47). An evaluation of the BRFSS fat module has been completed and a manuscript is in press (50). The methodology and the populations used for the evaluation are the same as those used for the BRFSS fruit and vegetable module (26). A copy of the module and a brief description is included in Dietary Assessment Resource Manual (20).

According to the author, the evaluation of the BRFSS fat module shows that most but not all substantial differences in fat intakes between subgroups were identified. The module will not capture small differences between subgroups. It is inappropriate for use when the sample size is small and when diets of the populations to be studied differ from average American diets. However, the authors believe that with attention to the limitations, the module is useful for surveillance (50). States and localities can compare the results from their area with the aggregated national data. The BRFSS includes key sociodemographic characteristics on respondents, which provide information that is essential for policy analysis and program planning. Respondent burden is low and the results are easily tabulated and analyzed.

Potential users are advised to carefully review and consider the data from the evaluation study, before using the module for their surveillance activities. It should be noted that the evaluation of BRFSS fat module was conducted on five different populations representing subgroups of interest to many states and localities. While the results of the evaluation do not apply directly to other fat screeners, they suggest that the brief indicators of dietary fat should be evaluated on the population of interest.

A 19 item Food Behavior Checklist (FBC) (51) was developed to measure food use related to adopting lower-fat and higher-fiber diets. It is a simplification of the 24-hour recall and asks yes/no questions about food use the previous day. The instrument was developed through a series of pretests using a broad range of socioeconomic and age groups. Focus groups were used to examine the relevance of the instrument to different ethnic groups (Black, Hispanic and Asian). A copy of the instrument is included in Dietary Assessment Resource Manual (20).

The validation compared the responses of 96 women aged 45 to 59 to information collected during a 24-hour recall. The association of items on the FBC with usual percent of energy from fat and usual fiber intake was also done. Usual intake was based on a full food frequency and eight days of dietary records (51).

The proportion of women reporting use of the 18 items on the FBC was higher than on the 24-hour recall. Observed agreement between responses on the two instruments was over 85 percent for all but three items. The Kappa statistic was used to assess agreement. Two items, high fiber cereal and bacon or sausage, had a kappa of less than 0.60, the level considered as the cutpoint for fair agreement beyond chance. Eleven items had good to excellent agreement (kappa > 0.80) and five had good agreement (kappa > 0.60). To improve agreement for high fiber cereals, the instrument now includes the brand names of high fiber cereals (51).

With one exception (vegetable at dinner) the direction of association of usual intakes of fat as a percent of calories and fiber with responses to the FBC was

consistent with the fat or fiber content of the item. The 95 percent confidence interval for the difference between the FBC and the diet record estimates of percent of calories from fat, indicates how well the two methods agree. If the 95 percent confidence interval for the estimated difference includes zero, then the *true* difference may be zero. Only four items (pastry, salad, butter or margarine on bread, and cold cuts) had 95 percent confidence intervals which excluded zero. Confidence intervals for fiber intake excluded zero only for cereal and fruit. Results did not differ when food use the previous day was taken from the 24-hour recall (51). A single 24-hour recall is not considered appropriate for measuring usual intake of individuals (10,15,18). This measure is designed to characterize groups, not individuals (20).

Further validation of the instrument in other population subgroups is needed. It may be appropriate to use the instrument in planning interventions, if it is validated on the population to be studied. If intervention program goals can be formulated as increases or decreases in the intake of specific foods, then the FBC may be appropriate for use in the evaluation of community intervention programs.

Kristal and others (52) have developed a 44-item questionnaire for use in estimating intake of total fat, saturated fat, dietary fiber and percent of calories from fat. While longer than the 20 items suggested in the definition of a brief indicator, its yes/no response to a series of questions is designed to reduce respondent burden. The questionnaire took an average of 4.2 minutes to administer by telephone. Respondents found a self-administered version easy to complete.

The Kristal instrument was developed using the "variance explained" approach (53) based on intake data from food frequencies completed by 93 women. Fat and calorie intakes are estimated using algorithms based on data from the sample used to develop the instrument. The food frequency used is similar to the Block 100 item questionnaire. The women who participated in the development stage and the 97 women who participated in the validation stage were 45 to 59 years old, tended to live in higher income households, completed college and were interested in nutrition and health (52).

The women in the validation study completed a questionnaire at baseline, a 4-day food record during week one, a food frequency during week six, the short diet questionnaire administered by telephone during week 12, and a second 4-day food record during week 13. Correlations between the self-administered questionnaires and the two 4-day food records were 0.52 for total fat, 0.53 for percent of calories from fat, 0.61 for saturated fat, and 0.40 for dietary fiber. These correlations are similar to the results obtained when the instrument was administered by telephone. The instrument also correctly classified the respondents by quartile based on an average of the food frequency and the two 4-day food records between

36 and 49 percent of the time, and misclassified them by more than one quartile between 10 and 21 percent of the time (52). The authors acknowledge that the participants in the study were not representative of the general population and recommend additional evaluation of the performance of the questionnaire in a less educated sample, in men, and in other subgroups (52).

Published evaluation or validation studies on the brief indicators of dietary fat intake are limited to only one population group. Thus, use of these should be preceded by evaluation studies on the population to be studied. The nutrient data base should also be reviewed to see that it reflects the foods consumed by the population to be studied.

Further research to develop and validate brief indicators of fat intake is needed, since reduction of fat intake in the American population is an important national goal. Longer food frequencies containing 60 or more items have been developed and validated with many population subgroups. Many of these are summarized in Dietary Assessment Resource Manual (20).

## Behavioral Indicators of Dietary Fat Intake

An alternative to assessing fat intake directly with a brief indicator is use of an instrument that measures behavioral indicators of fat intake. Kristal and others (54) have developed and evaluated a food habits and eating patterns questionnaire that measures dietary patterns related to selecting low fat diets. The original instrument had 18 questions and was designed to evaluate four relevant dimensions of dietary behavior – excluding high-fat ingredients and preparation techniques, modifying high-fat foods, substituting specially manufactured low-fat foods for their higher fat counterparts, and replacing high-fat foods with low-fat alternatives.

The instrument was evaluated in 99 women aged 45 to 59 years who had a wide range of fat intakes (19 percent to 49 percent calories from fat). The participants completed the diet behavior questionnaire twice, two 4-day food records and a food frequency questionnaire. Factor analysis confirmed the hypothesized dimensions (listed above) except the exclusion dimension. The exclusion dimension split into two factors – "avoid meat" and "avoid fat as a seasoning." The resulting five scales had high test-retest and internal consistency reliabilities. Correlations for the five scales ranged from 0.34 to 0.57, and the correlation for all 18 items with the percent of calories from fat was 0.68 (54).

A modified version of the questionnaire was validated and used to measure maintenance of low-fat dietary patterns in a group of 894 women aged 45 to 59 participating in the Woman's Health Trial (55). The modified instrument with 21 questions had high internal consistency and the correlation of the five scales with

the percentage of calories from fat ranged from 0.36 to 0.62. The correlation of the 21 items with the percent of calories from fat was 0.68.

A more recent version of the Kristal food habits instrument is composed of 26 items and is shown in Dietary Assessment Resource Manual (20). This was used in an Eating Patterns Study designed to test the efficacy of a low-intensity self help intervention to reduce fat and increase fiber intake through information distributed by physicians (56). The 1814 participants that completed this study were adults. No additional sociodemographic information was provided. The dietary habits questionnaire was highly correlated with the percentage of calories from fat as measured by a food frequency or a 4-day diet record.

The Kristal food habits instrument is also being used in a feasibility study of 2,100 individuals from minority populations (20). Results from this study should clarify if the instrument is appropriate for use in a variety of populations. Meanwhile, this instrument provides an alternative to or a brief additional measure of dietary fat intake. It also provides information on selected practices associated with low fat intake, which could help in program planning and evaluation.

## Calcium Intake

The Year 2000 objectives include an objective to increase calcium intake so at least 50 percent of youth aged 12-24 and 50 percent of pregnant and lactating women consume three or more servings daily of foods rich in calcium, and at least 50 percent of people aged 25 and older consume two or more servings daily. At the national level, the source of data for the baseline measure and progress toward meeting this objective will be measured with 24-hour recall data on consumption of dairy products from national food consumption surveys (41).

Several brief measures (approximately 20 items or less) of calcium intake have been published (57-59). All the measures estimating calcium intake included non-dairy foods in the instruments to reflect the small but important contribution of non-dairy foods to calcium intake.

Cummings and others (57) used the list of calcium-containing foods in the 100 item Block Questionnaire (48). Thirty-four food items accounted for 85 percent of the calcium intake based on data from NHANES II (1976-80). Calcium intakes estimated from these food items, along with portion sizes of small, medium, and large, produced a 0.76 correlation with the estimated calcium intake from 7-day food records provided by 57 elderly women (57).

The estimated mean calcium intakes were 612 mg for the 7-day food record and 637 mg for the 34 item food frequency. Limiting the instrument to the top 15, 10, or 5 foods had little effect on the correlation (0.76, 0.75 and 0.67 respectively).

However, reducing the number of items reduced the estimated mean intakes from the food frequency. The top five items contained only one non-dairy food - white bread, rolls and crackers. The top 10 items included three non-dairy items and the top 15 items included seven non-dairy items (57). These data suggest that milk and milk products are generally the key sources of calcium, but not the only sources.

NHANES III (1988-94) includes eight milk and milk products items in the food frequency questionnaire (46). While this expanded food frequency has not been validated, comparison of these data with food intake data from the 24-hour recall in NHANES III is planned by NCHS. It will provide national estimates by sex, age and selected ethnic and racial groups that could be compared with state and local estimates. Besides these measures, it would be appropriate to estimate the proportion of the total calcium intake provided by various food groups for the total population and sex, age, and selected ethnic and racial groups. These would show the importance of milk products in calcium intake of various subgroups.

## Alcohol Intake

The Year 2000 objectives include two objectives related to alcohol consumption of youth. They include reduction of the proportion of young people who have used alcohol, marijuana, and cocaine in the past month to 12.6 for 12-17 year olds and 29.0 for 18-19 year olds, and the reduction in the proportion of high school seniors and college students engaging in recent occasions of heavy drinking of alcoholic beverages to no more than 28 percent of high school seniors and 32 percent of college students.

At the national level, the source of data for the baseline measure and progress toward meeting first objective is the National Household Survey of Drug Abuse, by the Substance Abuse and Mental Health Services Administration, and the second objective by the Monitoring the Future, a survey of high school seniors by National Institutes of Health (42).

The Youth Risk Behavior Survey (YRBS), sponsored by the National Center for Chronic Disease Prevention and Health Promotion (39) includes questions that address both issues. It is conducted periodically. In 1992, YRBS was conducted as a follow-back to the 1992 National Health Interview Survey and included persons aged 12 to 21 (60). The number of participants was 10,645. A brief report presenting data from that survey was recently published on current heavy episodic drinking as described in Objective 4.7 (60).

The 1995 YRBS, like the 1990 YRBS, will be a representative sample of students in the 9th through 12th grade (39,61). The 1995 survey will include six alcohol related questions. Two will specifically measure the two Year 2000 objectives.

The other questions ask about the age of first drink, number of days consuming alcohol during the teen's lifetime, and drinking on school property.

The Year 2000 objective for alcohol consumption by the general population (Objective 4.8) is measured by per capita consumption data (42). BRFSS (39) includes five questions on alcohol consumption. These include questions about consumption of alcohol during the last month, the frequency and amount of consumption, the number of occasions on which five or more drinks were consumed (62).

Use of the questions from either YRBS or BRFSS on questionnaires designed for the age groups covered allows for comparison of results with aggregated "national" data. BRFSS and YRBS are part of national surveillance in the NNMRRP. Thus, states and localities can compare the results from their area with the aggregated "national" data and with data from other states. The BRFSS and YRBS systems include key sociodemographic characteristics on respondents, which provide information that is essential for policy analysis and program planning. Respondent burden is low and the results are easily tabulated and analyzed.

NHANES III (1988-94) includes three alcoholic beverage items – beer (including lite), wine, and hard liquors (such as tequila gin, scotch and whiskey) – in the food frequency questionnaire (HHS, 1994). While this expanded food frequency has not been validated, comparison of these data with food intake data from the 24-hour recall in NHANES III is planned by NCHS. It will provide national estimates by sex, age and selected ethnic and racial groups that could be compared with state and local estimates.

A discussion of issues related to measuring alcohol consumption can be found in the chapter titled, "The Measurement of Alcohol Consumption."

## Measuring Food Sufficiency

Measuring food sufficiency or food security is a high priority of many State and local health and nutrition organizations. It is also part of the Ten-Year Comprehensive Plan for NNMRRP (2). Valid brief indicators of food sufficiency should be part of nutrition monitoring.

Several terms are used to describe food sufficiency. Food insufficiency has been defined as an inadequate amount of food intake due to a lack of money or resources (63). Other authors use the term food insecurity, which they define as limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways (17,64). Hunger is defined as the uneasy or painful sensation caused by a lack of food. It includes the recurrent and involuntary lack of access to food. Hunger may

produce malnutrition over time (17). Radimer and co-authors (63) have a similar definition for hunger; while Wehler's and co-authors' (65) definition of hunger combines some concepts of food sufficiency/insecurity and hunger in the same term. Because of the differences in use of terms to describe measures, users must carefully review the documentation of the various measures of food sufficiency/hunger to fully understand the measures.

The Community Childhood Hunger Identification Project (CCHIP) has developed and evaluated an instrument to measure hunger in low-income households with children under 12 years in the United States (65). They define hunger as the mental and physical condition that comes from not eating enough food due to insufficient economic, family or community resources. The hunger index is based on this definition and a conceptual model of hunger. The index includes eight questions with either a household, adult or a child focus. An example of a question with a household focus is "Does your household ever run out of money to buy food?" An example of a question with a child focus is "Do your children ever say they are hungry because there is not enough food in the house?" When respondents respond positively to the questions, additional information is asked to establish the frequency of the situation.

The CCHIP index was evaluated in a demonstration project in the state of Washington. The sample, which included households with at least one child under 12 and with incomes of less than 185 percent of the poverty level, was randomly selected from lists of children eligible for free or reduced price school meals. A total of 377 households participated (65).

Radimer and others (64) developed an instrument to assess hunger by first developing an understanding of hunger through a series of in-depth interviews with 32 women who had experienced hunger or near hunger. This research suggested that hunger existed at two levels – household and individual. Each level had qualitative, quantitative, psychological and social components. Based on this conceptualization of hunger, survey items were developed and evaluated.

A series of items was developed to measure the concepts at the household level and at the individual level for adults and children separately. As often as possible, the women's own words from the in-depth interviews were used. An example of a household level item is "The food that I bought just didn't last and I didn't have money to buy more?" Each question had five response choices. The questions were pilot tested with 16 women representative of the proposed study population. The final questionnaire included 30 hunger items and other items to measure risk factors for hunger, to assess coping tactics and demographic information. It was administered by trained interviewers to a convenience sample of women of childbearing age who were likely to have experienced hunger and to

40 women who were unlikely to have experienced hunger. The total sample was 189 (64).

Based on item analysis and item reliability, four items to measure household hunger, four items to measure women's hunger and four items to measure children's hunger were selected. The three scales each correlated with risk factors for hunger. Further validation of the scales is necessary for the use of the questionnaire with other groups including men, the elderly and other ethnic groups (64).

The Radimer hunger index was further evaluated in a 1993 survey of 193 women in households with children in a rural New York county (66). The revised hunger measure included the 12 Radimer items and an additional item to measure diet quality at the household level. Items were analyzed for construct validity and reliability.

The revised index, now called the Radimer/Cornell index, was used to categorize households into four mutually exclusive categories - Secure (negative responses to all items), Household insecure (positive response to one or more household level items only), Individual insecure (positive response to one or more adult and child quality items and adult quantity items), and Hungry child (positive answers to one or more child quantity items). This categorization was believed to represent progressively more severe levels of food insecurity and hunger (66).

Food security status was negatively related to income, education, and employment status and positively related to participation in food assistance programs. A household food inventory instrument showed that as the level of food insecurity increased the amount of food available declined significantly (66). While further validation of the Radimer/Cornell for males and the elderly is still needed, the index and the development of the four levels of food security/sufficiency provides a basis for monitoring food sufficiency status, policy development and program planning (66).

A single question on household food sufficiency has been asked in the USDA's NFCS and CSFII since 1977 (67). The question asks "Which of the following statements best describes the food eaten in your household?" The four possible responses are as follows: "Enough and the kind wanted to eat"; "Enough, but not always the kind wanted to eat"; "Sometimes not enough to eat"; and "Often not enough to eat." The question was designed so that the respondent had to consider both the quality and the quantity dimensions together.

The USDA food sufficiency question was evaluated using an economic demand model. The study included households from the 1977-78 NFCS that were eligible to participate in the Food Stamp Program (household income less than 130

percent of poverty). Results based on estimates from the model indicated that households reporting that their food supply was insufficient would adjust their food energy consumption more drastically in response to a small change in income than households reporting sufficient food supply (66). Another study using data from the 1985-86 CSFII found lower intakes of some foods and most nutrients by women reporting "sometimes/often not enough to eat." Similar results were not found for their children. This suggested that the question may not be an appropriate proxy for children's intake (68).

Two sets of food sufficiency questions - household and individual - were developed for NHANES III. They were developed based on recommendations from Federal agencies, the scientific community, and the private sector. Questions used in Federal, State and local surveys, including USDA food consumption surveys and CCHIP, were reviewed and selected for further review by the staff of the NCHS Questionnaire Design Research Laboratory and for pilot testing. The reliability of the questions was evaluated by reviewing the consistency of responses between questions, the relationship of the responses to other variables such as income, and apparent comprehension of the questions by respondents. Questions were redesigned between pilot tests and some questions were reduced in scope or dropped because of the time constraints of the interview (46,63).

The final set of NHANES III household questions was administered during the household interview. The respondent is the family head or spouse. All respondents are asked about the perceived sufficiency of the family's food. Those who respond that they "sometimes" or "often do not have enough to eat" are asked how many days during the past month they had no food or money to buy food, and the reasons they did not have food or money to buy food. In 1991, two additional questions on cutting back or skipping meals by children and adults were added to the family questionnaire. A final set of seven questions at the individual level are asked during the private dietary interview in the Mobile Examination Center. These questions ask about the availability of food or money to buy food and about the number meals skipped due to a lack of food or money. These will be useful for interpretation of the 24-hour recall data (63).

Data collected in NHANES III are being used to estimate the prevalence of reported food insufficiency in the population and subgroups. These data can be used to relate measures of food sufficiency to measures of dietary and nutritional status. NHANES III will provide national estimates by sex, age and selected ethnic and racial groups that could be compared with state and local estimates. Researchers using another set of food sufficiency questions may wish to use the NHANES III questions to serve as a bridge between their data and a national data set that includes diet, nutritional status, and health measures.

Since 1992 an interagency working group led by Food and Consumer Services (FCS), formerly the Food and Nutrition Service, of USDA and NCHS, CDC has met to develop a common food security/sufficiency measurement tool for use across nutrition monitoring surveys and surveillance systems (69). In 1993, a conference was held to address this issue; invitees from academia, research institutes, hunger advocacy groups, and federal agencies met to review available methodologies. To followup on technical issues raised during the conference, FCS commissioned two additional analyses based on two recently developed independent data sets of comprehensive hunger and food-insecurity indicator items. One data set was developed by a Cornell University team headed by Dr. Christine Olson and uses data from the 1993 one-county population sample in New York State. The development of the Cornell/Radimer hunger and food security items using this data set was discussed earlier (66). This data set included the Cornell/Radimer Index, selected CCHIP hunger and food-coping items, and an NHANES question on household food sufficiency (70).

The second data set was developed by the CCHIP research team headed by Dr. Cheryl Wehler. It includes data from about 2,200 low-income households sampled in five diverse sites in 1992-93. It includes the CCHIP survey instrument (65), a selected subset of Cornell/Radimer items, and an NHANES food sufficiency question (70).

