

National Children's Study Workshop
Dietary Assessment in a Prospective Epidemiologic Study of Pregnant Women
and Their Offspring
September 21–22, 2004
Hilton Hotel
Silver Spring, MD

This meeting was held in conjunction with the National Children's Study, which is led by a consortium of federal agency partners: [the U.S. Department of Health and Human Services](#) (including [the National Institute of Child Health and Human Development \[NICHD\]](#) and [the National Institute of Environmental Health Sciences \[NIEHS\]](#)), two parts of [the National Institutes of Health](#), and [the Centers for Disease Control and Prevention \[CDC\]](#)) and the [U.S. Environmental Protection Agency \(EPA\)](#).

Introduction to the National Children's Study

Adolfo Correa, M.D., Ph.D, M.P.H., National Center on Birth Defects and Developmental Disabilities, CDC, DHHS

Dr. Correa welcomed attendees, thanking them for participating in the workshop and for being part of the National Children's Study (Study). He briefly addressed the history, background, and goals of the Study, stressing the importance of dietary intake on child health and development.

The Study was authorized by Congress in the Children's Health Act of 2000 (PL 106-310), which directed NICHD to conduct a national longitudinal study of environmental influences on children's health and development. He summarized the basic constructs of the Study as follows:

- Longitudinal study of children, their families, and their environment
- National in scope
- Hypothesis driven
- Environmental exposure defined broadly (chemical, physical, behavioral, social, cultural)
- Assess common range of environmental exposures, as well as less common outcomes, in approximately 100,000 children
- Exposure period begins in pregnancy
- Environment and genetic expression (that is, gene-environment interaction)
- State-of-the-art technology for tracking, measurement, and data management
- Consortium of multiple agencies
- Extensive public-private partnerships
- National resource for future studies.

Dr. Correa presented the basic elements of the Study sampling strategy:

- National probability sample
- Multistage design, collecting data on chemical, physical, and social characteristics of communities as well as individuals
- Center-based structure
 - Central coordinating center
 - 50 regional centers and more than 100 clusters.

The Study cohort will encompass a diverse and widespread population. Dr. Correa noted that the Study will recruit women of child-bearing age and include an appropriate range of environmental exposures so that Study findings will be generalized to the U.S. population overall. The Study cohort also will include specific high-risk groups including agricultural and industrial communities, as well as the economically disadvantaged.

Dr. Correa next noted that the Study will be organized around several key categories of priority exposures, as follows:

- **Physical environment:** Housing, neighborhoods and communities, climate, radiation
- **Chemical exposures:** Air, water, soil, food, dust, industrial products, pharmaceuticals, complex ubiquitous low-level exposures and unique exposures (special substudies)
- **Biological environment:** Intrauterine, infection, nutrition; inflammation and metabolic response
- **Genetics:** Genetic components of disease; effects of environmental exposures on gene expression
- **Psychosocial milieu:** Influence of family, socio-economics, community, stress.

He also briefly provided examples of anticipated exposure and outcomes measures. In concluding his remarks, Dr. Correa summarized the projected timeline for the Study, discussed the status of Study funding to date, and emphasized the use of data to maximize output, ultimately resulting in Study findings that could be used to inform relevant prevention initiatives.

Review of Major Hypotheses, Nutrition-Related Core and Minor Hypotheses, Charge of Workshop, What We Are Not Discussing

Nancy Potischman, Ph.D., National Cancer Institute, NIH, DHHS

After welcoming participants, Dr. Potischman reviewed workshop objectives. She asked that participants focus discussion on:

- The current state of knowledge about methodologies used to assess dietary intake during pregnancy, lactation, infancy, early childhood, and adolescence
- The validity, feasibility, strengths, and limitations associated with measurement methods during each of these time periods
- Priorities and recommendations for Study instruments that will:
 - Capture information at specific ages
 - Be used throughout the entire span of the Study.

Dr. Potischman next discussed development of core Study hypotheses, including several related to nutrition. She explained that more than 50 hypotheses have been formally evaluated; these were classified as core and secondary hypotheses.

Dr. Potischman discussed several core hypotheses related to dietary intake:

- Antioxidant constituents of diet are associated with decreased risk of asthma.
- Breast milk feeding, compared with formula feeding, and breastfeeding duration, are associated with lower risks of obesity and insulin resistance in offspring.

- Dietary predictors of obesity and insulin resistance include reduced intake of fiber and whole grains, and high glycemic index.
- Social, behavioral, and family factors that affect development of dietary preferences and physical activity patterns early in childhood determine risk of childhood obesity and insulin resistance.