The results of these two analyses will be published as Appendices to the Proceedings of the Conference (69). They were used by the interagency working group to finalize a survey measurement tool that FCS would sponsor for inclusion in the April, 1995 Current Population Survey (CPS). It is intended that a core set of food sufficiency indicators will be derived from the full set of questions asked in the April, 1995 CPS. These questions will be periodically asked in nutrition surveys and surveillance systems. State and local groups could ask the core set of food sufficiency measures or the full battery of questions, depending on data needs.

## Recommendations

This Section reviews selected brief indicators of dietary assessment and identifies their strengths and limitations. The following recommendations are based on this review.

For most of the brief indicators reviewed, the validation studies were very limited in scope. Most of the indicators were validated/calibrated in a single narrow population. Authors of brief indicators should continue to validate and publish the results of their evaluations. Others who use the indicators should also publish the results of any validations they conduct. All researchers should include sufficient

data so that users can review the results of the validation studies and draw their own conclusions.

Ongoing validation and calibration of current brief indicators is needed to assure that the instruments continue to reflect the food supply and the dietary patterns of the populations to be studied. If a nutrient composition data set is required, it should be updated regularly to reflect changes in the food supply and consumer choices.

Portions of the food frequency questionnaire in NHANES III were suggested for use as a brief indicator of fruit and vegetable intake, calcium intake, and alcoholic beverage intake. Validation studies of these parts of the food frequency would be appropriate. These questions should also be calibrated with dietary intake data (24-hour recalls or food records) and with other sets of questions such as the 5 A Day questionnaire and the BRFSS fruit and vegetable module.

Research should be conducted using national survey data to produce a list of important food contributors to calcium, fat, and fruit and vegetable intakes. These lists could be used to establish "indicator foods" that are predictive of total fat, calcium or fruit and vegetable intake. This research needs to be conducted periodically to account for changes in the food intake and food composition.

Although, considerable efforts have been devoted to the development of a brief indicator of fat intake, the measures reviewed were limited in their ability to discriminate between small but important differences in fat intake, particularly if percent calories from fat is the variable of interest. Additional research should be supported to develop a brief indicator of fat intake. Innovative approaches to developing an indicator are needed.

Planners of national surveys and surveillance systems should consider the needs of State and local organizations for indicators of dietary status that can be incorporated into their monitoring activities. To the extent possible, national surveys should include specific items that can serve as a link between national data and brief indicators appropriate for use in State and local nutrition monitoring activities. Emphasis should be placed on those items that provide links to measures in national surveys of diet, nutrition and health status.

Finally, the Dietary Assessment Resource Manual recently published as a supplement in The Journal of Nutrition provides an excellent overview of many assessment strategies (20). Copies of many brief indicators reviewed here are included. Periodic updates of this type of overview of methodologies and instruments would contribute to meeting the NNMRRP objectives to enhance State and local capacity to monitor nutritional status and dietary practices. The

addition of measures of food sufficiency would be of interest to many State and local nutrition organizations.

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# SECTION III

# BACKGROUND PAPERS

# CHAPTER 8
# STATISTICAL ISSUES IN ESTIMATING USUAL INTAKE FROM 24-HOUR RECALL OR FREQUENCY DATA: A WORKING REPORT FOR THE CONSENSUS WORKSHOP ON DIETARY ASSESSMENT

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## 1. Introduction

The National Health and Nutrition Examination Survey (NHANES) conducted by the National Center for Health Statistics every 10 years will provide the primary data for monitoring the Year 2000 nutrition objectives. Two different types of dietary data have been collected in the previous surveys: a single 24-hour dietary recall and semiquantitative food frequency data. Currently in NHANES III, two 24-hour recalls have been collected in a subsample of individuals for estimation of the day-to-day variation (intraindividual variation) for each nutrient. For monitoring changes in U.S. population dietary intake, the same methods are likely to be used in the future surveys to avoid biases created by different methodologies. Thus, it is important to discuss whether data collected by these methods are adequate for monitoring the Year 2000 nutrition objectives.

Two different parameters are usually estimated from the NHANES data to evaluate the status of the U.S. population regarding a nutrient or dietary factor, i.e., the mean intake and the prevalence rate of excess intake or inadequate intake. These parameters provide the primary basis for evaluating the nutrition objectives. For example, U.S. population estimates of mean fat intake will be required to monitor Year 2000 Objective 2.5: reduce dietary fat intake to an average of 30% of calories or less and average saturated fat intake to less than 10% of calories. The estimated prevalence rate of iron deficiency will be needed to monitor Objective 2.10: reduce iron deficiency to less than 3% among children aged 1 through 5 years and among women of childbearing age.

The underlying assumption for assessing the nutritional status of a population is that people usually maintain their dietary habits and the parameter of interest, (e.g., population mean intake) is defined based on the usual intake of individuals. Unfortunately, neither a single 24-hour recall nor the semiquantitative frequency method accurately reflect an individual's true usual intake of a nutrient or dietary factor. As a result, estimates of the mean population intake and/or prevalence rate of nutrient deficiency (or excess intake) based on these data could be seriously biased. This paper discusses the statistical issues associated with the use of one 24-hour recall or semiquantitative food frequency to estimate these parameters. The purpose is to establish a framework for discussion at the workshop.

## 2. Statistical Issues Associated with 24-Hour Dietary Recalls

An individual's dietary intake varies from day to day. One 24-hour dietary recall cannot accurately characterize an individual's usual intake. Many researchers have estimated the ratio of intra- to interindividual variance for various nutrients (1-4). For many nutrients, the intraindividual variances (within-person variances) are much larger than the interindividual variances (the between-person variances of individuals' usual intakes) and create serious problems in statistical analyses (1,5).

Under the assumption that an individual's daily intakes are independent of each other, the population variance of the daily intake (e.g., based on one 24-hour dietary recall) of a nutrient is the sum of the intraindividual and interindividual variances. For example, in the Primary Prevention of Hypertension Study, the estimated intraindividual variance for saturated fat (percent of calories) is 2.7 times the interindividual variance (6). Thus, the population variance of saturated fat intake based on one 24-hour recall is 3.7 times the variance for usual intake of saturated fat. If the intraindividual variation is random, then the estimate of mean intake of a nutrient will not be influenced, i.e., the mean daily intake for the population is the same as the mean usual intake for the population. The increased variance of the daily intake indicates that the distribution of the daily intake is wider and flatter than that of the usual intake. As a result, the prevalence rate of nutrient deficiency defined by usual intakes less than a fixed intake level could be seriously inflated if this prevalence rate is based on individuals' daily intakes. (Note: this fixed level is assumed to be less than the mean intake of the population.) Similarly, the prevalence rate for excess intake of a nutrient could also be inflated.

## 3. The National Academy of Sciences Recommendation

The US National Academy of Sciences (NAS) Subcommittee on Criteria for Dietary Evaluation proposed an approach to estimate the prevalence rate of nutrient deficiency of usual intakes based on multiple daily intake data (7). The procedures can be summarized as follows:

a. Transform the daily intake data to ensure the normality of the intake distribution.

b. Estimate the intraindividual variance and interindividual variance based on the transformed data. The variance of the observed (transformed) data is the sum of the intra- and interindividual variances.

c. Use the following formula to compute the adjusted intake (based on the transformed data):

Adjusted intake = (observed intake - mean intake) x (SD(inter)/SD(Observed)) + mean intake,

where SD(inter) and SD(observed) are the interindividual standard deviation and the observed standard deviation of daily intake, respectively.

d. Transform the adjusted intake back to the original unit and compute the prevalence rate.

The Committee emphasized the importance of the transformation for normality, but did not recommend any specific methods for this purpose. In an example provided in the report, daily protein intakes estimated from the 1977-1978 Nationwide Food Consumption Survey (one 24-hour recall and two-day food record) were logarithmically transformed and analyzed.

## 4. Issues Related to the NAS Approach

The NAS approach has made several assumptions implicitly. For i=1,...,k, let $Y_i$ be the i-th observed intake of a nutrient, and let $X_i=T(Y_i)$ be the corresponding transformed intake, where T( )is a monotonically increasing (or decreasing) transformation. The NAS approach assumes the model

$$X_i = W + e_i$$

where W is a normal random variable with mean $m_w$ and variance var(inter), and $e_i$, i=1,...k are independent, identically distributed normal random variables with mean 0 and variance var(intra). The variables W and $e_i$, i=1,...k are also assumed to be independent. Let U be the random variable representing the usual intake of this nutrient and let c be a fixed cutoff intake level indicating deficiency of the intake. If the model and assumptions are valid, then:

$$P(U < c)=P(W < T(c))=P(\text{adjusted intake} < T(c)).$$

[See step 3c above for adjusted intake]. Thus, the prevalence rate, P(U < c) can be estimated by the proportion of the adjusted intakes that are less than T(c).

## 5. Criteria for a Satisfactory Transformation

If a nutrient intake is normally distributed there is no need for the transformation step. one can directly estimate the intra- and interindividual variances and then

apply steps 3c and 3d to compute the prevalence rate. However, for most nutrients, the distributions are not normal. Thus, it is necessary to perform the initial transformation, T ($Y_i$). To meet the assumptions made in the NAS approach, an appropriate transformation should satisfy the following criteria:

a. $T(Y_i)$ is normally distributed. The validity of this assumption can be tested easily by applying standard tests for normality an transformed intake. Power transformations may be good candidates for transforming macronutrients. However, for certain very skewed micronutrients (due to supplementation), other transformations may be necessary.

b. X and $e_i$, i=1,...,k, are independent random variables. (Tests for this condition need to be discussed at the workshop.)

c. The assumption of constant intraindividual variance for the transformed intake is valid. For many nutrients, especially micronutrients, the intraindividual standard deviation is highly correlated with the mean intake. Thus, the assumption of constant intraindividual variance is not valid for many nutrients in the original scales. The validity of this assumption should be tested for the transformed data. How this condition should be tested needs to be discussed. It is inadequate to simply demonstrate that the intraindividual standard deviation and the mean of the transformed intake are not correlated. One possible procedure for testing this assumption is to compare the estimated intraindividual variance divided by the pooled estimate of the intraindividual variance to a Chi square distribution with k-1 degrees of freedom.

d. The inverse transformation for the adjusted intake discussed in step 3c. is the usual intake in the original scale. This condition raises some questions about the appropriateness of certain power transformations. For example, the mean value, $m_y$, estimated from daily intake distribution should be the same as the mean usual intake, $m_u$, if the intraindividual variation is a random variation. Thus, the mean value for the estimated usual intake following the NAS procedures, i.e., $T^{-1}(W)$, should be the same as the mean value of the daily intake, $m_y$. If the two values are not the same, some of the assumptions for the NAS procedures may be invalid. If this is the case, power transformations are not appropriate. For example, the logarithmic and square root transformation do not satisfy this condition. It is difficult to test this criterion since usual intake cannot be observed. These issues should also be discussed at the workshop.

## 6. Statistical Issues Related to Semiquantitative Food Frequency Methods

Semiquantitative food frequency methods are useful methods to examine the relationships between dietary factors and disease or disease risk factors in large scale epidemiologic studies because they are relatively more feasible and inexpensive than multiple 24-hour recalls or food records. However, the measurement error associated with the semiquantitative food frequency methods could seriously impact statistical analyses (8). For the purpose of estimating mean intake for a population or the prevalence rate of nutrient deficiency (or excess intake), the methods are inappropriate because of their potential biases (9). However, for monitoring some of the Year 2000 nutrition objectives, the use of the food frequency data is necessary. For example, one 24-hour recall cannot provide accurate information on alcohol drinking, as binge drinking may be missed. The objective for calcium intake is based on the frequency of consumption of calcium-rich foods. Thus, the estimation of the prevalence rate has to be based on frequency data. Unfortunately, the potential misclassification of the frequency data has not been well examined. Again, this issue should be discussed at the workshop.

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# CHAPTER 9
# COGNITIVE ISSUES IN TWO DIETARY SURVEY METHODS

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## Introduction

This paper examines some cognitive issues that are important in developing valid and reliable 24-hour recalls and food frequency questionnaires. Table 1 describes the two methods briefly. Acquisition, retention, and retrieval of dietary information are involved in both methods, but the dominant memory tasks differ, and so do both the errors involved and the memory strategies that may help to improve recall. Differences between true and reported intakes arising because of errors in recalling what is eaten, how often or how much is eaten when using the 24-hour dietary recall and food frequency questionnaires are considered. The paper concludes with suggestions for improving the quality of information obtained, and recommendations on related issues requiring more research.

## Memory for Foods

Memory differentially affects the accuracy of responses for 24-hour recalls and food frequency questionnaires. Table 2 summarizes some of the differences between 24-hour recalls and food frequency questionnaires on various cognitive tasks involved in food memory.

Verbal memory is particularly important for recalling names of foods. If food names cannot be acquired (as is the case in very young children or adults who have cognitive impairments), if food names are not recognized because they are called by other names (as may be the case with certain ethnic subgroups), or if food names fail to be retained or retrieved, related information on food frequency and portion size may also be lost.

## Frequency of Consumption (How Often the Food is Eaten)

Recall of frequency of consumption of various foods or food groups is a challenging task. Studies of other autobiographical events that involve frequency estimates may be relevant (1).

### Memories for Foods Based on their Frequency of Consumption

The acquisition of memories about foods probably differs depending on how frequently the foods are eaten. However, other factors are probably also involved.

The first time a person has a drink of alcohol or eats a strange food is more salient than the first time one eats a commonly eaten food. People are able to state that they have never eaten a food with accuracy. For foods that are eaten frequently, the task is more difficult, except for foods that are eaten at every meal or foods that are eaten only at a single meal.

Differences in retention and retrieval also depend on frequency of consumption. Even with similar questions, different retrieval skills may be required depending on frequency of consumption. For example, a food which has only been eaten once in a person's lifetime (chocolate-covered grasshoppers or okra) and one eaten every day (milk) may require very different retrieval strategies from a food which is eaten only sporadically. It probably takes little effort to retrieve a summary statement such as "I never ate" or "I always ate" a specific food. The task requires little estimation and the summary statement can then be applied in retrieval tasks, although memory for episodes is not involved.

People are probably able to recall foods ever eaten versus those never eaten for much longer periods than they are exact consumption frequencies. Foods that are eaten in a ritualistic, stereotyped fashion (e.g., shredded wheat or orange juice for breakfast every morning) are also probably remembered very well. Thus it seems that for food items never eaten and for those that are always or very frequently eaten, intakes reports are most accurate. Intakes of other foods probably merge into an average.

The retention function for autobiographical memory has not been well studied (2). Both the retention curves as well as the retrieval processes for various foods and other events are probably different; that is, there is probably not a single retention and retrieval curve for autobiographical memory relating to food items. However, this is very difficult to test empirically and only a few studies exist that examine it explicitly over many decades (3). Eating okra only once in one's life involves an episodic memory. Drinking milk every day at every meal in a ritualistic manner involves an inference based on episodic memories. In contrast, consuming some food like a milkshake or yogurt, eaten somewhat frequently, may be more amenable to socially facilitated responses and lead to estimates in the middle of the perceived range of acceptable responses. Thus, individuals who eat okra frequently and those eating it only once in their lives probably have arrived at consumption estimates using very different memory strategies, even for this same food. Note that examination of the question does not reveal the memory retrieval strategy that has been used, that is, the same question (e.g., "how frequently did you eat okra?") asked of different individuals may result in different retrieval strategies being used. The same individual may use different strategies for retaining and retrieving memories of these different foods eaten with different frequencies.

Frequency of consumption is recalled with reasonable accuracy, and probably a rough rank order of frequency does in fact exist for many foods. However, people calibrate their frequency estimates in various ways, and because of this analyses of the frequency with which different individuals eat particular items are not optimal since there is no common anchor point of reference (4).

## Memory of Frequency of Consumption Based on the Dietary Survey Method

The cognitive processes that are employed in responding to questions on 24-hour recalls and food frequency questionnaires differ. Some of these differences are summarized in Table 3.

For the 24-hour recall, the task is to recall and count the foods eaten in a series of specific episodes over the past day. The memory task in a 24-hour recall is temporal. It consists of a series of short episodes that are more like short, soap opera sequels than a long-running movie or a videotape that records all events evenly. The recall task then is one of recalling the foods that were eaten within these short episodes. The 24-hour recall does not involve a recall of a single "24-hour long videotape"; it does not appear to be such a continuous record.

Recall of frequency is relatively straightforward since the time period over which recall occurs is relatively short and frequency of consumption is relatively low. The retrieval process probably involves enumeration; recall of individual episodes during the previous 24 hours and then counting the consumption frequency. For those with ritualistic types of food habits for meals they may recall summary statements and insert them in lieu of a specific episodic memory. If the respondent has no recall of what was eaten at a specific meal, it is possible that the respondent will provide a modal food or meal (e.g., the type of meal or foods that are most usually consumed by the individual).

Thus memory plays a large role but inference and social desirability can also play a lesser role particularly if episodic memory fails. The mix of retrieval strategies and inference probably varies by age (older individuals perhaps relying more on inference and social desirability), intelligence and other factors.

Retention of food consumption frequency information on the food frequency questionnaire probably involves autobiographical sequences rather than the distinct episodes that are likely to be recalled on 24-hour recalls. Retention of memories may be more difficult because of the longer time; remote memory is involved rather than long-term memory. There is more chance that inaccuracies due to forgetting will intrude than in the 24-hour recall. Because many similar eating incidents are usually involved over the long period of interest (several weeks or months or years), individual episodes may not be held in memory but

rather a prototype memory is stored that merges individual autobiographical episodes together with each other.

Retrieval of frequency of food consumption from remote memory is a complex task when consumption is greater than "never" and less than "always". The task presupposes that the respondent has an eating pattern with fairly fixed meal schedules, that he/she is interested enough to attend to and to perform the retrieval and inferential tasks for up to 100 separate foods, that stamina is sufficient to avoid fatigue while doing this, that arithmetic ability is sufficient to perform the necessary calculations and inference tasks involving counting, and that intelligence is sufficient to make reasonable guesses that correspond with reality. The retrieval task probably involves many different strategies, most of which rely on inference and social desirability as well as memory per se.

The method of recall and counting each individual time of consumption, which is used for 24-hour recalls, is probably not used for counting intakes of items that are frequently consumed over this longer time period. The longer the period the less likely that counting or enumeration will be used and the less likely that a person could use it successfully. However, it is possible that for special or infrequently consumed foods, such as snails, such a strategy might be employed on a food frequency questionnaire.

Other strategies involving decomposition approaches are more commonly employed when the reference period of recall is many weeks or months. These memory strategies, which include decomposition, normative expectations, interpolation, relational reasoning, and probably many other techniques, rely heavily on inference as well as memory.

One such strategy is a rate-based or multiplicative decomposition strategy. The individual separates personal individual autobiographical episodes into subparts, decomposes each into rates using inference (e.g., probably not often; ate French toast at Christmas, Thanksgiving and when I went to New York), and then uses arithmetic to develop a plausible answer that fits the question asked (e.g., three times per year). For a more frequently eaten food, this strategy might also be used. The following statement is an example of this strategy, "I ate baked beans almost every Saturday night when I was at home. But I wasn't at home some Saturdays, and I may have eaten sausage a couple of times a month. So, I'll answer that I ate baked beans twice a month." Note that to perform these operations and calculations, a great deal of motivation is needed, and it may be difficult to sustain attention to such a task when dozens of different items are being queried.

Another strategy is additive decomposition. For example, sequences are broken down into meals and snacks. Estimates of food consumption at each specific meal

and snack are made using inference, and then the results are added up and reported.

There is also an inferential retrieval strategy that involves balancing the individual's view of normative expectations and his/her awareness of deviations from it. For example, a respondent might say to him or herself, "I know that I don't eat as much calcium-rich food as I should, and I know that the doctors say to drink three glasses of skim milk a day, so I'll say two since I think I'm a little under." Note that this strategy presupposes that the individual has a knowledge of normative expectations, or that the normative expectation can be inferred from the ways the items are asked.

Another strategy is interpolation between the largest and smallest plausible values. For example, "I have no idea how much I eat of that food, so I will select the middle category on the questionnaire and that will fit." On a semiquantitative food frequency questionnaire this might lead to selection of the middle consumption categories.

The strategy of relational reasoning may also be involved, in which the person infers an answer from something that is known with a fair degree of certainty. For example, "I drink milk about once a day. I don't eat yogurt as often, certainly not every day, but maybe every week or month, and certainly more than a couple of times last year, so I'll put down 6 times a year."

In reviewing answers, individual respondents may also modify their initial estimates so that the entire questionnaire appears more plausible to them (5). For example, in reviewing the individual responses for all fruit and vegetable items, if the respondent is aware that usually he/she consumes about 4 servings per day (less than the current 5 A Day recommendation), and the total of the responses to individual items sums to 5 or 6 servings a day, he/she may alter individual responses.

## Time Period Covered

Table 4 summarizes some of the differences between methods that are attributable to time period covered. Three opposing errors may exist that complicate interpretation when the time periods covered by recall differ. One error that may occur is telescoping; the importation into the reference period of an event that happened earlier. This may occur because it is assumed that an event that is remembered must have been recent enough to be within the reference period. However, the event may have been retained for some other reason, not because it occurred during the time period in question. A related problem that leads to time-interval related errors is the lack of clear anchor points for the beginning and end of the reference period over which consumption information is being requested.

The second error is forgetting, either because the memory is an old memory, or because of interference from new memories. Generalization about forgetting is hazardous, and many characteristics other than time interval play a role in the ultimate extent to which a memory becomes less accurate. It is generally thought by laymen that the longer the time lapse between the eating occasion and the time of asking the question, the greater the inaccuracy of response. The decline is thought to follow a linear function. This supposition may in fact apply for long-term memory (e.g., 1 day to 3 days), but it does not seem to do so for some remote memories. The function for remote memory is not necessarily linear, and there are many different retention functions depending on the nature of what is being retained. For example, memory for irrelevant details about what a tablecloth looked like at this year's wedding anniversary dinner, and that for what the entree and wine were at the same event may be quite different.

There is not one single autobiographical memory function that describes forgetting over time. Salience, uniqueness, frequency and other factors will influence retention. Unfortunately, vividness of a memory does not necessarily guarantee accuracy. Moreover, the memory function may vary depending on what it is that is being remembered. For example, there may be a very slight decrement in recall ability in faces of high school classmates from a yearbook, or remembering having had a specific disease (6,7).

Third, memory retention and retrieval processes operate differentially depending on the frequency of consumption of the food in question, and probably also vary with many other characteristics as well. Recalling that a food was ever or never eaten probably persists for much longer than the frequency or the amounts of food that were eaten, since frequency and amounts eaten may vary over the interval.

Also, there may be individual differences in the retrieval processes that are used because of differential abilities of the respondents. An individual who has poor arithmetic abilities may rely more on inferential strategies that involve social acceptability or some other technique such as relative ranking to provide a plausible response. The individual might commit himself to one frequency and adjust all other responses for other food items to that frequency. For example, "I eat rice once a week and potatoes more than that, so I'll say twice a week for potatoes."

For 24-hour dietary recalls, long-term memory is used. There is good evidence that people are able to recall their dietary intakes and many other details about their personal lives over one or two days, and perhaps for as long as a week or two. The task of anchoring the beginning and end of the period is relatively easy, particularly over a single day. When questioned, most individuals are able to recall over this period, at least vaguely, where they ate and with whom, and telescoping can usually be avoided. Forgetting and difficulties in describing

frequencies are also probably less since the time interval is short, and the frequency of consumption relatively low, often permitting recall and enumeration. Recall can be enhanced by careful probing, presentation of lists of foods or other cross checks.

Whether retention and recalls are sound for more than one or two days is more problematic. The use of non-quantitative food records may extend the time period that can be used for recalls from one day to many more days.

Whether social desirability is more or less of a problem with a 24-hour recall versus a food frequency is unknown. However, it may be that there is less of an effect on the 24-hour recall since a supposed "deviation" is reported only for a single time, whereas the FFQ implies a more longstanding deviance. This is a matter than deserves more research.

Little is known about long-term memory for foods, but much less is known about remote memory; the very type of memory that is involved in retrieval of information on food frequency questionnaires. People probably answer questions about intakes over long reference periods by using any information they have at their disposal that will help them to generate a reasonable answer. Because the food frequency questionnaire covers a much longer time period (and less well-defined from the personal point of view) than the 24-hour recall, anchoring of the time period is difficult. Telescoping may occur, prior memories may intrude, forgetting may occur, and difficulties in estimating frequency of consumption may present larger obstacles.

The food frequency usually includes instructions to estimate intakes over a week, a month or a year. One problem is that the anchor points over which recall is requested may not be entirely clear to the respondent without further instruction and assistance. Although the chronological periods are clear, these may not be salient and meaningful memory retrieval anchor points for the individual respondent. Recall calendars or other techniques that ask the individual to recall what happened in his personal life a year ago (e.g., where he/she lived, what was going on in his/her life and with his/her loved ones, where he/she usually ate and with whom, etc.) serve to anchor the chronological periods to a personal autobiographical period and help to minimize telescoping (8). Nevertheless, there appears to be a tendency in other types of studies to place especially salient personal events forward into the time period in question, and the same phenomenon may exist in dietary recall (9). Other very dramatic and memorable events, such as a birthday, or a special dinner on a specific holiday, may be recalled very precisely.

The issue of forgetting curves has been discussed in another section of this report, and these considerations apply to food frequency questionnaires. Whether in fact

the respondent can remember intakes over very long time periods remains a matter of conjecture. For example, when asked to report dietary intakes using specified reference periods, subjects in Smith's studies (4) relied on inference and general or generic knowledge of their diet, tending to report commonly eaten or likely items that they might have eaten versus items that they actually remembered having eaten during the designated period. The more remote the time of recall was from the reference period, the more pronounced the tendency became to remember likely or generic food intakes rather than actual food intakes. In addition, the estimates of consumption frequency also deteriorated over time as the interval between the reference period and frequency test became more distant. As described in other sections of this review, errors related to the frequency of consumption probably are also larger on the food frequency questionnaire.

The optimal recommendations about the time period to use for food frequencies vary depending on the purpose of the study. For semiquantitative and other food frequency questionnaires shorter time periods are recommended. Present evidence suggests that recalls over a few weeks or a month are more accurate than those over many months or a year.

However, if the objective is to also obtain usual intakes of food items that vary over seasons, longer time periods may be needed. During longer time periods, food consumption patterns may change. For example, food consumption may vary by season or by variations in health status. It may also vary because the individual embarked upon a diet, or changed his/her living situation or employment, or for other reasons. Many semiquantitative food frequency questionnaires ask respondents to estimate seasonal fluctuations in intake. The memory and arithmetic needed to do this may be beyond the individual's ability in many instances, further increasing errors. Some strategies for facilitating recall by season or by other temporal patterns have been discussed elsewhere. These represent potentially very large errors and deserve more study.

## Memory for Portion Sizes Consumed

The estimation of portion sizes is a boring, difficult, and error-prone task for most people much of the time. The problems with acquiring accurate portion size information are formidable. Recall of size probably involves tasks and abilities, such as spatial comparisons and orientation, and size estimation. The relevant literature here involves psychophysics, but few studies exist that are specific to diet, although it is likely that some general principles may apply to food-related tasks (10-13). Table 5 summarizes some of the errors involved in portion size recall.

Other tasks related to food consumption memory involve recall of food names, which relies on verbal memory, or recall of intake patterns, which involves pattern

recognition or other skills. Errors in estimation of portion size frequently occur at the time of consumption. These errors are present even when the subject has the food items in view and they must be recorded on food records. Unfortunately, these estimation errors are not uniform from food to food. Some items, such as cartons of milk, brands of candy bars, and other prepackaged foods, are usually consumed in standard portions. Other food items, such a meat, fish, poultry, and snack foods, are not and these are subject to large errors in estimation.

Some errors apply to both 24-hour recalls and food frequency questionnaires. Memory for portion sizes is poor to begin with. The initial memory trace of the food portion that is acquired may be incorrect, regardless of method employed. Food portion sizes vary in the degree to which they are over or underestimated in reporting for other reasons as well. Overconsumption of items such as alcohol, fats, sweets, and other items are currently socially unacceptable in many circles, whereas increased intakes of fruits and vegetables, and fiber and grain products are given social approval. Therefore, even if the individual has an accurate idea of how much he/she has eaten (which is unlikely) he may bias his/her report. This error too may apply to both types of survey instruments. Other factors may also be involved that complicate retrieval, such as the presence of disease. For example, during eating binges, bulemics may experience amnesia with regard to the huge portion sizes that are consumed.

The units of serving or measurement may be important sources of error. Some measurements are made in fluid ounces and others in solid ounces; some in household measures, like cups, and still others by weight or by size (like a slice of pizza or pie wedges). Ervin (14) suggested that familiarity with the unit of measure improved a person's ability to estimate amounts accurately in her study.

Errors in portion size judgments are smallest probably when foods are weighed (assuming the subject knows how to use measuring scales correctly) or measured with household utensils. Judgments are somewhat less accurate when they are compared to utensils or other size standards. When comparisons are made to some arbitrarily-defined and verbally-stated standard, judgments are even more inaccurate, and "guesstimates" that all portions consumed are "normal" are the worst.

Measuring cups or utensils or food models may help to reduce recall errors if they are used at some later time, but they are a poor substitute for weighing. Errors of overestimation of portion size are probably most common and they occur among both obese and lean individuals, and among older and younger groups of subjects (14-17). Individuals often underestimate portion sizes, too.

Judgments of the size of three dimensional objects, like a serving of peas, mashed potatoes, and meat on a plate, are very difficult. As size increases geometrically,

estimates of increasing size tend to increase in an arithmetic fashion. Reference points also create problems in some studies. Individuals familiar with measuring or weighing foods or judging amounts often perform better on portion judgment tasks than those who are not.

Portion sizes of foods eaten are not always constant, and probably differ by time, place of eating, appetite, and mood for some respondents. In addition, characteristics of the respondents, such as sex, age, education, or following special diets, are sometimes, but not always, associated with better performance on portion size estimation. Better performance on some memory tasks involving portion size appears to be associated with intelligence (18).

Individuals not only have fragile memories about the portion sizes of foods that they view but they may also be insensitive to the definitions of portion size provided on food frequency questionnaires (4). For example, when Smith increased or decreased the definitions of a "medium" serving size of a food, the subjects he tested did not readjust their descriptions of typical serving sizes in the directions they should have if such portion sizes were meaningful (4).

A weighted estimate of the usual range of portion sizes of each food chosen by the individual would be necessary for the portion size to truly represent usual estimates on a semiquantitative food frequency questionnaire. It cannot be automatically assumed that these will correspond to the defaults that may be built into the program. When the portion size estimate is for a food group, it must further be assumed that the distribution of intakes of the individual for each food and for the portion sizes of each food within the food group are similar to the reference population used to construct the questionnaire (in the case of the Block food frequency questionnaire the reference population is NHANES II age and sex categories). Whether, in fact, any or all of these assumptions are valid remains undetermined, and empirical evidence is necessary to resolve these questions.

## Issues Related to Population Subgroup Coverage

There is good evidence that cognitive strategies must be modified to take into account the age and other characteristics of respondents. Population subgroups differ in both their innate cognitive capacities to acquire, retain and retrieve dietary information. They may also differ in their willingness and ability to respond to different types of survey techniques. In addition, for racial or ethnic groups who eat a diet that is very much at variance with usual fare, special survey instruments may be required, or adaptations of existing techniques may be necessary. Time does not permit a detailed discussion of this subject, but these differences and some of the newer techniques for dealing with them are dealt with in greater detail elsewhere (19-21).

## Children

The reason for special concern about dietary assessment in children is that there is good evidence to suggest that children may have different capacities to acquire food-related information in the first place, and that their retention and retrieval processes may also differ from those of adults. The ability to remember food consumption seems to be closely associated with language ability, at least in early life.

Recall is limited in children; they are often unable to remember their previous intakes without a good deal of help. In studies of children's diets, response bias (22), recall bias, and difficulty in assessing portion sizes (23,24) have all been noted. For very young children, such as preschoolers or grammar schoolers, often surrogate respondents must be used since the children are unable to provide accurate information on 24-hour recalls. Children's vocabulary and ability to describe the foods, the frequency, and the portion sizes may be limited. Errors may also be increased based on their inability to distinguish between what was served and what was eaten, or between what should have been eaten and what was eaten (25-43).

Several different strategies have been employed to obtain 24-hour recalls from children. The food record-assisted 24-hour recall uses a qualitative food record that the child collected the previous day (sometimes with the assistance of a parent or adult proxy). Validation studies were satisfactory (44).

A second approach is to use a parental report of food intake of the child. This is often employed with young children. However, it is often difficult to obtain complete intakes because neither parents nor anyone single adult may be aware of all the foods the child has eaten over the course of the day, particularly if the parent is working and the child is out of the home or under someone else's supervision for most of the day (45).

## Older Americans

The elderly also present special problems. Disabilities in hearing, sight, or attention may complicate the process of acquiring food-related memories. Diseases such as stroke, senile infarct dementia, or senile dementia of the Alzheimer's type, may make it impossible for individuals to encode the dietary intake information in the first place and impossible for them to recall what they ate. Spells of illness may disrupt habitual intake patterns and make it more difficult to retain or recall intake patterns (46). Some older people simply omit reports of intake on sick days and report their habitual diets in good health (47). Also, some elderly persons may not have clearly defined eating patterns, but may eat in a "catch as catch can" and on a more unstructured pattern than younger people. Recall ability,

attention and motivation may be hindered owing to medications, advanced age, or other disabilities. Fatigue may ensue earlier than in younger adults.

Few studies exist to definitively answer the question of whether older people report current or past food intakes as accurately as younger adults. In one study using 24-hour recalls, younger adults provided less accurate information than did older persons (22). There is much dispute about whether or not the declines that do appear to exist in specific memory abilities with advancing age inhibit acquisition of memory, retention, or retrieval (48).

### Racial and Ethnic Groups

Different population subgroups also appear to respond differently to food recall tasks (49).

### Recommendations

Recommendations for improving the accuracy of the 24-hour recalls and food frequency questionnaires are given in Tables 6, 7 and 8. Clearly memory strategies and aids do exist that can improve recall. The memory aids that are available and useful also vary depending on the type of interview being used, the degree of specificity required, and probably by other factors as well. Some aids are useful with all methods. Other techniques are specific to a single method.

### Conclusions

Table 9 summarizes several caveats that need to be kept in mind. Even in this very cursory review it is obvious that the cognitive tasks involved in dietary recall (and especially in the food frequency questionnaire) are not solely memory tasks. They also involve inference, probably to a much greater degree that has been recognized until now, and many other skills, such as computational ability. The tasks are probably much more complex than was imagined until lately (1). There may be gender, age, socioeconomic or other differences in the accuracy of diet-related recall that depend on motivation or other characteristics associated with individuals.

More research is needed on the various memory tasks associated with dietary methodology. It cannot be assumed that general findings from cognitive research about other types of memory will suffice for solving survey method problems that are so apparent in food consumption studies today.

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| Table 1: Memory Tasks Involved in Various Dietary Methods | | |
|---|---|---|
| Characteristic | 24-Hour Dietary Recall | Food Frequency Questionnaire (FFQ) |
| Usual Modes of Administration | Face-to-face interview; telephone interview; self-administered (rare) | Self-administered; face-to-face interview; telephone interview |
| Usual Task | Recall all foods and beverages consumed, including cooking methods, brand names, supplements, and other details, with quantities usually estimated in household measures | Obtain qualitative, descriptive information about usual food consumption patterns; not usually designed to be quantitative; uses a list of foods and frequency-of-use response categories provided to the subject; intakes are supposed to represent usual intakes over an extended period of time |
| Memory Aids Employed | Food models, household measurement utensils to document or estimate portion size | Food lists focusing on groups of foods or particular foods; these act as a memory prompt; seasons of consumption, etc. |

| Table 1: Memory Tasks Involved in Various Dietary Methods, continued | | |
|---|---|---|
| Characteristic | 24-Hour Dietary Recall | Food Frequency Questionnaire (FFQ) |
| Respondent Problems | Omission or forgetting of foods; telescoping; inclusion of foods from another day or days; inability to describe portion size exactly; inability to provide a response (e.g., the very old, the very young, confused people, etc.); flat slope syndrome or "talking a good diet;" overestimation of low intakes and underestimation of high intakes[50, 51] | Fatigue; misunderstanding of instructions if self-administered; inability to estimate or very accurately estimate food intakes in the remote past[52, 53] |
| Interviewer-related Problems | Leading questions and judgmental comments may bias results; inability or mistakes in converting volume estimates into grams | Questionnaire may be self-administered instead of obtained by a standardized interview with an interviewer |

| Table 1: Memory Tasks Involved in Various Dietary Methods, continued | | |
|---|---|---|
| Characteristic | 24-Hour Dietary Recall | Food Frequency Questionnaire (FFQ) |
| Portion Size Prompt | Descriptions with memory aids; standard household measuring cups and spoons, ruler (e.g., meat, pizza), counts (e.g., eggs, slices of bread) are most common; telephone interview 24-hour recalls sometimes use two-dimensional food portion visual aids with sizes of cups, pieces of meat, etc. mailed to respondents in advance[54] | Either a reference serving size of the food or food group is provided, or a standard serving and an option for small, medium, or large versus the standard (sometimes using portion sizes from NHANES II as the standard[55]) |

| Table 2: Contrasts Between 24-Hour Recalls and Food Frequency Questionnaires on Food Names | | |
|---|---|---|
| Task (FFQ) | 24-Hour Recall | Food Frequency Questionnaire |
| Acquisition | Acquisition of each individual episode is probably identical with that in food frequency; motivation, cognitive ability and verbal memory are all essential; food memory is embedded in a sensory context | Acquisition of each individual episode is probably identical with that in 24-hour recall |
| Retention and Retrieval | Episodic memories involves recalling foods consumed over a short time; start and stop dates are clear for time interval; less opportunity for forgetting to intrude than with FFQ | Pattern of consumption over many days or months must be acquired; semantic memory, recall, inference and other memory processes are probably involved in recall of "chunks" or summary statements; involves recognizing foods from a food list which were consumed over a long time; long time, with vague start and stop dates; more opportunity for forgetting to intrude |

**Table 3: Contrasts Between 24-Hour Recalls and Food Frequency Questionnaires on Memory for Consumption Frequency**

| Task (FFQ) | 24-Hour Recall | Food Frequency Questionnaire |
|---|---|---|
| Acquisition | Salience is important; finite discrete memories with minimal interference obtained | Acquisition is similar to 24-hour recall; may be semantic memory with rehearsal and a blend or estimate of many acquisitions, possibly with memory actually being of stereotyped, rehearsed memory |
| Retention and Retrieval | Simple discriminations (ate versus didn't eat) are easy; common strategy is enumeration involving recall and counting of foods eaten in specific episodes; however, other strategies are probably used as well; time of retention is short, frequency is low and interference with memory trace is probably minimal | Simple discriminations (ate versus didn't eat) are easy, as are stereotyped or ritualistic patterns, but intermediate frequencies are more difficult; retention is over a long and indefinite time, frequency of consumption may be high; retention curves and retrieval processes probably vary; many retrieval strategies are probably used, more inference and other strategies than memory alone; these probably include enumeration with recall and counting, especially for short periods or rare events; however, more common strategies are decomposition, involving memory and inference |

| Table 4: Contrasts Between 24-Hour Recalls and Food Frequency Questionnaires on Memory for Time Period Covered | | |
|---|---|---|
| Task (FFQ) | 24-Hour Recall | Food Frequency Questionnaire |
| Acquisition | Time period covered is short with fairly discrete anchor points | Long time involved |
| Retention and Retrieval | Long-term memory involved, with clear anchors, short interval, low frequency event | Remote memory involved, anchors are vague, interval is long, frequency is high, forgetting or new eating events may intrude; common errors include telescoping with importation of material into reference period from some earlier time, especially likely when there is lack of clear anchor points; forgetting or decline in retention due to time itself or because of interference from new memories, and variations due to consumption frequency food etc.; there is no single autobiographical memory function that describes forgetting of food intake over time: salience, uniqueness, frequency and many other factors are all important in determining individual forgetting curves |