She also briefly reviewed secondary nutrition-related hypotheses, including vitamin A and folate intakes related to schizophrenia, breastfeeding and asthma, carotenoid intake and dysplastic nevi and nutritional influences on bone density. Environmental exposure hypotheses were reviewed. Those exposures related to food intake may be quantitated using typical dietary instruments but if the major exposure was not food-based then diet would not be helpful.

Dr. Potischman next presented examples of core hypotheses potentially influenced by dietary intake. In particular, hypotheses related to inflammation and glucose metabolism may be influenced by dietary intake and nutritional status. She provided examples of typical hypotheses of interest to maternal and child nutritionists that are likely to emerge as data become available from the Study.

Dr. Potischman stated that participants were being asked to recommend types of instruments (rather than specific instruments) to be used for each age group. She reminded attendees that the main focus of the Study is on foods, nutrients, and supplements, although they also should not overlook food-borne contaminants of interest to the Study.

During Day 1 each workshop speaker was asked to discuss:

- Current methods for assessment of dietary intake in each age group
- Extent to which supplements have been addressed
- Ability of the methods to capture foods as well as nutrients
- Methods that have been applied to minority groups
- Special issues for this group in terms of a large cohort study (such as dietary intake in a daycare setting)
- Major knowledge gaps and research needs and their implications for the National Children's Study.

Dr. Potischman also mentioned topics that would not be discussed due to time constraints or because these topics are not within the Study or workshop purview. She concluded by asking participants to keep in mind that it was imperative to provide reasonable recommendations within the context of a study of 100,000 mothers and their offspring, multicentered across the country, with substudies possible.

Objectives and Methods for Literature Review

Carolyn Sharbaugh, M.S., R.D., Westat

Ms. Sharbaugh reported on the literature review conducted to identify validated methods to assess:

- Food intake

- Vitamin, mineral, and herbal supplement intake
- Food-borne environmental exposures.

In addition to reviewing specific objectives for the literature review, Ms. Sharbaugh discussed the framework used to define and guide the review. First, the literature review encompassed several target populations, including:

- Pregnant or lactating women
- Infants (0–12 months)
- Toddlers (13–24 months)
- Preschoolers (25 months–5 years)
- School-aged children (6–12 years)
- Adolescents (13–18 years).

Ms. Sharbaugh explained that within those target populations, the literature review focused on:

- Identifying and describing validated instruments used in dietary assessments
- Identifying and describing validated instruments to assess exposure to environmental contaminants from food
- Describing the socioeconomic, ethnic and cultural characteristics of the validation study populations
- Describing instruments used in large (>100) epidemiologic studies and the rationale for selection
- Identifying methodological issues and challenges in each target group
- Describing the weight of the evidence for the various methods and key unresolved issues.

In addition, Ms. Sharbaugh described the exclusion criteria and the main end products—summary tables of instruments used in large studies and validation studies, and a short summary for each group. The summary tables from validation studies were organized by:

- Test method
- Reference method (criterion or relative validity)
- Study population characteristics
- Design effects
- Results.

Two major databases—the National Library of Medicine Pub Med and CABI Publishing Nutrition Abstracts and Reviews—were the major reference sources. The main components of the search methodology used in the literature review were:

- Key word search string development and modification in consultation with research librarians
- Key author searches
- Reference list review
- Review article cross referencing.

Accepted records were housed in a Reference Manager database and an MS ACCESS customized database, using a “3 Pass” review process. Initially a total of 2,088 citations were

stored on the Reference Manager database; of those, 612 abstracts passed the first review. A total of 297 articles passed the second review and were housed on the ACCESS database.

General Results from Dietary Assessment Literature Review

Mary Frances Picciano, Ph.D., Office of the Director, NIH, DHHS

Dr. Picciano first reviewed the objectives of the literature review of studies that assessed food and dietary supplement intake in women and children. The primary objectives were to:

- Identify and describe validated instruments for assessment of usual food and nutrient intake patterns, and/or vitamin-mineral or herbal patterns, and/or vitamin-mineral or herbal supplement intake patterns in the target population
- Identify and describe validated instruments for assessment of exposure to environmental contaminants from food in the target population
- Describe the socioeconomic and ethnic/cultural characteristics of the populations in which the instruments were validated
- Describe dietary and supplement assessment instruments employed in large epidemiological studies of one or more of the target age groups and discuss the rationale for the instrument selection
- Identify methodological issues inherent in assessment of food intake in pregnant or lactating women, infants, children, and adolescents
- Describe the weight or evidence for the various methods, key issues that are unresolved, and additional information needed to resolve key issues.