**Table 5: Contrasts Between 24-Hour Recalls and Food Frequency Questionnaires on Memory for Portion Sizes**

| Task (FFQ) | 24-Hour Recall | Food Frequency Questionnaire |
|---|---|---|
| Acquisition | Psychophysical tasks involved make acquisition difficult and error-prone; differences in individual abilities (e.g., spatial comparison, orientation, size estimation) differ from individual to individual; memory acquired and stored for 24 hours | Acquisition is difficult as in 24-hour recall; variable portions at different times over many occasions long ago must be developed and synthesized into a pattern using semantic memory; the result of this synthesis is what is elicited |
| Retention and Retrieval | Familiarity with units of serving or measure may be important; recall is of specific episodes and portion sizes; other factors such as social desirability, salience, etc. also probably influence recall | Other factors (see 24-hour recall) may be involved; portion size and number of servings often confused; portion sizes change over time and from setting to setting, so inferences about usual size are necessary; reference standard is often difficult to relate to; for food groups, unclear if "size" is a meaningful concept; defaults using standard sex- and age-specific sizes may be helpful, but probably obscure some real individual differences |

| Table 6: Memory Strategies and Aids for Improving Recall When Using Various Dietary Assessment Methods | |
|---|---|
| General Strategies for Most Methods | Ask the subject to recall the places he/she ate in yesterday and the people he/she usually eats with (24-hour recall) prior to beginning the interview |
| | Ask if the subject understands the task before starting the interview |
| | Ask if he/she understood the interview after its completion |
| | Include a cognitive test or some other methods to assess cognitive status if it is in doubt |
| | Include prompts (24-hour recall) or items (FFQ) to ensure that all foods (or food groups) have been included |
| | Probe or cross-check to ensure that commonly forgotten items such as alcohol intakes, spreads, sauces, sweets, and vitamin/mineral supplement intakes are included |
| | Use linguistic atlases to ensure that food lists or food group terms use common names familiar to respondents (e.g., include "tonic" as a term instead of soft drinks in some regions) |
| | When using telephone interviews, it may be necessary to mail sheets for estimating portion size to the respondent ahead of the interview |
| | For self-administered questionnaires, the respondent burden, and the inability or greater difficulty involved in seeking help, and also the inability to probe after the interview is over, means that probes for requesting help must be explicitly included, and methods developed for contacting and assisting the subject |

| Table 6: Memory Strategies and Aids for Improving Recall When Various Dietary Assessment Methods, continued | |
|---|---|
| 24-Hour Recall | Train subjects using instructional videotapes to motivate them and to show them ways to overcome common errors in responding, using a portable VCR or presentation graphics on a computer (the authors have developed two such instructional videotape films for 24-hour recalls and semiquantitative FFQs, and many others also exist) |
| | Mail subjects a food record or tape recorder to use on the day the 24-hour recall will later target; ask subjects to bring in or to have handy labels or other aids for describing what was eaten on the day to be targeted |
| | Use a computerized (completely computerized) software program with pictures of foods which appear when subjects select or type in the food name (or a cognate), with appropriate probes for details for eliciting the 24-hour recall from the subject |
| | Have subjects fill out trial questionnaires that can be reviewed for accuracy with the subject |
| | Ask subjects to bring in the typical utensils and measuring implements they use, especially if the utensils are atypical |
| | Ask subjects to do a simulation of a recorded intake on a 24-hour recall, using food models with standardized portion sizes; such a recall done prospectively provides an anchor against which 24-hour recalls and diaries can be evaluated |
| | Train interviewers in the use of standardized and computerized probing techniques and monitor them periodically |
| | Use computer technology that has cross checks and range checks built in |
| | Use standardized computerized protocols and probes |

| Table 6: Memory Strategies and Aids for Improving Recall When Using Various Dietary Assessment Methods, continued | |
|---|---|
| Semiquantitative Food Frequency Questionnaire | Use practice questions to test understanding |
| | Use food lists that are constructed around consumers' cognitive structures rather than lists designed on the basis of the preferences and categorizations of the interviewer; with computer technology, it should be possible to group food lists in various ways (e.g., by meal, by location of eating, by other variables that help the subject to recall) |

| Table 7: Some Strategies and Techniques to Improve Portion Size Estimation in 24-Hour Recalls and Food Frequency Questionnaires | |
|---|---|
| All Methods | Orient and motivate respondents about the importance of portion size estimation for accurate reporting of food intake, using videotapes and simulations which provide instrument-specific instruction |
| | Provide an opportunity for simulation and for correction of errors in estimation |
| 24-Hour Recall | Give subjects advance notice that they will be asked to recall portion sizes (However, even with such warning, portion size estimates are poor, at least among the elderly[56, 57]) |
| | Include a short size estimation task using three-dimensional models or other objects to assess if subjects systematically appear to under- or overestimate sizes; such information may be useful in correcting existing estimates |
| | Use food models and measuring tools to help people judge amounts; use abstract shapes and drawings during recall to help individuals recall amounts (However, errors are still large, often one quarter to one third, or more, even with advance warning about the task[58]; the use of such models therefore reduces, but does not eliminate, the estimation errors[59-61]) |
| | Provide a random sample of subjects with disposable cameras and standard size references, and have them photograph all times eaten |

| Table 7: Some Strategies and Techniques to Improve Portion Size Estimation in 24-Hour Recalls and Food Frequency Questionnaires, continued | |
|---|---|
| 24-Hour Recall, continued | Ask subjects to weigh all foods or measure all foods on the day before the recall |
| | Train those who are to be interviewed to judge portion sizes; this training appears to temporarily improve portion size judgement ability in some individuals[62, 63], but the effects of training are lost in less than one month[64], and some individuals, including people with diabetes, for whom portion size determination is very important, do not appear to improve with training[65] |
| | Ask an individual who is involved in food shopping or preparations for the individual to provide information and, if available, request and measure commonly used eating vessels in the home; although findings are mixed about the efficacy of such procedures, this may be helpful in improving portion size judgement accuracy; foods such as meats, vegetable, and desserts appear to be particularly difficult to estimate, and these, or other foods known to be particularly rich contributors of certain nutrients, may deserve special attention |

| Table 7: Some Strategies and Techniques to Improve Portion Size Estimation in 24-Hour Recalls and Food Frequency Questionnaires, continued | |
|---|---|
| Food Frequency Questionnaire | Include size and pattern recognition tasks with the food frequency questionnaire to determine overall ability top perform pattern recognition tasks |
| | When computerized interactive versions of semiquantitative FFQS are used, provide life-size images |
| | Use portion size defaults that are well-validated for different age and sex groups |
| | Develop items on the semiquantitative food frequency questionnaire that eliminate respondent confusion in differentiating between portion sizes and numbers of servings of foods they have eaten |

| Table 8: Some Additional Techniques for Maximizing Recall on 24-Hour Recalls and Food Frequency Questionnaires | |
|---|---|
| 24-Hour Recall | Start with the most recent eating occasion and go backward in time through each eating episode; within each eating episode, go forward through the meal; recent evidence from the study of other memory tasks suggests that for memory over a 24-hour period working backward through each discrete eating episode from the present may be a better strategy than working forward from the beginning of the 24-hour period; however, within each eating interval, working forward from the start of the meal to the end of the meal is probably easier for most respondents, and the recital of one food cues the next one; for some types of memory tasks, such as eyewitness (or flashbulb) memory of crimes or other dramatic events that were encoded, especially when every incidental detail of the event is of interest (as it often is in cases in which crimes were committed), working forward to the event may be helpful |
| | Organize the questionnaire so that the items of greatest importance are placed after the respondent has warmed up, but before he/she has become fatigued |

| Table 8: Some Additional Techniques for Maximizing Recall on 24-Hour Recalls and Food Frequency Questionnaires, continued | |
|---|---|
| Food Frequency Questionnaire | Highlight the most important questions on the questionnaire so that the respondent is well aware that frequency information is more important for some items than others, and for such items, provide more time for the individual to recall relevant autobiographical events that might surround the consumption of these foods and to give responses; this suggestion is based on our knowledge that the accuracy of responses increase with the amount of time an individual has to give it |
| | For important foods that are eaten with seasonal variations in frequency, it may be useful to test the utility of a decomposition strategy, for example, intake of fresh fruits and vegetables such as tomatoes; instead of a question which asks the individual to perform the task of calculating an average, ask "how often did you eat fresh (food like tomatoes) in the summer; then how often in the fall, in the winter, in the spring;" the specific episodes may be better recalled |

| Table 9: Some Caveats and Conclusions About Cognitive Issues and Dietary Methods |
|---|
| The information most useful for calculating intakes of food constituents involves eliciting a great deal of information about small events that occurred in the context of other, much larger episodes involving sensory and other experiences |
| Different cognitive tasks are probably involved in acquisition and retention of information about various foods and food attributes such as food name, portion size, frequency, and time interval involved |
| The type of information retained and retrieved differs with the dietary method (24-hour recall versus food frequency), by interviewing techniques, by attributes (such as food names, portion size, frequency, time interval), and also by respondent characteristics (age, ethnicity, cognitive ability, etc.) |
| Dietary recall involves more than memory |
| No single autobiographical memory function exists that describes forgetting of diet over time; salience, uniqueness, frequency, and many other factors are all important |
| Accuracy of retrieval is what is usually measured, not accuracy of retention; what is retrieved and how it is retrieved differs with dietary method |
| Error can be tolerated; systematic error is more difficult to deal with, but may be present |
| New technologies and development of more game-like tasks may offer more hope than making marginal improvements in existing methods |

# CHAPTER 10
# THE MEASUREMENT OF ALCOHOL CONSUMPTION[1]

by Michael E. Hilton, Ph.D., National Institute on Alcohol Abuse and Alcoholism

## 1. Introduction

This paper provides background on the measurement of alcohol consumption in surveys that are a part of the National Nutrition Monitoring and Related Research Program (NNMRRP). The goal is to raise issues that will be discussed by workshop participants, who will then craft a consensus statement on the methods of measuring alcohol consumption in NNMRRP surveys.

The paper starts with a discussion of the alcohol-related objectives enunciated in Healthy People 2000 (1). One goal of NNMRRP surveys is that they be designed in ways that are appropriate for monitoring these objectives. The discussion then reviews the alcohol consumption items contained in the leading NNMRRP surveys. These show where we stand today with regard to measuring alcohol consumption. The critique of existing items, as it emerges from the workshop discussion, may suggest a need for change or improvement. Other topics covered in the paper are those suggested by the workshop organizers; they cover special populations, the time frame for measuring consumption, and the location of consumption.
The purpose of the paper as a whole is to bring to the table issues, criticisms, and suggestions for group discussion. Other workshop participants may wish to revise or reject any of the ideas offered here; they may also wish to raise issues that the paper does not address. The consensus that finally emerges may or may not be consistent with the views expressed in this background paper.

## 2. Year 2000 Objectives

An objective of this workshop is to determine whether existing NNMRRP data collections are suitable for monitoring progress toward the objectives stated in Health People 2000 (1). Three of those objectives concern the use of alcohol.

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[1] The views expressed here are those of the author and should not be interpreted as representing the views of the NIAAA.

*Objective 4.6:* Reduce the proportion of young people who have used alcohol, marijuana, and cocaine in the past month, as follows:

| Substance | Age (years) | 1988 Baseline | 2000 Target |
|---|---|---|---|
| Alcohol | 12-17 | 25.2% | 12.6% |
| Alcohol | 18-20 | 57.9% | 29% |

Baseline data source: National Household Survey of Drug Abuse, ADAMHA

*Comment:* Measuring progress toward this goal requires only a simple frequency-of-drinking measurement. Hence, the objective could be monitored satisfactorily by several of the survey instruments considered here. However, survey items would have to be administered to persons in the relevant age categories.

*Objective 4.7:* Reduce the proportion of high school seniors and college students engaging in recent occasions of heavy drinking of alcoholic beverages to no more than 28 percent of high school seniors and 32 percent of college students. (Baseline: 33 percent of high school seniors and 41.7 percent of college students in 1989.)

*Comment:* In this objective, recent heavy drinking is defined as consuming five or more drinks on one occasion during the previous two-week period. The two week time frame is inconsistent with the one month time frame of the previous objective. Note also that five drinks per *occasion* is specified rather than five drinks per *day.*

*Objective 4.8:* Reduce alcohol consumption by people aged 14 and older to an annual average of no more than 2 gallons of ethanol per person. (Baseline: 2.54 gallons of ethanol in 1987.)

*Comment:* Baseline figures used in developing this objective were derived from apparent consumption statistics and not from survey data. Apparent consumption statistics are per capita consumption estimates that are calculated from State-by-State beverage sales data. It has long been established that the total amount of alcohol consumption reported in national surveys is only a proportion of the amount known to have been sold.[2] Midanik (2) notes that survey-reported total consumption is typically between 40% and 60% of apparent consumption calculated from sales data. Hence, a survey conducted at a time when sales data showed an average consumption of 2.54 gallons of ethanol consumed per adult can

[2] In the parlance of survey researchers in the alcohol field, this is known as the coverage rate.

be expected to report a survey-based estimate of average consumption between 1.02 and 1.52 gallons per adult. An estimate in this range would create the erroneous impression that substantial progress toward the objective had been made, when in fact aggregate consumption would have remained unchanged at 2.54 gallons per adult.

Given the disparity between sales-based and survey-based estimates of total consumption, it would be inappropriate to use data collected from any NNMRRP survey to monitor progress toward Objective 4.8.

### 3. Definitions Appropriate to the Year 2000 Objectives

Monitoring the above objectives would require standardized definitions for the following terms:

- heavy drinking
- drinking occasion
- standard drink

NNMRRP data is used for a variety of purposes in secondary analyses. Many of these analyses can be expected to require measurements of:

- frequency of heavy drinking occasions
- volume of alcohol consumed

It would be of great benefit to the research community if NNMRRP surveys contained items from which these two variables could be constructed.

Also required for Objective 4.8 is a standard system of beverage equivalents, or conversion factors that allow an investigator to convert gallons of beer, gallons of wine, and gallons of distilled spirits into gallons of pure ethanol. Williams, et al. (3) and Doernberg and Stinson (4) report a system of beverage equivalents that has been used for many years in generating aggregate consumption figures. However, Turner (5) notes that the research literature contains a variety of such systems and is far from consensus on what standard should be adopted.

## 4. Review and Critique of Currently Used Survey Items

The principal NNMRRP surveys that have collected alcohol consumption data in the recent past are the following:

Third National Health and Nutrition Examination Survey (NHANES III)
1992 National Health Interview Survey (NHIS)
1993 National Health Interview Survey on Cancer Epidemiology and Control (NHIS CANCER)
1993 Behavioral Risk Factor Surveillance System (BRFSS)
1993 Youth Risk Behavior Survey (YRBS)

The Detailed Note reprints the alcohol consumption items from these surveys. Four general observations can be made about these sets of items.

*Observation 1:* Three of the five surveys (NHANES III, BRFSS, and YRBS) ask about any drinking in the past month and are therefore suitable for measuring progress toward Objective 4.6. Neither NHIS, which uses a two-week time frame, nor NHIS CANCER, which uses a one year time frame, are suitable.

*Observation 2:* None of the five sets of items are suitable for monitoring progress toward Objective 4.7. Unfortunately, this objective is stated in terms of a two-week time frame, which though standard in the Monitoring the Future data series, is less common in other surveys. Of the five surveys considered here, only NHIS uses a two-week frame, but NHIS does not ask about the consumption of five or more drinks per occasion. BRFSS and YRBS both ask about occasions where five or more beverages were consumed, but do so using a one-month time frame.

*Observation 3:* No two of the five surveys considered here provide comparable data. Achieving comparability across NNMRRP surveys is an important goal, but one that remains distant at present. The principal axes of difference, with which survey designers will have to grapple in order to resolve this problem, are the following:

> *A. Time Frame.* A one-month frame is the most common here (and in the research literature generally) but two-week and one year frames are also often used. The research literature has not established whether shorter recall periods are more accurate or what the optimal time frame from a validity-of-recall perspective is (6,7).
>
> *B. Separate Beverages versus Combined Beverages.* Some surveys ask separate series of questions about each of the three beverage classes: wine,

beer, and distilled spirits (e.g. NHIS CANCER). Other surveys ask the respondent to include beverages of any type when reporting his or her consumption (e.g. BRFSS). Studies have not established whether either alternative produces greater reliability or validity.

*C. Per Day Reporting versus Per Occasion Reporting.* Some item systems ask about the number of days the respondent has drunk, or has drunk a certain amount, or the average number of drinks per day. Other systems ask about the number of occasions and the average number of drinks per occasion. As the two can not be expected to produce similar results, a deliberate choice between the two should be made.

*Observation 4:* Most of the item sets discussed here take a "usual quantity" approach toward measuring consumption (8). This is only one of several approaches that can be found in the research literature, and it is probably the least informative approach.

In a usual quantity approach, the respondent is asked how often he or she drinks alcoholic beverages, followed by a question on how many drinks are usually consumed during a typical drinking occasion (or during a typical drinking day). The responses are then multiplied together (and summed across the three beverage types, if each beverage is asked about separately) to estimate the volume of alcohol consumed.

There are two basic problems with the usual quantity approach. First, because the respondent is asked about his or her usual drinking amount, the occasions (or days) when atypically large amounts are consumed are ignored, leading to an underestimate of consumption. For example, suppose that a respondent drank on ten occasions during the past month and usually had two drinks per occasion, but on three occasions, the respondent consumed an entire six-pack of beer. The usual quantity approach would record 20 drinks for that month, but the true figure would be 32 drinks (an underestimate of 38%). Lemmens et al. (9) found that a usual quantity measure gave a markedly lower estimate of total alcohol consumed than did four other measurement approaches that were studied.

Second, usual quantity approaches tend to focus attention on volume of consumption, when other dimensions of an individual's drinking pattern may be more important. As Knupfer (10) has persuasively argued, the frequency of intoxication, or the frequency of occasions where large amounts are consumed, is a much more important factor in the risk for many alcohol-related problems. For example, the person who drinks two beers every day has a much different risk for a traffic crash than does a person who drinks seven drinks every Friday night and another seven drinks every Saturday night.

Room (8) discusses several other approaches that have been used in alcohol surveys. He distinguishes between a North American tradition in which respondents are asked to summarize their current drinking pattern and a European tradition that asks respondents to list each of several specific recent drinking occasions. Among the former are graduated frequencies approaches (11, 12), which ask the respondent how often he or she has engaged in various levels of consumption. For example, the series:

> On how many occasions during the last month did you have any alcoholic beverages?
> On how many of those occasions did you have three or more drinks?
> On how many of those occasions did you have five or more drinks?
> On how many of those occasions did you have eight or more drinks?
> On those occasions when you had eight or more drinks, how many did you usually have?[3]

Retrospective recall-of-days approaches (13) ask respondents to think back over the past one or two week period and report, day-by-day how many drinks were consumed. It is thought, though not established by research evidence, that respondent recall is more accurate when shorter time frames and the recall of specific days or events are involved (note, however, that Midanik et al. (6), and Williams et al., (7) offer contrary evidence). The "time line" method of Sobell et al.(14) is similar, but it extends the recall period back over periods of a year or longer. Prospective diaries ask respondents to record their drinking for the next few weeks on forms that are left by the interviewer and collected later (9, 15). These are more expensive to administer. A European tradition of asking detailed questions about each of approximately four recent occasions can be seen in the work of Simpura (16, 17), Duffy (18), and Alanko (19). These can be termed event-focused approaches, and are discussed in the "Location of Consumption" section below.

## 5. Special Populations

In setting dietary guidelines for moderate drinking, women and older persons have been special populations of interest. Guidelines put forth jointly by the U.S. Department of Agriculture and the U.S. Department of Health and Human Services define moderate drinking as no more than one drink a day for most women, and no more than two drinks a day for most men (1). A similar gender differential is proposed in guidelines for the United Kingdom (20-22). The establishment of separate guidelines for men and women reflects research findings

[3] This last question is included so that analysts will have a value to assign to the unbounded "eight or more" category.

showing that: (1) women become more intoxicated than men at an equivalent dose of alcohol (23); (2) a gastric enzyme that breaks down alcohol before it reaches the bloodstream is four times more active in men than women (24); and (3) women have proportionately more fat and less body water than men (25). Lower standards for older persons are recommended because body fat increases with age (26).

NNMRRP survey data on alcohol consumption will be used by a variety of researchers for diverse purposes. Some of these researchers will want to establish differential consumption standards for special population groups while others might feel that such differentials are unnecessary. This might suggest the need for flexibility in the data so that various cutpoints, criteria, and categorization schemes might be developed at the analysis stage.

### 6. Time Frame

Each of the three Year 2000 objectives has a different time frame (two weeks for Objective 4.6, one month for Objective 4.7, and one year for Objective 4.8). Hence, any standard system adapted by NNMRRP can not be strictly appropriate for all three objectives. A necessary compromise might involve collecting data on a "last month" basis and halving the results to estimate the "last two weeks" consumption. Note, however, that this would not be strictly accurate since a month consists of slightly more than four weeks (28 days).

Existing alcohol research surveys use a variety of time frames. Shorter time frames, such as two weeks, carry the disadvantage that a substantial proportion of respondents drink infrequently and may therefore have no drinking to report. Only about 35% of adults drink as often as once per week; 54% drink at least once per month (27).

### 7. Location of Consumption

For research projects focused on the location and context of drinking, event-focused approaches are preferable to summary recall approaches. Event-focused methods ask the respondent to recall the last few drinking occasions and, for each one, to describe the amount drunk, the location, other members of the drinking group, etc. (16-19). In order to estimate a drinker's overall consumption pattern from this type of data, one must assume that the last few occasions (typically three or four) are representative with regard to both the amounts consumed and the time intervals between occasions.

Drinks consumed at bars and restaurants may be smaller than those poured at home. In the context of an event-focused approach or a usual quantity approach, this problem may be addressed by asking about the sizes of the glasses of beer and

wine and of the shots poured into mixed drinks (28). However, not all of the approaches discussed here lend themselves easily to such an adjustment. For example, it is difficult to propose a practical adjustment that might be made for the question, "On how many occasions did you have five or more drinks?"

## 8. Summary

No one set of survey questions would be appropriate to monitor progress toward the Year 2000 objectives. Indeed, one of these Objectives (4.8), is more properly monitored through apparent consumption statistics than through survey data. Existing sets of alcohol consumption items in NNMRRP surveys tend to be inconsistent with each other. Most item sets are cast within a usual quantity approach toward measuring alcohol consumption, which is only one of several approaches that could be considered.

Since this background paper is supposed to open the discussion of pertinent issues, it would be premature to suggest conclusions here. However, it may be appropriate to suggest that the discussion begin with a consideration of whether NNMRRP should continue to utilize a usual quantity approach. If not, the discussion would then have to decide which of the alternative approaches might be more suitable. Having resolved the question of the basic approach, discussion might then turn toward such finer-grained issues as common definitions of variables, the proper time frame, standard drink sizes, the suitability of items for special populations, whether location of consumption should be collected, and the advisability of achieving comparability across survey data sets.

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## Detailed Notes

### Questionnaire Items from Selected NNMRRP Surveys

1. Third National Health and Nutrition Examination Survey (NHANES III)

Now I'm going to ask you how often you usually eat certain foods. When answering think about your usual diet over the past month. Tell me how often you usually ate or drank these foods per day, per week, per month, or not all.

h. Beer and lite beer
i. Wine, wine coolers, sangria, and champagne
j. Hard liquor such as tequila, gin, vodka, scotch, rum, whiskey, and liqueurs, either alone or mixed

2. 1992 National Health Interview Survey (NHIS)

These next questions are about drinking alcoholic beverages. Included are liquor, such as whiskey or gin, beer, wine, and any other type of alcoholic beverage.

1. Have you had at least one drink of beer, wine, or liquor during the PAST YEAR?

2. During the past 2 WEEKS (outlined on hand calendar), beginning Monday (date) and ending this past Sunday (date), on how many days did you drink any alcoholic beverages, such as beer, wine, or liquor?

3. On the (number in 2) day(s) that you drank alcoholic beverages, how many drinks did you have (per day on the average)?

4a. Was the amount of your drinking during that 2-WEEK period typical of your drinking during the past 12 months?

4b. During that 2-week period, did you drink MORE or LESS than usual?

3. 1992 National Health Interview Survey on Cancer Epidemiology and Control (NHIS CANCER)

57A. During the past year or so, how often did you drink beer?

58A. During the past year or so, how often did you drink wine?

59A. During the past year or so, how often did you drink liquor?

60A. Was there ever a period in your life when you drank five or more drinks of any alcoholic beverage almost every day?

60B. For how long did that period last?

4. 1993 Behavioral Risk Factor Surveillance System (BRFSS)

29. During the past month, have you had at least one drink of any alcoholic beverage such as beer, wine, wine coolers, or liquor?

30. During the past month, how many days per week or per month did you drink any alcoholic beverages, on the average?

31. A drink is 1 can or bottle of beer, 1 glass of wine, 1 can or bottle of wine cooler, 1 cocktail, or 1 shot of liquor. On the days when you drank, about how many drinks did you drink on the average?

32. Considering all types of alcoholic beverages, how many times during the past month did you have 5 or more drinks on an occasion?

33. During the past month, how many times have you driven when you've had perhaps too much to drink?

34. During the past month, how many times have you ridden with a driver who has had perhaps too much to drink?

## 5. Youth Risk Behavior Survey (YRBS)

The next four questions ask about drinking alcohol. This includes drinking beer, wine, wine coolers, and liquor such as rum, gin, vodka, or whiskey. For these questions, drinking alcohol does not include drinking a few sips of wine for religious purposes.

32. How old were you when you had your first drink of alcohol other than a few sips?

33. During your life, on how many days have you had at least one drink of alcohol?

34. During the past 30 days, on how many days did you have at least one drink of alcohol?

35. During the past 30 days, on how many days did you have 5 or more drinks of alcohol in a row, that is, within a couple of hours?

# CHAPTER 11
# ASSESSMENT OF CALCIUM INTAKE

by Mary Fran R. Sowers, Ph.D., The University of Michigan

## I. Assessment of Calcium Intake

*Year 2000 Nutrition Objective 2.8*

Increase calcium intake so that at least 50 percent of youth aged 12 through 24 and 50 percent of pregnant and lactating women consume 3 or more servings daily of foods rich in calcium and at least 50 percent of people aged 25 and older consume 2 or more servings daily.

Baseline: 7 percent of women and 14 percent of pregnant and lactating women consume 3 or more servings, and 15 percent of women and 23 percent of men aged 25 through 50 consumed 2 or more servings in 1985-86. Source: Continuing Survey of Food Intakes by Individuals.

### A. Definitions

1. Dietary calcium: Calcium intake specifically from food, which may arise from the native food or from enrichment.

2. Calcium from supplement: Calcium intake arising from non-food commercially-based products specifically designed to increase calcium availability to the gastrointestinal tract.

3. Calcium from water: Calcium intake available in the form of calcium carbonate (measured as water hardness) and which occurs as a native constituent of certain water supplies

4. Foods rich in calcium:
   A. Foods high in calcium and which consumed by themselves have less competitive complexing by other substances, which decreases availability for absorption.
      Dairy products (excluding butter and ice cream), fortified cereals, fortified orange or other fortified juices

B. Foods high in calcium, including those foods for which absorptive efficiency may be more limited.

Dairy products (excluding butter and ice cream), fortified cereals, fortified orange or other juices, dark green vegetables, legumes, cornmeal soaked with lye, foods prepared with pot liquors where an acid media is used to soak bones from fish or animals, and soy-based foods such as tofu.

B. Statement on Calcium and Disease Relationships

In addition to the recognized requirement for calcium during infant, childhood and adolescent growth, there is interest in the study of calcium and its metabolism from at least three different chronic disease perspectives. They are: 1) calcium and cancer, 2) calcium and hypertension within the cardiovascular system, as well as 3) calcium and metabolic bone disease.

*Cancer.* The impact of calcium intake and cancer has been examined relative to two different sites, colon cancer and mammary or breast cancer. Relationships have been described between calcium and gastrointestinal epithelial cell proliferation and differentiation, as well as tumor occurrence in both rodent models and human subjects. Epithelial cell proliferation is increased in the colon, stomach and esophagus of human subjects with susceptibility to cancer. Thus, one approach has been the analysis of gastrointestinal cell proliferation patterns as intermediate cancer markers to examine the role for oral calcium administration. Several studies (2-5) have suggested that there is decreased hyperproliferation after dietary calcium supplementation at a level of 1200 to 2000 milligrams of elemental calcium (Table 1). Changes in proliferation were not observed when lower levels of cell replication were present (3,6).

In vitro studies have demonstrated that increasing physiologic concentrations of calcium decrease the proliferation of normal-appearing flat mucosal cells of the intestinal tract and may protect colonic epithelial cells against bile acids and fatty acids. The response to physiologic levels of calcium appears to be heterogeneous in familial polyposis cells while there appears to be a loss of response to calcium in advanced stages of adenomas and carcinomas (7-9). The reader should be aware that the number of cancer centers investigating the role of calcium and cancer biomarkers is quite limited and that the group at Sloan-Kettering have been responsible for much of the literature in this area. Typically, hypoproliferation of colonic epithelial cells is decreased (as shown in Table 2) but not consistently as was observed by Karkare (10) and Kaup (11).

It is important to recognize that, in these studies, measurement of cellular proliferation and differentiation serve as intermediate biomarkers as measures of potential risk for cancer. These are not direct studies of cancer itself.

Beginning in 1980, a series of epidemiological studies suggested a relationship between colon cancer and calcium and vitamin D. Much of the early work has been summarized in a review by Sorenson et al. (12), and further reviewed by Garland and Garland (13). Some of the studies are shown in Table 3.

A number of possible hypotheses are available to explain the potential role of tumorigenesis and calcium or vitamin D. In brief, they may be summarized as follows:

1. The presence of residual fatty acids in the bowel causes a sufficient alteration in the local pH that the integrity of the colonic epithelium is disturbed. This leads to tissue damage and proliferation. Calcium abates this process by its capacity to bind ionized lipids. The bound complexes are virtually soaps which are less damaging to the colonic epithelial tissue.

2. A second area which has been much less explored in the epidemiology literature actually focuses more on the vitamin D element of the calcium metabolic process. This aspect suggests that metabolic product of 1,25-dihydroxyvitamin D is responsible for the integrity of cellular distribution including the integrity of the colon epithelial cell. Therefore, inadequate levels of 1,25-dihydroxyvitamin D could lead to cells that were less responsive to appropriate differentiation.

The role for calcium intake and carcinogenesis has also been explored relative to the mammary gland particularly in animal models. Rats fed 7,12-dimethylbenza-anthracene (DMBA) and calcium with vitamin D showed mixed results (14). In using mammary cell proliferation studies, Zhang (15) reported decreased proliferation induced by dietary fat; Carroll (16) reported decreased proliferation and tumor formation induced by dietary fat and carcinogen. The theoretical model advanced for the use of calcium is that dietary fats are associated with breast cancer (a hypothesis that is still under investigation) and that calcium saponifies fat, makes fatty and bile acids unavailable for metabolic activity (17).

*Hypertension.* A relationship between dietary calcium and blood pressure has been argued for both essential hypertension and hypertension of pregnancy (18). Inadequate dietary calcium intake may be related to increased arterial blood pressure by altering the set point for blood pressure homeostasis. As this hypothesis evolved early in the 1980s, it was recognized that additional dietary factors which suppress dietary calcium absorption (alcohol use) as well as factors

which alter urinary calcium excretion (sodium intake) may impact the calcium/blood pressure linkage and cause differential expression of the relationship within population groups.

McCarron (19) has suggested that the following populations might be at risk for calcium deficiency hypertension: blacks, Southeast Asians and the Japanese, alcoholics, diabetics, salt-sensitive persons, pregnant women, and elderly people.

Apart from compromise is the provision of dietary calcium, recent examinations have focused on calcium metabolism and calciotrophic hormones, specifically 1,25-dihydroxyvitamin D. First, 1,25-dihydroxyvitamin D is required for active transport of dietary calcium across the gut wall via the calcium binding protein. Second, it has been well established that in hypertension, peripheral vascular resistance contributes to the elevation of blood pressure. There is now data which is consistent with hypothesis that 1,25-dihydroxyvitamin D modulates ionized calcium metabolism and impacts the contractibility of vascular smooth muscle (20,21).

The extensive work in calcium and hypertension also includes a literature about hypertension of pregnancy. In 1983, Villar et al. published information reporting that the incidence of pre-eclampsia in three populations was increased as the calcium content of the diet decreased (22). Two major concepts have emerged from this body of work. They are:

- Blood pressure is reduced because of smooth muscle relaxation mediated by the calciotrophic hormones, specifically 1,25-dihydroxyvitamin D and parathyroid hormone, in response to plasma calcium concentrations.

- The positive impact of dietary calcium intake may be extended to low birth weight via the same smooth muscle contractility hypothesis if the level of uterine contractility is reduced.

It is important to underscore that dietary calcium intake (or dietary vitamin D intake) is quite different than the ionized calcium levels or calciotrophic hormone levels that are associated with these postulated physiological mechanisms.

*Metabolic Bone Disease.* The greatest interest in calcium intake has arisen based on its potential relationship with lower bone mass and osteoporotic fracture. The Consensus Conference of 1984 sponsored by the National Institutes of Health (NIH) provided a forum for proponents of higher calcium intake to promote higher intake as a national policy in preventing bone loss and its attendant osteoporotic fracture (23). Table 4 describes a series of recent clinical trials of calcium supplementation in altering bone mass or preventing fractures. These trials

indicate that the role of dietary intake is an important one; however, supplementation with additional calcium appears to be a beneficial practice under two conditions: when dietary intake is less than 400 mg/day and when the supplement is presented in a highly absorbable formulation. This would appear to have several implications for the role of dietary calcium.

- Focus should be placed on improving nutriture in persons at the lowest level of the distribution (intake is less than 400 mg/day).
- It is as important to focus on appropriate calcium absorption as calcium intake, suggesting a stronger role for evaluation of vitamin D status.

One of the primary proponents of the focus on dietary calcium intake, Robert Heaney, has since placed calcium intake within a context of other risk factors in what he believes to be the attributable proportion of the population variance to low bone mass.

| Factor | | Attribution portion of population variance |
|---|---|---|
| Heredity | | 25% |
| Weight or body size | | 10% |
| Exercise | | 15% |
| Alcohol/smoking | | 10% |
| Medications | | 5% |
| Calcium | | |
| | Low intake | 5% |
| | Excess loss | 5% |
| | Low absorption | 5% |
| Other | | 20% |

The relatively limited influence (five percent of the attributable variance) of calcium intake is an observation that is frequently loss on much of the nutrition community. Other components of calcium metabolism including excess loss which may be associated with alcohol intake, lack of potassium, excess sodium, or excess fat, are frequently not evaluated in relationship to the availability of calcium from the gut for potential absorption. The other component of this model, the

availability of absorption, is also frequently not addressed with the recognition that low absorption is a function of the vitamin D system rather than the direct dietary calcium intake.

Increasingly, a shift has occurred in terms of interest in the role of calcium in bone disease with the appreciation that the greatest impact of calcium may be occurring in younger age groups particularly in pre-adolescents, adolescents, and young adults. Recent reviews (24-26) suggest that while studies do not demonstrate a strong association between dietary calcium intake in older women, there is a greater likelihood for a relationship to exist in young adult women. The reviews suggest that the impact is not large, and the studies upon which these relationships are based are in highly selective non-randomly generated populations. Investigations using questions about adolescent dairy intake in mature women have sometimes (27), but not consistently (28) suggested a relationship.

*Summary.* There is a strong interest in calcium intake for its potential relationship with both appropriate growth and development as well as prevention of chronic disease. However, review of the literature in chronic disease suggests that dietary calcium deficiency represents the etiologic factor of interest. The interaction of calcium with many other nutrients including vitamin D, dietary fats, sodium, potassium and alcohol, present a more complex picture in which there must be consideration of dietary factors, absorption factors, and the eventual translation into the metabolic environment.

## II. Currently used methods

The currently used methods for assessing dietary calcium intake have been discussed relative to their general strengths and weaknesses. These methods are:

1. 24-hour recall (including variations such as telephone-based 24-hour recall)
    a. Single days
    b. Multiple days
2. Food Frequency
    a. Assess multiple nutrients or foods
        1. NCI
        2. Willett
        3. Others (Tecumseh, etc.)
    b. Abbreviated to assess limited numbers of nutrients
        1. Musgrave (1)
        2. Tylasky
        3. Sowers
        4. Others

3. Questions about use of dairy products during adolescence
4. Biochemical measures
   a. 25-hydroxyvitamin D
   b. 1,25-dihydroxyvitamin D
   c. There are no biochemical measures of dietary calcium intake
5. Food Patterns -- very little work has been done

## III. Considerations in selecting a method to assess calcium intake

A. Populations

Major ethnic groups:

*Hispanics*

a. Mexican American
b. Cuban American
c. Puerto Rican American

*Asians*

a. Japanese
b. Korean
c. Chinese (multiple subtypes)
d. Indian
e. Vietnamese
f. Thai
g. Other South Asian groups

B. Reference points of interest: Currently, questions about use of dairy products during adolescence have been developed (see purpose for measuring calcium under section on Metabolic Bone Disease). To my knowledge, these questions about historical calcium consumption have not been used in studies of cancer or cardiovascular disease.

C. Analytic Issues

1. Are other variables such as total calorie intake needed?

   Ideally, other variables that would be available:

   a. weight and height
   b. total calories/energy
   c. vitamin D
   d. sodium intake or urinary sodium excretion
   e. urinary calcium excretion to establish ratio
   f. alcohol intake
   g. index of renal function (creatinine)
   h. dietary fat intake

2. Are total quantities or approximate ranking needed?
    a. either measure is usable; however, the greater the information, the greater the opportunity to explore threshold models or examine interactions
    b. Why respondents don't like food frequencies:
        - how to handle seasonality, i.e. holidays
        - how to be appropriate in estimates of serving size
        - how to handle mixed dishes
        - how to respond to mixed categories
        - how to respond to special products (turkey replacement products, egg substitutes)
        - fatigue at having to make multiple decisions continuously for every food
        - lack of cultural specificity
        - the greater the variation in their eating, the more difficulty they have responding

3. Are individual or group estimates needed?
    a. Individual - most chronic disease research
    b. Group - most managerial decision-making relative to the food supply

4. Variation of calcium by season
    a. Seasonal variation is generally not an issue if the primary source of calcium is dairy products, provided the user has access to adequate refrigeration
    b. Seasonality becomes an issue when vegetables are a significant source of the dietary calcium
    c. Other factors which may generate variation
        1. supplement use characteristics
        2. medication use
        3. presence or absence of disease states

5. The number of measurements recommended
The following table summarizes the work on the contribution of intraindividual to interindividual variation and the variability around the central tendency which influence the number of measurements taken.

| Investigator | Population | Mean±SD | Ratio | No. of days True correlation estimate >80% |
|---|---|---|---|---|
| Hunt | elderly<br>25 men<br>25 women | 602±148<br>709±188 | 1.1<br>1.7 | 4-6 days<br>6-10 days |
| Sempos | 142 women | 680±253 | 1.1 | 4-6 days |
| Sowers | Post-partum<br>62 lactating<br>40 controls | data in preparation | data in preparation | data in preparation |

6. Modification of food frequency for ethnic group.
Substantial modification will be required of the food frequency to address major sources of calcium outside the dairy products. Recent steps to include yoghurt is reflective of the type of modification required.