Dr. Picciano pointed out that most studies have been conducted among white, upper-income, well-educated groups. Findings from these studies, therefore, may have limited applicability. Also, the review focused on large epidemiological studies recently completed or currently underway. Dr. Picciano noted that most of the studies included in the review are assessments of relative (rather than actual) validity. She cautioned that it was very important to continually balance how these tests were performed against what was actually being measured. Dr. Picciano then summarized the characteristics of the validation studies of each of the main groups.

Dr. Picciano reported that 15 validation studies were included in the literature review for the pregnancy group:

- 2 doubly labeled water (DLW) versus 4- or 7-day weighed food (WFR)
- 1 diet history (DH) versus 7-day food record (FR)
- 1 24-hour recall (24HR) with biomarkers of caffeine intake
- 11 food frequency questionnaire (FFQ).

Studies using DLW demonstrated underreporting of 6 to 27 percent by WFR. Of the 15 studies, 7 included Caucasians only. No studies included Asians. Dr. Picciano also noted that only the studies using the FFQ format assessed supplement intake.

The literature review included four validation studies that assessed dietary and food supplement intake among lactating women:

- 2 DLW versus WFR (4- and 7-day)

- 1 FFQ versus estimated food record (EFR) (7-day)
- 1 FFQ versus 24HR (3).

Dr. Picciano reported that these studies yielded divergent results, although the methodologies were quite similar. She noted that most study participants were Caucasians. None of the studies assessed dietary supplement intake.

There were 21 validation studies identified for infants (0–12 months). Of those, 14 studies assessed early infancy milk diets:

- 7 test-weighing (TW)
 - 3 formula fed (FF)
 - 4 breastfed (BF)
- 7 DLW
 - 4 FF
 - 3 BF.

Another seven studies were conducted later in infancy using solid foods:

- 3 FR or DH
- 2 24HRs
- 1 FFQ
- 1 other questionnaire of postpartum women interviewed at 12 months after birth.

Dr. Picciano remarked that the studies of this age group yielded some of the “best” data. Findings from TW versus direct measurement using FF varied within 1 percent when conducted by trained staff and within 7 to 10 percent when conducted in home settings.

Within the toddler age group, nine validation studies were identified:

- 1 DLW (malnourished children)
- 4 FR or DH
- 1 24HR
- 3 FFQs.

Dr. Picciano reported a 6 percent underestimate in WFR versus DLW when assessing children 1½ to 2½ years of age; there was a 1 percent overestimate for 3½ to 4½-year-olds. She suggested that results may reflect portion sizes used or may be due to consistent over-reporting. She also noted that because the DLW study assessed malnourished children, the results might not be relevant to this discussion.

There were 23 validation studies identified for the preschool-aged (25 months–5 years) group. Dr. Picciano reported that there was a 3 percent underestimate of intake in DLW versus WFR (4-day) studies. In studies using DLW versus DH, there was a 9 percent overestimation. In two separate studies using DLW versus 24HR, there was a 3 percent underestimate to an 11 percent overestimate. She also noted that there was a 50 percent overestimate in studies using DLW versus FFQ.

Within the school-aged group, there were two recent reviews (through 2000). Dr. Picciano explained that the literature review report summarizes the conclusions of these two independent reviews and validation studies published thereafter. Dr. Picciano further noted that the findings from studies included in the reviews appear to conform to patterns that emerged among preschool children.

A total of 25 validation studies were identified as pertinent to adolescents. Dr. Picciano summarized findings and general conclusions from these studies:

- Dietary assessment of adolescents is challenging.
- Underreporting and misreporting are cited frequently.
- Dietary supplement intake is seldom addressed.
- When studying this age group, it is important to assess performance-enhancing drugs and herbals.

The literature review identified only one validation study relevant to food-borne exposure assessment. A duplicate diet study (7-day) versus alternating 24-hour food diary, 24-hour food checklist, or 24-hour food group checklist was used in this 28-day study of nine adults and three children. Two other questionnaires documented location and any dietary changes. Participants collected 98 percent of meals eaten. Laboratory measurements found an estimated energy intake 12 percent lower than estimated energy expenditure.

Dr. Picciano concluded by listing several key points that should be considered when determining the methodology for the Study dietary assessment:

- Comparability of the findings identified in the literature review report with those from other large epidemiological studies
- Interpretability of findings from various dietary assessment instruments over time
- Lifecycle-specific issues.