D. Other issues

- need food composition tables for vitamin D
- need food composition tables for many ethnic foods
- need measures of cultural transition (related to food)
- need measures of food patterns, not single nutrient, to overcome the nature of nutritional interaction
- need ratios of interindividual/intraindividual variation developed in multiple types of populations including ethnic groups and during reproduction
- need to develop estimates of inter-individual to intra-individual variance ratios for categories (like food groups) as well as nutrients.
- need a better way to account for the contributions of supplement and water calcium to total intake
- need to develop a national data base of dietary calcium assessment to take better advantage of what is being collected.

Example: 125 lactating women: three food frequencies and three 24-hour recalls including their infants at five points in one year
: 600 Amish men and women: one food frequency annually for three years

: 850 women 20-80 years: simultaneous 24-hr recalls and food frequencies with supplements, at baseline and 5 years later: 1400 black men and women: food frequencies
: 600 women 20-40 years: food frequencies in 1988,92,93,94,95.

- need to develop specific questions which will be asked of the data base which could be developed.

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Table 1

| Table 1: Supplemental calcium and proliferation and differentiation of colonic cells in human subjects | |
|---|---|
| Calcium Effect | Reference |
| *Dietary in vivo* | |
| Decreased hyperproliferation | Lipkin, 1985 (2) |
| Decreased hyperproliferation | Lipkin, 1989 (3) |
| Decreased hyperproliferation | Rozen, 1989 (4) |
| Decreased hyperproliferation | Isbell, 1989 (5) |
| Unchanged hyperproliferation | Gregoire, 1989 (6) |
| *In vitro* | |
| Decreased proliferation (2 mmol/L) | Buset, 1986 (7) |
| Decreased proliferation (2-4 mmol/L) | Appleton, 1988 (29) |
| Decreased proliferation (2 mmol/L) | Arlow, 1988 (30) |
| Decreased proliferation (2 mmol/L) | Buset, 1987 (8) |
| Decreased proliferation (2 mmol/L) | Friedman, 1989 (9) |
| Protects versus toxicity of bile acids, fatty acids (5 mmol/L) | Buset, 1989 (31) |
| Increased histone acetylation: cell differentiation (1-2 mmol/L) | Boffa, 1989 (32) |

Table 2

| Table 2: Supplemental dietary calcium and proliferation and differentiation of colonic cells from rodents | |
|---|---|
| | References |
| Decreased hyperproliferation induced by deoxycholic acid | Wargovich, 1983 (33) |
| Decreased hyperproliferation induced by fatty acids | Wargovich, 1984 (34) |
| Decreased hyperproliferation induced by cholic acid | Bird, 1986 (35) |
| Decreased hyperproliferation induced by partial enteric resection | Appleton, 1986 (36) |
| Decreased tumor formation induced by partial enteric resection and carcinogen | Appleton, 1987 (37) |
| Decreased proliferation and tumor formation induced by dietary fat and carcinogen | Pence, 1987 (38) |
| Decreased intestinal tumors of Azomethane | Skrypec, 1988 (39) |
| Decreased hyperproliferation induced by nutritional stress diet (low calcium, vitamin D; high fat, phosphorus) | Newmark, 1990 (40) |
| Decreased Azomethane-induced hyperproliferation and colonic tumors on low-fat diet | Reshef, 1989 (41) |
| Decreased colonic tumors induced by Azomethane | Wargovich, in press (42) |
| Decreased deoxycholic acid-induced hyperproliferation (calcium effect blocked by phosphate) | Hu, 1989 (43) |
| Decreased ODC[1] and tyrosine kinase induced by Azomethane | Arlow, 1989 (44) |

| Table 2: Supplemental dietary calcium and proliferation and differentiation of colonic cells from rodents, continued | |
|---|---|
| | References |
| Decreased ODC[1]-induced by bile | Baer, 1989 (45) |
| Decreased cholic acid-induced mortality | Cohen, 1989 (46) |
| Unchanged tumor incidence after DMH[2] | Karkare, 1989 (10) |
| Unchanged tumor incidence after DMH[2] | Kaup, 1989 (11) |
| [1] ODC = ornithine decarboxylase | |
| [2] DMH = dimethylhydrazine dihydrochloride | |

Table 3

| Table 3: Epidemiologic Studies of Calcium and Colon Cancer | | | | | |
|---|---|---|---|---|---|
| Reference | Study Design | Calcium | Vitamin D | Anatomic Site | Relationship |
| Garland, 1980 (47) | ecologic | | geography of sunlight | colon cancer | reduced risk |
| Garland, 1985 (48) | pooled population prospective white men | yes | yes | colon and rectum cancer separately | decreased risk with calcium and vitamin D |
| Kune, 1987 (49) | case/control male & female | yes | not reported | colon and rectum cancer separately | decreased risk; dose response |
| Slattery, 1988 (50) | case/control male & female | yes | not reported | colon cancer | decreased risk; dose response |
| Stemmerman, 1990 (51) | prospective Japanese/ American | yes | not reported | subsites in colon and rectum | decreased risk only in sigmoid |
| Garland, 1989 (52) | prospective male & female | no | serum 25-OH-D | colon | decreased risk; dose response |

Table 4

| Table 4: Some Trials of Calcium Supplementation | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Reference/ Date | | Subjects | Dose | Duration (years) | Bone Mass Measurement | Significant Improvement | Randomized | Blinded |
| *Premenopausal Women* | | | | | | | | |
| Baran (53) | 1989 | 17 C<br>20 T | ~750 mg from dairy products | 3 years | dual photon differences | yes, 2.5% | no | no |
| Smith (54) | 1989 | 19 C<br>16 T | 1500 mg/day | 4 years | single photon | no | yes | yes |
| Elders (55) | 1991 | 97 C | 1000 and 2000 mg/d | 2 years | dual photon | 1st year only | yes | yes |
| *Postmenopausal Women* | | | | | | | | |
| Nordin (56) | 1980 | 41 C<br>20 T had vertebral fracture | 12 mg | variable | x-ray | no | no | no |
| Smith (57) | 1981 | 18 C | 750 mg | 3 | single photon | yes | yes | yes |
| Riggs (58) | 1982 | 46 C<br>27 T | 575-1000 mg (some vitamin D) | variable | vertebral compression | yes | no | yes |

| Table 4: Some Trials of Calcium Supplementation, continued | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Reference /Date | | Subjects | Dose | Duration (years) | Bone Mass Measurement | Significant Improvement | Randomized | Blinded |
| Nilas (59) | 1984 | 4 C<br>39 T<br>young post-menopausal | 500 mg + food | 2 | single photon | yes | no | no |
| Polley (60) | 1987 | 52 C<br>158 T | 1000-1250 mg | 9 months | single photon | yes | no | no |
| Smith (54) | 1989 | 38 C<br>44 T, young post-menopausal | 1500 mg/day | 4 years | single photon | yes | yes | yes |
| Dawson-Hughes (61) | 1990 | 93 C<br>167 T young and old post-menopausal | 500 mg/day calcium carbonate or other | 2 years | dual photon | yes, in 400 mg/day older women | yes | yes |
| C=control T=treated | | | | | | | | |

Table 5

| Table 5: Current Calcium Intake and Bone Mass in Premenopausal Women as Evaluated in Cross-sectional Studies | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Reference | N | Age group/ mean age | Randomly chosen | Calcium Assessment Methodology | Mean Intake (in mg) | Bone Measurement[1] | Finding | Date |
| Sowers, 1985 (62) | 86 | 20-35 | yes | food frequency; 24-hour recall | 1000 | SPA radius | positive (p=0.07) | 1985 |
| Freudenheim, 1986 (63) | 17 | 43 | no | multiple recalls | 800 | SPA forearm | no association | 1986 |
| Angus, 1988 (64) | 89 | 38 | no | 4-day food record | 700 | DPA lumbar spine<br>DPA proximal femur | no association<br>no association | 1988 |
| Picard, 1988 (28) | 183 | 40-50 | no | diet history | 600 | DPA lumbar spine<br>SPA distal radius | positive (p=0.05)<br>no association | 1988 |
| Elders, 1989 (65) | 86 | 46-52 | yes | food frequency | 1000 | DPA lumbar spine | positive (p=0.03) | 1988 |

| Table 5: Current Calcium Intake and Bone Mass in Premenopausal Women as Evaluated in Cross-sectional Studies, continued | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Reference | N | Age group/ mean age | Randomly chosen | Calcium Assessment Methodology | Mean Intake (in mg) | Bone Measurement[1] | Finding | Date |
| Mazess, 1991 (67) | 243 | 20-39 | no | food frequency | 900 | DPA lumbar spine<br>DPA proximal femur<br>SPA forearm | no association<br>positive (p=0.03)<br>no association | 1991 |
| McCulloch, 1990 (68) | 101 | 20-35 | no | food frequency | 800 | CT os calcis | positive (p=0.10) | 1990 |
| [1]SPA= single photon densitometry; DPA= dual photon densitometry; CT= computerized tomograph | | | | | | | | |

# CHAPTER 12
# ASSESSMENT OF FAT INTAKE

by Linda Van Horn, Ph.D. R.D., Northwestern University Medical Center

## I. Introduction

The stated purpose of this workshop is "to make progress in defining standardized dietary indicators that can be related to health indicators such as those measured in NHANES".....and indirectly to "contribute to the planning process for the future NHANES and other national surveys that collect dietary intake data". Discussion is to focus on dietary indicators used for nutrition monitoring, with an emphasis on current and future linkages that will maximize the opportunities for comparability among national, State and local nutrition surveys and thereby facilitate evaluation of progress in meeting the Year 2000 nutrition objectives. The complexity of these issues is made even more difficult by the synergistic nature of the dietary indicators. None of these exist in isolation and measurement errors committed in assessing any one of them have potential impact on assessing or interpreting the others. The acknowledged imprecision of any one dietary assessment method complicated by the limited comparability of existing dietary data collected via various methods, are major obstacles in attempting to correlate diet with health or risk for disease. Add to this confusion the lack of a universally accepted, current , brand-specific nutrient data base that can be interchanged between surveys, and the quest for answers seems almost futile. Viewed in this context, the charge to the nutrition epidemiologic community becomes quite clear. Weigh the strengths and weaknesses of the available assessment methodology and come to a consensus on the best approach to address at least the most compelling diet-health associations, and then apply it to all current and future dietary surveys to better standardize and compare results.

The purpose of this paper is to address these questions as they relate to the assessment of fat intake. The specific considerations assigned to this task include the measurements required to assess whether the Year 2000 objective of 30 percent of calories or less from total fat and less than 10 percent of calories from saturated fat are being met by people age 2 years and older, as well as other fat-related health issues. The methods currently used to assess fat intake will be summarized and the special needs related to target subgroups, reference periods and other key analytical issues will be briefly described. It is not possible within the scope of this paper to be either exhaustive nor conclusive about any of these important matters, but purely to introduce them for further exploration by the workshop attendees.

## II. Assessment of Fat Intake: The Need

### A. Year 200 Nutrition Objectives

In order to evaluate whether the Year 2000 objectives for total and saturated fat intake have been met, the assessment method must be capable of producing both quantitative data on total caloric intake with the contribution from fat differentiated from the other macronutrients, and qualitative data on the specific sources of fat intake to identify saturate and unsaturated components. Because fat is consumed directly, as a food itself, e.g. margarine or butter, as well as indirectly, as an ingredient within a food product or in preparation of a food product, the assessment method must capture and quantify these diverse contributions to overall nutrient intake. The method must also allow for documentation of change in these values over time to evaluate intervention progress within a population or subgroup. There should be sufficient precision in this documentation to demonstrate changes in absolute values to differentiate certain subgroups that may be adhering more closely to the dietary recommendations than others that would otherwise go undetected if only relative intake was assessed. The point can be further illustrated by comparing two prominent surveys.

NHANES II (1976-1980) and CSFII (1985) both estimated 36 percent of calories from total fat and 13 percent from saturated fat for people aged 20-74 years and for women aged 19-50 years, respectively. Without absolute values for calorie and fatty acid intake, it is not possible to differentiate whether shifts in energy intake have occurred and/or whether simultaneous shifts toward increased saturated fatty acid intake could actually constitute a decrease in saturated fatty acid intake over this period for this subgroup. Given the diversity of the population, not only gender and age, but culture, socioeconomic status, and other characteristics may be important to distinguish from the population as a whole in order to identify those subgroups that may require expanded intervention efforts tailored specifically to them. If absolute values are deemed critical to this process, then certain methodologies could be ruled out since their inherent limitations preclude such analyses.

### B. Measurements Required

To assess total and saturated fat intake, at least three major factors must be included; total calories from fat, frequency and specificity of fat-containing foods (including fat used in preparation of any foods) and portion sizes of fat-containing foods. Since it is habitual rather that acute fat intake that is suggested to be associated with development of risk for chronic disease, the assessment period should be sufficient to represent typical or usual intake over time, taking into account seasonal variability, week-day versus week-end differences, etc. Assessing

individual mean fat intake over time, such as a year, expressed as percent of total calories per day or as grams per 1,000 calories allows greater flexibility for evaluating either diet and health relationships and/or distribution of mean fat intake across a population.

## C. Purpose and Needs for Measuring Fat Intake

There are several primary purposes for measuring fat intake including diet and health research, nutrition monitoring of the Year 2000 and other health objectives, making nutrition policies and implementing risk reduction/prevention type interventions. Diet and cardiovascular disease, diet and cancer, diet and diabetes, diet and obesity, diet and hypertension are some of the most prevalent public health concerns that have been handicapped by incomplete, inaccurate and/or non-specific dietary assessment data that have consistently undermined attempts at establishing causal or at least positive associations between nutrients and/or foods and disease. Not only total fat, but specific fatty acids have been associated with certain risks. Trans-fatty acids appear to raise LDL-C, omega-3 fatty acids reduce triglycerides and VLDL-C, palmitic and myristic fatty acids raise LDL-C, but stearic fatty acids apparently lower it. For all these and numerous other potential associations, the assessment methodology should permit such specificity if these relationships are to be fully explored.

Nutrition monitoring has encompassed ongoing assessment of nutritional status, particularly in target subgroups that are known to suffer from certain deficiencies, e.g., elderly, women, children, minorities. As they dietary guidelines advocated by Healthy People 2000, the Diet and Health Report, the National Cholesterol Education Programs (NCEP) and other major health-related programs become implemented, there is an even greater need to document the level of adherence to these guidelines within and between these groups, especially regarding level of fat intake and change in fat intake over time.

Not only the specific nutrients and fatty acids, but the sources or the foods providing them need to be identified. For example, there appear to be benefits from eating fish that go beyond the contribution of omega-3 fatty acids to the diet and even beyond the absence of saturated fat relative to meat. Data from the Zuthphen study and others that have collected sufficient dietary data continue to illustrate not only lower total and LDL-C levels and lower rates of CHD mortality among those who consume the most fish, but all cause mortality is lower as well. Why?

## III. Currently Used Methods

There have been numerous excellent and extremely comprehensive published reviews of the strengths and weaknesses of various dietary assessment methodologies that are commonly used to assess dietary fat intake. In the interest of brevity, these will be summarized below:

| Method | Strengths | Weaknesses |
|---|---|---|
| Recalls/records | measures individual intake; documents specific portions; culturally sensitive; more precise estimates of absolute intakes of nutrients; can reflect usual diet if sufficient days are collected; includes preparation methods; additional sources of fats; provides opportunity to correlate individual's intake with risk for disease | may under-report energy; relies on respondent's knowledge of food composition; multiple days needed to accommodate intraindividual variability; relatively expensive to collect and analyze |
| semiquantitative food frequency | measures usual intake of individuals providing distribution of usual intake in the population; easier and faster than records or recalls; less time; less expense; ranks nutrient intake of individuals; works well in homogenous populations | not uniformly sensitive to all diet types; ethnic backgrounds, and ages; over-reports energy and certain nutrients; no specificity regarding brand names, preparation techniques, serving size |

The previous national surveys that have been conducted, regardless of the assessment methods used, have been an invaluable source of data for evaluating the nation's current nutritional status, monitoring changes, especially in fat intake, that have occurred, and planning nutrition intervention strategies for certain subgroups that may be at greater risk for nutrient deficiencies and/or chronic disease. The lack of standardized methodology across surveys such as the

National Health and Nutrition Examination Survey (NHANES), the National Health interview Survey (NHIS), USDA's Continuing Survey of Food Intakes by Individuals (CSFII) and Nationwide Food Consumption Survey (NFCS) and the Nurses Health Study, have made cross-comparisons difficult or even invalid. While the premise that "any dietary data were better than none" may have been acceptable ten or twenty years age, the recent advances that have occurred in understanding the possible etiologic relationships between diet and disease, now make it imperative that the most accurate data possible be collected regarding nutrient and even specific foods. Ideally, standardized methodology and a common nutrient database, would allow for cross-comparisons across surveys over time that would serve everyone's needs from the biochemist interested in cellular level issues, to the nutritional epidemiologist interested in identifying dietary factors that prevent or promote disease, and even to the food producer interested in marketing products based on their health-related benefits.

## IV. Considerations in Selecting a Method to Asses Fat Intake

### A. Special Population Needs

Whatever dietary assessment method is selected, it must accommodate ethnic, cultural, sociodemographic, and other differences that characterize our extremely heterogeneous population. Despite acculturation that commonly occurs within a newly migrated ethnic group, it is evident that certain dietary behaviors transcend "typical American" food intake. It is highly unlikely that sufficient numbers of predetermined survey methods could be validated for use across all age, ethnic and sociodemographic strata. Indeed, even dietary records or recalls that permit self-described eating behavior produce foods and preparation techniques that are not readily accommodated by an American nutrient data base. To ignore these ethnic foods, or to impute values that approximate the nutrient contributions relative to foods currently in the data base could do a major disservice to the cause. The cross-cultural differences in the incidence of disease are considered at least in part due to dietary intake differences in fat and other nutrients. Even age-related differences in dietary intake should be adequately measured to better evaluate the advantages of consuming certain dietary patterns early in life that may help to prevent nutrient imbalances or disease later in life.

### B. Reference Period of Interest

Estimate of both usual and past intake can be important. In the case of the former, usual intake can help assess current eating behavior as it may relate to future risk of disease. Estimates of past intake may offer the opportunity to evaluate ways to predict future incidence of disease, but the obvious memory limitations of distant recall almost assure less accuracy of recall of the remote past than recall of the last day, or week or month, or even the last year. While

methods to elicit long-term recall have reportedly been remarkably successful on a macro level, it is unclear how much such analyses will contribute that cannot be derived from cross-sectional and prospective analyses of usual intake.

### C. Analytic Issues Regarding Fat Intake: A Summary

1. Other variables needed to assess fat intake include: total calories/energy, total fat, total fatty acids, portion sizes, preparation methods, brand names, and fats added to other foods, e.g., margarine on bread, dressing on salad, etc.

2. Both total quantities and approximate ranking of fat intake are needed to fully explore the diet and disease relationships described above.

3. Ideally, both individual and group estimates are needed to better accommodate interindividual differences in diet that may or may not contribute to differences in risk for disease when other physiological and environmental factors are considered.

4. Intake of fat is variable not only quantitatively but qualitatively due to factors such as season, age, sex, culture, economics, and a host of other factors.

5. Number of measurements required should be sufficient to accommodate the intraindividual variability known to be associated with dietary intake. Preferably, data should be collected four times per year to accommodate seasonality.

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# CHAPTER 13
# ASSESSMENT OF FRUIT AND VEGETABLE INTAKE

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## I. Purposes

The purposes for measuring fruit and vegetable intake as part of national nutrition monitoring are many and varied. These include:

*Measuring progress on the Year 2000 Objective 2.6 related to fruits and vegetables.* This objective is to:

"Increase complex carbohydrate and fiber-containing foods in the diets of adults to five or more daily servings for vegetables (including legumes) and fruits...(Baseline: 2 1/2 servings of vegetables and fruits ... for women aged 19 through 50 in 1985)."

Measurement should assess intake of the total population and identify subgroups in the population at risk for low consumptions. In addition, issues related to measuring program effectiveness at the State and local levels are relevant.

*Monitoring the dietary levels of components of fruits and vegetables.* Fruits and vegetables may be measured not as an endpoint in and of themselves, but as a way of assessing intakes of nutrients, fiber, pesticides, and other components of the foods.

*Assessing changes in the content, availability, and consumption of various products in the food supply.* This includes tracking such items as irradiated foods and genetically altered fruits and vegetables (such as the flavr savr tomato), as well as assessing the many ways fruits and vegetables are processed and consumed.

*Evaluating the effectiveness of dietary guidance campaigns and programs aimed at increasing the intake of fruits and vegetables.* Programs, such as the National 5 A Day for Better Health Program, need to be evaluated in much the same way as the Year 2000 objective is monitored, except that the definition of what constitutes a fruit or vegetable may be more specific for the program, and the timing of the measurements would more likely be tied to specific points in the intervention.

*Studying the relationships between fruit and vegetable intakes and health outcomes.* This purpose may require assessments for two different variables--food intake and health outcome--at two different periods of time. For example, cancer incidence would not necessarily be expected to be an outcome of food intake at the current period of time; an assessment of usual intake for some former time would be more relevant.

Decisions regarding how to measure fruit and vegetable intakes will vary, depending on the purpose. These decisions include how to define fruits and vegetables, whether and how to account for serving sizes, what method to use for gathering the data, and how to analyze them.

## II. Definition of Fruits and Vegetables

Some of the questions which confront researchers in this arena are: If apples, applesauce, and 100% apple juice are classified as fruits, what decision criteria should be used to classify processed fruit products such as apple pie, apple butter, apple jelly, fruit roll-ups and fruit drinks? Since most fruits and vegetables are nutrient dense and also naturally low in fat (and high in fiber), should criteria for fat, sodium, and sugar be used to define fruits and vegetables? Do legumes such as soybean products or tofu belong in the vegetable or the meat substitute group or both? Are corn products, such as grits, corn bread, and corn chips, vegetables or grains? How should fruits and vegetables eaten as part of mixed dishes be counted?

These questions reflect several key issues in defining fruits and vegetables which are examined below. Throughout this section, criteria established for the National 5 A Day for Better Health Program (1) (see Detailed Note III) are mentioned to provide examples for discussion of the issues.

*Fat, sugar, and sodium content.* With few exceptions (e.g., avocados, olives, coconuts) most fruits and vegetables are naturally low in fat and high in fiber, vitamins and minerals. By setting fairly strict criteria about what products can be promoted, the 5 A Day Program has established a narrow definition of what counts toward five servings of fruits and vegetables. This definition excludes jams, jellies, fruit candies, pies, and most grain products. Some researchers have defined fruit pies as desserts rather than fruits (2), while others have summed fruits and vegetables from all sources, including small amounts of fruits and vegetables which are contained in relatively high-fat foods (3).

The particular purpose for the assessment may dictate whether criteria related to fat, sugar, and sodium are needed. In measuring the effectiveness of a program or of some particular dietary guidance, a definition tailored to the program or guidance would seem appropriate. On the other hand, a broader definition could

be used in measuring the distribution of fruits and vegetables in the food supply. For example, in evaluating progress toward meeting the objective, it would be of interest to determine what proportion of fruits and vegetables consumed would fall into the narrow classification of those low in fat, sugar, and sodium, and whether this is changing over time.

*Common perceptions of food group classifications.* Corn is commonly considered a vegetable, but what about products made from corn, such as grits, popcorn, and corn chips? Should tofu count as a vegetable? It is generally up to the discretion of the researcher or program director to make these judgements. For both dietary guidance and measurement purposes, it would be useful to develop some consensus on these classifications.

*Mixed dishes.* Mixed dishes are becoming an increasingly important part of the American diet. How should the fruit and vegetable components of mixed dishes contribute to the assessment of fruit and vegetable intakes? The answer depends on the purpose of the assessment. If the purpose is to evaluate a particular program with explicit criteria, then those criteria should be used to guide the way in which mixtures are counted. If, however, the purpose is to assess how fruits and vegetables are dispersed in the food supply, then fruits and vegetables from all sources would need to be captured.

*Fruit drinks.* Should fruit drinks be included? What percent juice would be required to qualify? Another issue, reflective of the changing marketplace, is that many new juices and juice drinks use filtered grape juice as a base. Although this would seem to be an advantage, some concerns have been raised about the level of retained nutrients in such juice bases. Should they still be considered fruit juices?

*Legumes.* Legumes are included in the objective to increase fruit and vegetable intakes. The National 5 a Day Program also includes them in order to encourage their consumption within the Program and because the public considers them to be vegetables in common usage. However, the California 5 A Day program excluded legumes in what counted towards meeting the recommended five servings using the rationale that in order to obtain enough fiber, people should be eating legumes in addition to the five servings of other fruits and vegetables. In the USDA Food Guide Pyramid, dried beans and peas are pictured with the meat group, but referred to in both the meat and vegetable groups (4).

*Fruit versus vegetable.* When fruits and vegetables are examined separately, individual items need to be classified as one or the other, and for some the choice is not clear. While nuts are botanically classified as fruits and are also frequently included in the fresh produce section of grocery stores, they are not generally thought to be fruits or vegetables. Foods such as tomatoes, avocados and pumpkin are botanically classified as fruits, but commonly perceived to be vegetables.

## III. Serving Sizes

Serving sizes are sometimes not assessed by dietary assessment instruments. If they are quantified, especially with detailed methods such as the 24-hour recall or the food record, then several questions arise regarding the appropriate definitions.

*Which set of serving sizes to use.* FDA regulations use 140 grams as the serving size for all fruits (except those listed separately); 240 ml for juice; and 85 grams for vegetables without sauce (except those listed separately). These amounts do not always equate with the dietary guidance serving sizes, which are: 1 medium piece or 1/2 cup fruit; 3/4 cup of juice; 1/2 cup cooked vegetable; 1 cup of raw leafy vegetable; and 1/4 cup dried fruit. The two sets of serving sizes were established for different reasons. However, the implications of the discrepancies between the two need to be assessed with respect to issues of measurement and educating the public. Which set of serving sizes are the most appropriate for assessing achievement of the Year 2000 objectives?

*Serving sizes for children.* Policy regarding serving sizes for children is stated as follows in the 1990 publication of the Dietary Guidelines for Americans (5) and the 1992 Food Guide Pyramid (4), respectively:

- "Young children should have a variety of foods but may need small servings."
- "Preschool children need the same variety of foods as older family members do, but may need less than 1600 calories. For fewer calories they can eat smaller servings."

The appropriate size of servings for very young children can be debated; however, if different serving sizes are used, measurements of consumption need to be adjusted accordingly.

*Assessing serving sizes for fruits and vegetables eaten in small or large quantities.* If a researcher has the capability to sum across all fruits and vegetables eaten, regardless of how small the quantities, then would it be worthwhile to do so? Are garnishes worth counting? What about a few bites of a fruit or vegetable that were not meant to be a garnish per se? What should be done about servings that are larger than a stated standard?

## IV. Data Collection

The method selected for collecting data with respect to fruit and vegetable intakes will depend on the research questions of interest. Such questions may focus on

long-term usual intake, short-term detailed intake and/or dietary behaviors. Researchers may want to investigate current intake, past intake or changes in intake. Long-term usual intake and short-term usual intake are conceptually different constructs which may require different assessment tools. Current methods of assessing fruit and vegetable intakes in various surveys are listed in Detailed Note I. The major strengths and weaknesses of each method are reviewed in the Dietary Assessment Resource Manual by Thompson and Byers included in background materials (6). Particular concerns relative to collecting data to assess fruit and vegetable intakes are discussed below.

*Features of current methods.* Food records and 24-hour recalls, as used in NHANES, NFCS, and CSFII, provide more detailed data regarding all fruits and vegetables and the quantities consumed than can be obtained from a food frequency questionnaire. Methods of data collection are fairly standard though differences between studies arise regarding level of probing, use of food models, type of interviewing and coding. The level of detail provided in records and recalls allows for quantification of fruits and vegetables eaten as part of mixed dishes, though data analysis is complicated by the need to sort out the components of food mixtures, assign individual foods to groups and assign serving sizes for each food. These methods, while providing detail, may be prone to underestimation (7) and generally do not provide data regarding usual intake for the individual especially when restricted to only a few days.

Food frequency questionnaires seek to determine usual fruit and vegetable intake over a specified period of time, usually one year or less. Such questions lend themselves to simpler, quicker administration and assessment, but are prone to loss of detail. Portion size information may or may not be queried, but when it is, respondents estimate a usual amount based on a standard reference or on a perception of their own portion size. When portion size is not queried, investigators sometimes impute a standard portion size for all individuals. Generally, portion size information is used only to estimate intakes of nutrients.

The methods by which food frequency data are collected vary considerably. Data may be collected by telephone or by personal interview, response categories may be open or closed ended and portion size information may or may not be included. With respect to fruits and vegetables, Krebs-Smith, et al. (8) has quantified that the longer the list of fruits and vegetables which is asked, the larger the estimated total number of servings tends to be. This may be less of a problem when the data are used to rank individuals for epidemiological research. However, this is a problem for nutrition surveillance and monitoring if more accurate measures of intake are desired. Summary questions, which help adjust these large totals to a summary intake established by the respondent have been developed and have been shown to somewhat improve nutrient correlations (9) (see Detailed Note II). However, these questions probably need further refinement and calibration.

Further, the algorithms used to calculate these adjustments vary between studies. The short BRFSS questionnaire has recently been calibrated by Serdula et al. (10) and shows correlations of approximately 0.5 with both extensive food frequency questionnaires and three day food records.

*Constraints in selecting methods.* Many investigators have specific considerations and constraints with respect to assessment methods for monitoring trends or evaluating the effectiveness of dietary guidance interventions. Such efforts raise issues of: 1) methods that can be practically applicable at the State and local levels under a variety of constraints imposed by the research or program setting and 2) the appropriate methods to use to measure dietary change. Although several 24-hour recalls might be the scientifically preferred method for obtaining fruit and vegetable consumption at the beginning and end of an intervention, doing so in various public health and local settings is usually impossible. For example, in worksites, the major constraints are access to workers and inadequate resources. Few companies will allow time for personal interviews of workers or for completion of self-administered questionnaires. Nor are companies willing to provide telephone numbers of workers. In addition, adequate numbers of personnel trained in dietary interviews are rarely available or affordable at the State and local levels. Thus consideration needs to be given to which instruments might be used in various community settings.

*Special populations.* Healthy People 2000 identifies persons of low income, blacks, Hispanics, Asians and Pacific Islanders, American Indians and Alaskan Natives, and people with disabilities as groups which should be given special attention (11). In addition, that document suggests that children, adolescents, young adults, and older adults need to be monitored separately. Few of these groups are present in large enough numbers to produce adequate estimates of intakes in surveys in which the sample selection is based on general population representation. For most groups, targeted surveys or oversampling within current surveys may be necessary.

Assessment of diet within subpopulations may also require modifications of the diet assessment tool. For example, the food list on a food frequency questionnaire developed for the general population may not be appropriate for Hispanics or other ethnic groups who regularly consume foods which are not on the list, conceptualize foods differently and eat foods in different ways.

Whatever the purpose for assessing fruit and vegetable intakes, it is almost always instructive to analyze whether the estimates are different for various groups in the population.

## V. Analytic Issues

There are several analytic issues related to the assessment of fruits and vegetables. As for other types of issues, the major factor to consider is the purpose of the assessment.

*Days of data collection required.* Depending on the research questions, investigators will be interested in inquiring about dietary intakes of fruits and vegetables over various periods of time. The 24-recall and food record approaches gather the most detail and provide relatively accurate mean intakes of fruits and vegetables on any given day or number of days for a population. However, if researchers are interested in accurately assessing individuals' usual intakes of fruits and vegetables, more than a single day or a few days of recorded intakes will be necessary. Hartman and Block (12) have concluded that 10-20 or more days of records or recalls are required to accurately estimate usual nutrient intakes for individuals. Sempos et al. (13) determined the number of repeated dietary records needed to ensure that estimated correlation and regression coefficients are greater than or equal to 90% of the true value for servings per day of several food groups, including legumes, high vitamin C vegetables, dark green vegetables and other vegetables. Numbers ranged from 10 days, for a correlation coefficient for "other vegetables," to 117 days for a regression coefficient for dark green vegetables. Hartman et al.(14), also found a wide range in the within person to between person variation ratio for food groups. It is clear that there is considerable intraindividual variation in consumption of various fruits and vegetables.

The purpose of food frequency questionnaires is to measure usual intakes, though detail is compromised and the length and composition of the food list are important factors. Use of summary questions (see Detailed Note II) may be helpful in improving accuracy with respect to usual intakes of fruits and vegetables, but more research is required to assess their utility.

*Means and distributions; group or individual intakes.* Data from NHANES, CSFII or NFCS are all used to estimate mean intakes of nutrients and food groups in the population. However, the distribution of intakes for a single day, as collected in the NHANES series, is wider compared to data from many days or to data collected in food frequency questionnaires. For monitoring fruit and vegetable intake, comparing intake to the objective, or evaluating program effectiveness, group level data are appropriate. However, in all of these instances, it would be beneficial if they represented usual intake of the group, so that distributions could be assessed as well. For risk assessment or epidemiologic research, usual intake of the individual is necessary in order to relate it to the health measure of interest. Some food frequency questionnaires, when compared to multiple days of food records have similar mean nutrient values but larger standard deviations

resulting in wider distributions (15) and correlations between the two range from 0.5-0.8 (14). With respect to foods, Salvini et al.(16) have shown that intakes of individual food items as measured by a food frequency questionnaire correlated at about 0.5 (range: 0.08-0.90) when compared to four seven-day food records. More research needs to be done regarding the calibration of food frequency instruments with respect to food groups.

*Reference period of interest.* Time frame about which respondents are queried is important in terms of both research questions and in terms of the limitations of memory. For food records or recalls, this question is relevant with respect to individuals remembering incorrectly or forgetting. This is also an issue in food frequency questionnaires when individuals are asked to report usual intake over more extended periods of time in the past. Cognitive research has shown that reporting accuracy decreases as time intervals increases and individuals then tend to rely on more generic dietary knowledge (17). Further research regarding diet in the distant past shows that respondents asked about past diet are influenced by current diet, but do a reasonable job in evaluating past diet (18). Asking about frequency of intake over the past few weeks or months instead of the past year may increase accuracy, but may not well represent usual intake over all seasons especially with respect to fruits and vegetables. It may be possible to develop questions which better allow individuals to report seasonal or atypical intakes which occur at various times of the year.

*Need for other dietary variables.* If the goal is simply to measure fruit and vegetable intake per se (e.g., in order to measure progress toward meeting the objective), then no other dietary components need be measured. A strict evaluation of the impact of the 5 A Day for Better Health Program would require being able to determine whether the fruits and vegetables eaten conformed to the 5 A Day criteria, so some indication of fat, sugar, and sodium in the foods would be necessary. This might have an impact on dietary guidance strategies.

Some investigators may be interested in assessing fruit and vegetable intakes in the context of the total diet. Do persons with greater caloric intake tend to consume greater amounts of fruits and vegetables? Do persons with greater intakes of fruits and vegetables consume lower fat diets? How does the nutritional adequacy of persons with high levels of fruit and vegetable intake compare to that of those with low levels? Total diet measures are also important in epidemiologic research of diet and disease.

*Quantitative estimates or rankings.* In order to assess whether the population is meeting the Year 2000 objective or to evaluate the impact of a program such as the 5 A Day program, quantitative estimates are needed. Rankings may be more appropriate for epidemiologic research.

*Variation of fruit and vegetable intakes by season.* For population level estimates derived from surveys which sample in all seasons, this is not an issue. This may be a concern if the survey is conducted in only one season of the year. While intake of varieties of fruits and vegetables vary by season, total daily intake of all fruits and vegetables may not vary extensively. Research from food frequency data in the 1987 NHIS (19) showed that individuals tended to report higher intakes over the past year for fruits and vegetables which were in season at the time the questionnaire was administered.

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## Detailed Note I

## Methods of Measuring Fruit and Vegetable Intake in Various Surveys

BRFSS

- six questions to assess fruit and vegetable intake:
- two summary questions developed by Block
- individual questions regarding potatoes, salad, juices and carrots (see Detailed Note II)

California 5 A Day Program:

- modified 24-hour recall approach; primarily, fruit and vegetable intakes from the previous 24 hours were queried; data regarding portion size, food preparation and portion size were collected; data regarding a few other food items related to fat and fiber intakes were collected

CSFII 1985 and 1986:

- 4 non-consecutive 24-hour recalls

CSFII 1989 - 1991:

- 24-hour recall and 2-day food record (3 consecutive days)

NFCS 1977-78 and 1987-88:

- 24-hour recall and 2-day food record (3 consecutive days) for individuals

- 7-day recall of food used by household

NHANES I (1971-73) and II (1976-80):

- 24-hour recalls
- three food frequency-type questions (see Detailed Note II):
- all fruits and vegetables
- fruits and vegetables rich in vitamin A
- fruits and vegetables rich in vitamin C

NHANES III (1988-1994):

- 24-hour recalls

- food frequency section with 19 individual fruit and vegetable items (rich in vitamins A and C)

NHANES I Epidemiologic Followup Survey (1982-84):

- food frequency with 40 individual fruit and vegetable questions; questionnaire allowed reporting for seasonality for all fruit and vegetable items

- one summary question regarding intake of all fruits and vegetables (see Detailed Note II)

NHIS 1987 and 1992:

- food frequency with 18 (1987) and 22 (1992) individual fruit and vegetable items

- 1992 included summary questions developed and validated by Gladys Block et al.(9) to adjust absolute servings of fruits and vegetables (see Detailed Note II)

5 A Day Baseline Survey:

- food frequency questionnaire with 33 fruit and vegetable items (questionnaire allowed reporting for seasonality for five fruits and vegetables)

- summary questions developed by Block (see question from NHANES I Epidemiologic Followup Survey in Detailed Note II)

## Detailed Note II

### Summary Questions Regarding Fruit and Vegetable Intake From Various Surveys

NHANES I (from Dietary Food Frequency Questionnaire)

7. FRUITS AND VEGETABLES
   a) All kinds, fresh, canned, frozen, cooked, or raw; juices

   b) fruits and vegetables rich in vitamin A (See guidelines)

   c) fruits and vegetables rich in vitamin C (See guidelines)

NHANES II (from Dietary Food Frequency Questionnaire)

11. Fruits and Vegetables
   a) All kinds, fresh, canned, frozen, cooked, or raw; juices, including Tang or fruit drinks

   b) fruits and vegetables rich in vitamin A (See guidelines)

   c) fruits and vegetables rich in vitamin C (See guidelines)

NHIS 1992 (summary questions developed by Block)

69. About how many servings of vegetables do you eat per day or per week, not counting salad or potatoes?

70. About how many servings of fruit do you eat per day or per week, not counting juices?

NHANES I Followup Survey

N-21. Now I'd like to ask you about fruits and vegetables of all kinds. This includes fresh, canned, dried, frozen, cooked, raw or juices. About how many servings of fruits and vegetables do you have per day or per week?

BRFSS

1) How often do you drink fruit juices such as orange, grapefruit, or tomato?

2) Not counting juice, how often do you eat fruit?

3) How often do you eat green salad?

4) How often do you eat potatoes (not including french fries, fried potatoes, or potato chips?

5) How often do you eat carrots?

6) Not counting carrots, potatoes, or salad, how many servings of vegetables do you usually eat? (For example, a serving of vegetables at both lunch and dinner would be two servings.)

## Detailed Note III

## Excerpts from Criteria for the 5 A Day for Better Health Program

### A. Products Promotable Through the *5 A Day* Program

The following products may be promoted in association with the Program:

1. All fruits and vegetables with the exception of avocados, coconut, olives, and nuts. The Program logo may be used to promote recipes with avocados, coconut, olives, and nuts as ingredients if recipes meet the *5 A Day* Recipe Criteria (Guideline 9).

2. All fruits and vegetables processed by drying, freezing, or canning (except avocados, coconut, olives, and nuts), provided that no fat or sugar (sucrose, glucose, dextrose, fructose, maltose, lactose, sorbitol, mannitol, honey, corn syrup, corn syrup solids, or molasses) have been added and the sodium content is less than 360 mg per serving.

3. All juice products that are 100% juice or juice concentrate, without added fat or sugar, as above.

All promotions of fruits and vegetables done in association with the Program must retain nutrient integrity of fruits and vegetables as low-fat, lower calorie foods.

### B. Serving Sizes

For Program recipes and consumer education activities, a serving* is: a medium piece of fruit, 1/2 cup of fruit or cooked vegetable, 1 cup of leafy greens, 1/4 cup of dried fruit, or 6 ounces (3/4 cup) of juice. Serving sizes used in the Program shall meet Federal labeling requirements.

* These serving sizes may be subject to change as a result of impending FDA regulations.

### C. Recipe Use

The *5 A Day* Recipe Criteria (Guideline 9) shall be the standard used for all recipes used in the Program activities and materials. The Program may occasionally revise the criteria to reflect changes in U.S. dietary recommendations.

## Guideline 9
## RECIPE CRITERIA

The National Cancer Institute requires that recipes associated with the *5 A Day for Better Health* program promote fruit and vegetables and be low in fat and cholesterol. The use of whole grains and minimal use of salt and sugar are strongly suggested. It is also recommended that 5 A Day recipes be simple and fast to prepare, use readily available, moderately priced ingredients, and be short in length.

All recipes associated with the *5 A Day for Better Health* Program must meet the following criteria:

1. *5 A Day* recipes must contribute at least one serving* of a fruit and/or a vegetable per serving of the recipe. Recipes for baked goods such as breads, cakes, pies, cookies, and muffins are not eligible for 5 A Day use.

2. *5 A Day* recipes may not contain more than 30% of calories from fat, not more than 10% of calories from saturated fat, not more than 100 milligrams of cholesterol, and not more than 360 milligrams of sodium per serving.

3. Official *5 A Day* recipes will be supplied by the Produce for Better Health Foundation. Recipes from other sources can be used but must be approved by the Produce for Better Health Foundation. NCI requires that the Mini Minnesota Nutrition Data System be used to analyze recipes because of its extensive and scientifically sound database. Recipe analysis and approval can be obtained for a nominal fee by sending the recipes to PBH consultant Christine Haar, M.S., R.D., 777 Fox Chase Circle, Bear, DE 19701-2709; phone 302/836-3685.

* A serving is a medium piece of fruit, 1/2 cup of fruit or vegetable; 3/4 cup (6 ounces) juice; 1 cup leafy greens; or 1/4 cup of dried fruit.

The *5 A Day* Recipe Criteria are based on the National Academy of Sciences Report Diet and Health: Implications for Reducing Chronic Disease Risk (1989) and the Dietary Guidelines for Americans (1990).

These criteria and serving sizes are subject to change, and should not be construed for use for manufactured products.

# APPENDICES
# WORKSHOP MATERIALS

## APPENDIX A
## AGENDA

**Consensus Workshop on Dietary Assessment: Nutrition Monitoring and Tracking the Year 2000 Nutrition Objectives**

Richmond Marriott Hotel in Richmond, Virginia

Sunday, February 21, 1993

| | |
|---|---|
| 3:00-4:00 p.m. | Registration and check-in |
| 4:00-6:00 p.m. | **(plenary)**<br>Welcome and introductions<br>--Manning Feinleib, M.D., Dr.P.H.<br><br>Purpose and goals of workshop<br>Overview of National Nutrition Monitoring and Related Research Program<br>--Ronette Briefel, Dr.P.H., R.D.<br><br>Year 2000 Objectives: Tracking the Nutrition Objectives<br>--Mary Anne Freedman, M.A.<br><br>Charge and Instructions to Participants<br>--Jacqueline Wright, M.P.H. and Bethene Ervin, Ph.D. ,R.D.<br><br>Strategies for building consensus<br>--Elizabeth Vasquez, Facilitator |
| 6:00-7:00 p.m. | Reception |

Monday, February 22, 1993

| | |
|---|---|
| 8:30-10:00 a.m. | **(plenary and working groups)** Brief review of consensus principles<br><br>Recommended methods & uses<br>o Issues in Statistical Research |

o Issues in Cognitive Research
o General dietary assessment: A
o General dietary assessment: B
o General dietary assessment: C
o General dietary assessment: D
o General dietary assessment: E
o General dietary assessment: F

10:00-10:30 a.m. Break

10:30-12:15 p.m. **(working groups)** Continued
o Issues in Statistical Research
o Issues in Cognitive Research
o General dietary assessment: A
o General dietary assessment: B
o General dietary assessment: C
o General dietary assessment: D
o General dietary assessment: E
o General dietary assessment: F

12:15-1:30 p.m. Lunch

1:30-3:00 p.m. **(working groups)** Continued
o Issues in Statistical Research
o Issues in Cognitive Research
o General dietary assessment: A
o General dietary assessment: B
o General dietary assessment: C
o General dietary assessment: D
o General dietary assessment: E
o General dietary assessment: F

3:00-3:30 p.m. Break

3:30-5:30 p.m. **(plenary)** Presentations and discussion from each working group

5:30 p.m. Adjourn

Tuesday, February 23, 1993

8:30-10:00 a.m. **(working groups)** Overview presentation in each breakout session on assessing dietary factor (10-15 minutes)

o Calcium: A
o Calcium: B
o Fat: A
o Fat: B
o Fruits and vegetables: A
o Fruits and vegetables: B
o Alcohol

10:00-10:30 a.m. Break

10:30-12:15 p.m. (**working groups**) Continued
o Calcium: A
o Calcium: B
o Fat: A
o Fat: B
o Fruits and vegetables: A
o Fruits and vegetables: B
o Alcohol

12:15-1:30 p.m. Lunch

1:30-3:00 p.m. (**working groups**) Continued
o Calcium: A
o Calcium: B
o Fat: A
o Fat: B
o Fruits and vegetables: A
o Fruits and vegetables: B
o Alcohol

3:00-3:30 p.m. Break

3:30-5:00 p.m. (**plenary**) Presentations and discussion from each working group

5:00 p.m. Adjourn

Wednesday, February 24, 1993

8:30-12:00 p.m. (**plenary and breakout sessions**) Review of recommendations and resolution of issues from Monday and Tuesday working groups

Identification of followup required and implementation of recommendations

Final Report of workshop: Publication and dissemination plans

10:00-10:30 a.m. Break

12:00 p.m. Adjourn

Note: Detailed agendas will be provided for working groups.

# APPENDIX B
# QUESTIONS ADDRESSED BY WORKING GROUPS

**Monday, February 22, 1993**

Consensus Questions on Dietary Assessment Methods

Nutrition Monitoring Objectives

1. Assess adequacy of nutrient intake of the U.S. population. Produce nutrient estimates for group(s). Descriptive statistics such as means and distributions are needed and population subgroup comparisons will be made.

2. Assess adequacy of food intake of the U.S. population. Produce estimates of intakes of foods for group(s). Descriptive statistics such as means and distributions are needed and population subgroup comparisons will be made.

3. Examine diet-health relationships. Produce nutrient intake estimates to be associated with disease outcomes. Produce estimates of food intake (foods that are either high or low in specific nutrients) to be associated with disease outcomes.

For each Year 2000 objective, address the following series of questions:
(For some of these questions the group may decide the answer is the same for more than one or for all objectives; please indicate if this is so.)

a. What type of intake data is needed-- quantitative or qualitative?

b. Define the following "temporal patterns" and others that should also be included: Usual diet, current diet, typical diet, and past diet. Answer this only once.

c. Which temporal pattern is best suited for measuring this objective?

d. What reference period should be used to estimate the temporal pattern? (e.g., "yesterday" for current diet?)

e. What characteristics should be considered when addressing different population subgroups? Such as, gender, race/ethnicity, age group, others?

f. For each characteristic, what special considerations should be made in assessing dietary intake of subgroups? For example, what considerations should be made in a school-based study of children?

g. Considering all previous answers specify the optimal method to measure the Year 2000 objective. Now assume that time and resources are limited, and recommend a practical and efficient method that can be calibrated with the optimal method. What methods are not appropriate for this objective?

h. For the methods selected, what administration methods are preferred-- face-to-face interview, telephone interview, self-administered questionnaire, paper and pencil or automated interview?

i. For the methods selected, should portion size estimation aides or food guides be used?

j. For the population characteristics previously considered (gender, age, race/ethnicity) what special considerations should be made in administration of the method?

**Tuesday, February 23, 1993**

**Consensus Questions on Assessment of Alcohol Intake**

Address the assessment of alcohol intake only for the purpose of measuring and tracking progress on the Year 2000 objectives. The questions are taken from the background paper on assessment of alcohol intake.

1. Address Year 2000 Objective 4.8 and whether it is appropriate to use survey data to monitor progress toward this objective. See the comment on page 132, 133 of the alcohol background paper, The Measurement of Alcohol Consumption".

2. Definitions for assessment of alcohol intake. Define the following terms for the purpose of assessing the Year 2000 objectives: heavy drinking, drinking occasion, and standard drink.

3. What time frame and reference period are appropriate (use definitions of time frames established from the General Dietary Assessment discussions)? Should questions ask about per day or per occasion reporting? Should questions use "usual quantity" approach, graduated frequency approach, or retrospective recall-of-days approach?

4. Should questions ask about alcoholic beverages using separate or combined questions, or both?

5. What estimates are needed-- quantitative and/or qualitative data, group and/or individual estimates?

6. Discuss the utility of the "location of consumption" approach for assessing the Year 2000 objectives, and their general utility in nutrition monitoring surveys.

7. Considering all previous answers, specify the optimal method to measure the Year 2000 objective. Now assume that time and resources are limited, and recommend a practical and efficient method that can be calibrated with the optimal method. What methods are not appropriate for these objectives?

8. What population subgroups are of interest in assessing alcohol intake? What special considerations should be made in administration of the method to different subgroups? For example, in measuring alcohol intake in adolescents versus adults.

9. For the methods selected, what administration methods are preferred? (face-to-face interview, telephone interview, self-administered questionnaire, paper and pencil or automated interview).

**Tuesday, February 23, 1993**

Calcium Working Group

Year 2000 Objective 2.8:

> Increase calcium intake so at least 50 percent of youth 12 through 24 years of age and 50 percent of pregnant and lactating women consume 3 or more servings daily of foods rich in calcium, and at least 50 percent of people 25 years of age and older consume 2 or more servings daily.
>
> *Note: The number of servings of foods rich in calcium is based on milk and milk products. One cup of skim milk or its equivalent in calcium (302 mg) is considered a serving.* The number of servings in this objective will generally provide approximately 3/4ths of the 1989 Recommended Dietary Allowance (RDA) of calcium. The RDA is 1200 mg for people 12 through 24 years of age, 800 mg for people 25 years of age and older, and 1200 mg for pregnant and lactating women.

Questions for the calcium working group to address in order to measure the Year 2000 nutrition objective for increasing calcium intake.

1. Method(s) used to measure calcium intake

   - What type of data are needed--quantitative or qualitative?
   - Should the focus be on measuring food intake, nutrient intake or both?
   - Is the emphasis on estimating the calcium intake of the group or the individual?
   - What temporal pattern is best suited for measuring this objective (current diet, usual diet, etc.)? Based on the temporal period selected, what reference period should be used to estimate calcium intake? How many measurements should one collect?
   - Based on the answers to these questions what method or instrument would this group recommend be used for measuring calcium intake to meet this objective and how should it be structured? Given limited time, personnel or financial resources, what method or instrument would this group recommend using for measuring calcium intake?

2. Measuring calcium intake.

   - Should intake of calcium-rich foods only be measured or all foods? Should foods with moderate to poor calcium contents be summed together and counted as full or partial servings of a calcium-rich food? Should calcium in food mixtures be measured?

   - Should the absorptive efficiency of the foods be considered and not just the calcium content of the food? Should foods or food components that interfere with or enhance calcium absorption be measured? If so, should this information be used?

   - Should food intake data be converted to nutrient intakes?

   - In order to satisfy this objective, is it necessary to measure intakes of supplement(s), water, and antacid(s)? If so, what recommendations would this group make about how this information should be collected?

   - Are there any other foods, nutrients or biochemical indices that should be assessed in order to measure this objective?

3. Administering the instrument.

   - How should the selected dietary method be administered? Are any modifications necessary based on whether the instrument is administered face-to-face, over the telephone, or self-administered?

   - Should portion size be estimated? If so, how should this be accomplished? Should any portion size estimation guides or aides to be used or should portion size to be defined on the instrument?

4. Population characteristics.

   - What modifications should be made to the instrument for men versus women, different racial/ethnic groups, and different age groups (e.g. children, elderly adults)?

   - What modifications should be made to the interview for varying recall abilities?

   - Is there substantial variation in calcium intake by season, and should it be considered when measuring the Year 2000 objective? If so, what modifications in the interview or instrument need to be made to take this into account?

5. Any other issues that should be discussed.

**Tuesday, February 23, 1993**

**Consensus Questions on Assessment of Fat Intake**

Address the assessment of fat intake only for the purpose of measuring and tracking progress on the Year 2000 objective.

1. What kind and type of data is needed to produce estimates for assessing the Year 2000 objective: quantitative and/or qualitative data? Are group and/or individual estimates needed? What other dietary variables are needed? (see page 171, of the background paper "Assessment of Fat Intake")

2. What degree or kind of specificity is required? For example, specificity of fat-containing foods and fat used in preparation.

3. What is the time frame or temporal pattern of interest? Use the definitions established in the General Dietary Assessment discussion from February 22, 1993.

4. How should seasonal variability be incorporated into the assessment?

5. What population subgroups are of interest in assessing fat intake? Are there special considerations that should be made in administration of the method to these different subgroups? (In addition to those determined in the General Dietary Assessment discussion from February 22, 1993.)

6. Considering all previous answers, specify the optimal method to measure the Year 2000 objective. Now assume that time and resources are limited, and recommend a practical and efficient method that can be calibrated with the optimal method. What methods are not appropriate for this objective?

7. For the methods selected, what administration methods are preferred? (face-to-face interview, telephone interview, self-administered questionnaire, paper and pencil or automated interview)

8. For the methods selected, should portion size estimation aides or food guides be used?

9. For the population characteristics previously considered (sex or gender, age, race/ethnicity) what special considerations should be made in administration of the methods?

10. Analytic issues. How many days of data collection are required?

11. Any other issues that should be discussed.

**Tuesday, February 23, 1993**

**Consensus Questions on Assessment of Fruit and Vegetable Intake**

Address the assessment of fruit and vegetable intake only for the purpose of measuring and tracking progress on the Year 2000 objective. The questions are taken from the background paper on assessment of fruit and vegetable intake.

1. Definition of fruits and vegetables.

   a. Include processed products made with fruits or vegetables such as apple pie, apple butter? Should french fries be considered a vegetable?

   b. Restrict definition based on fat, sugar and sodium content?

   c. Will fruits and vegetables be examined separately? If so, should common perceptions or botanical classifications be used to distinguish them? Foods commonly perceived as fruits and vegetables. Should tomatoes be considered as a fruit or a vegetable? Should corn be considered as a vegetable or grain? Should corn products such as grits, popcorn, and corn chips be included?

   d. How should fruit and vegetable components of mixed dishes be evaluated in assessing fruit and vegetable intake?

   e. Should legumes be included in the definition of fruits and vegetables?

   f. Should fruit drinks be included in the definition of fruits? What criteria should be used to define fruit drinks (percent juice)?

2. What serving sizes should be used? What are appropriate serving sizes for children?

3. What is the time frame or temporal pattern of interest (use definitions established in General Dietary Assessment discussion from February 22, 1993)?

4. How should seasonal variation of fruit and vegetable intake be incorporated into assessment?

5. What estimates are needed-- quantitative and/or qualitative data, group and/or individual estimates?

6. Considering all previous answers, specify the optimal method to measure the Year 2000 objective. Now assume that time and resources are limited, and recommend a practical and efficient method that can be calibrated with the optimal method. What methods are not appropriate for this objective?

7. Are there specific population subgroups of interest in assessing fruit and vegetable intake? Are there special considerations that should be made in administration of the method to these different subgroups? (In addition to those determined in the General Dietary Assessment discussion from February 22, 1993.)

8. For the methods selected, what administration methods are preferred? (face-to-face interview, telephone interview, self-administered questionnaire, paper and pencil or automated interview)

9. For the methods selected, should portion size estimation aides or food guides be used?

10. Analytic issues. How many days of data collection are required? What other dietary variables are needed?

## APPENDIX C
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## APPENDIX D
## OTHER USEFUL REFERENCES

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## Acronyms and Abbreviations

The following list of acronyms and abbreviations are used throughout the report. Parenthetical acronyms and abbreviations identify the parent department and agencies to which the listed agencies belong. Parenthetical acronyms and abbreviations identify the department or agencies which conduct the listed surveys.

| | |
|---|---|
| ADAMHA | Alcohol, Drug Abuse, and Mental Health Administration (HHS/PHS) |
| ARS | Agricultural Research Service (USDA) |
| BLS | Bureau of Labor Statistics (DOL) |
| BRFSS | Behavioral Risk Factor Surveillance System (HHS/PHS/CDC/NCCDPHP) |
| CDC | Centers for Disease Control and Prevention (HHS/PHS) |
| CSFII | Continuing Survey of Food Intakes by Individuals (USDA/ARS) |
| DASH | Division of Adolescent and School Health (HHS/PHS/CDC/NCCDPHP) |
| DOC | Department of Commerce |
| DOD | Department of Defense |
| DOL | Department of Labor |
| ERS | Economic Research Service (USDA) |
| FDA | Food and Drug Administration (HHS/PHS) |
| FNS | Food and Nutrition Service (USDA) (renamed as Food and Consumer Service) |
| FSP | Food Stamp Program |
| HHS | Department of Health and Human Services |
| HNIS | Human Nutrition Information Service (USDA) (now a part of ARS) |
| IBNMRR | Interagency Board for Nutrition Monitoring and Related Research |
| IHS | Indian Health Service (HHS/PHS) |
| NCCDPHP | National Center for Chronic Disease Prevention and Health Promotion (HHS/PHS/CDC) |
| NCHS | National Center for Health Statistics (HHS/PHS/CDC) |
| NCI | National Cancer Institute (HHS/PHS/NIH) |
| NFCS | Nationwide Food Consumption Survey (USDA/HNIS) |
| NHANES | National Health and Nutrition Examination Survey (HHS/PHS/CDC/NCHS) |
| NHIS | National Health Interview Survey (HHS/PHS/CDC/NCHS) |
| NHLBI | National Heart, Lung, and Blood Institute (HHS/PHS/NIH) |
| NIDA | National Institute on Drug Abuse (HHS/PHS/ADAMHA) |
| NIH | National Institutes of Health (HHS/PHS) |
| NNMRRP | National Nutrition Monitoring and Related Research Program |
| OASH | Office of the Assistant Secretary for Health (HHS) |
| ODPHP | Office of Disease Prevention and Health Promotion (HHS/OASH/PHS) |
| PHS | Public Health Service (HHS) |

| | |
|---|---|
| RDA | Recommended Dietary Allowances |
| SSI | Supplemental Security Income |
| USARIEM | United States Army Research Institute of Environmental Medicine (DOD) |
| USDA | United States Department of Agriculture |
| USGPO | United States Government Printing Office |
| WIC | The Special Supplemental Food Program for Women, Infants, and Children |
| YRBS | Youth Risk Behavior Survey |