Overview of Measurement Issues Related to Dietary Assessment, Different Methods over Time in Prospective Studies, Findings from IOM Report

Laura Caulfield, Ph.D., John Hopkins University Bloomberg School of Public Health

In discussing the two Institute of Medicine (IOM) reports on dietary risk assessment in the Women, Infants, and Children (WIC) Program, Dr. Caulfield emphasized the importance of nutritional factors on maternal, fetal, and child health and well-being. She summarized several challenges inherent in dietary assessments:

- Usual dietary intake is complex and not readily amenable to simple measurement.
- Dietary intake results from multiple individual decisions made daily over time.
- There is high day-to-day variability, even in resource-constrained settings.
- Food intakes are even more unstable.
- Instability varies across nutrients.
- Instability varies across specific food sources.
- Intakes may be 1 to 6 times more variable within individuals than between individuals.
- Individuals vary in the level of day-to-day variability.

Dr. Caulfield next discussed the characteristics of various current methods for estimating dietary intake:

- Multiple 24HRs
 - Obtain quantitative information on dietary intakes over a 24-hour period
 - Replicate the collection on more independent days
 - Average the information over days to obtain “usual” dietary intake
- FFQ
 - Respondent summarizes the variability in his/her diet by estimating the usual intake of specific food items over a specific time period (over the past year, month, during pregnancy)
- FR
 - Obtain quantitative information on intakes
 - Collect information on multiple days to obtain usual nutrient intakes
 - Can involve weighed samples
 - Place the largest burden on the respondent
 - Provide the potential for altering diet to meet collection needs
- Food patterns
 - Focus on intake of foods or food groups (for example, dairy products)
 - Can be used for a food guide pyramid
 - Can be assessed with either recall or FFQ
- Behavioral indicators
 - Are tied to consumption of specific foods or groups of foods
 - Help identify specific meal patterns (for example, percent meals consumed outside the home)
 - Are associated with health-related behaviors
 - Include psychosocial factors
 - Identify family food practices
 - Include ecological factors (home, neighborhood, or community).

Dr. Caulfield then discussed assessment of dietary exposures during pregnancy. In discussing dietary intakes during infancy, Dr. Caulfield pointed out that a combination of methods may be necessary to assess dietary intakes during infancy. She also listed several other factors that should be considered in attempting to measure dietary intake in infants:

- Pediatric dietary guidelines for infants less than 1 year of age
- Inability to measure usual breast milk nutrient intake
- True usual intake will not be known as long as child is breastfed
- Use of behavioral indicators for key behaviors
- Reported breastfeeding behaviors that support optimal feeding/intakes
- Infant may be put to the breast within 1 hour of birth
- Breastfeeding frequency and on-demand, day and night
- Feeding from both breasts
- No additional liquids, not even water
- Duration of exclusive breastfeeding
- Duration of any breastfeeding

- Number of feeds during day and during night.

Dr. Caulfield also discussed issues related to measuring dietary intakes among preschoolers:

- High numbers of feeding events and varied eating patterns
- Small portions of many food items
- Multiple caregivers, multiple respondents
- Dramatic changes in diet during the preschool years
- Dietary guidelines for children over 2 years of age
- Parenting theories about food intakes.

In discussing dietary exposures in school-aged children and teens, Dr. Caulfield presented some questions that should be considered:

- At what age will the child become the respondent?
- How frequently should dietary exposures be assessed within this age group?
- Are there key behavioral indicators to assess?

Dr. Caulfield also pointed out several issues concerning ethnicity and dietary exposure:

- Dietary intake and patterns are influenced by multiple factors, and importantly by ethnicity or culture group.
- There is a need for common methods of exposure assessment.
- Ethnic-specific assessment methods may be needed to achieve equivalent validity and reliability in exposures.

Dr. Caulfield reiterated several issues related to data collection. These factors include:

- Respondent burden
- How information will be collected (for example, self-administered or by an interviewer)
- Frequency of information collection (for example, during pregnancy, at 0–2 years of age, at 2–20 years of age).

Dr. Caulfield concluded her presentation by offering a number of recommendations:

- Develop estimates of dietary exposures in individuals, with acceptable validity and reliability at the level of individual.
- Use a combination of methods and types of indicators.
- Document the validity and reliability of each tool and determine appropriate calibration methods.
- Conduct a separate literature review on calibration methods for de-attenuation of risk estimates.
- Articulate the principles and priorities for data collection at each point as well as the limitations of each decision (what is given up).
- Identify research needs with respect to new, promising methods or methodological advances in calibration.

Assessment of Dietary Intake During Pregnancy

Anna Maria Siega-Riz, Ph.D., University of North Carolina, Chapel Hill

Dr. Siega-Riz discussed issues involved in assessing dietary intake during pregnancy:

- More within person than between person variation
 - Physiological changes that alter nutrient absorption, metabolism, and requirements (for example, basal metabolism increases by 10–20 percent, increase in red blood cell production)
 - Fluctuations in appetite
 - Development of medical complications
- Plasma volume expansion
- Exposure period can vary (past month, trimesters, all of pregnancy).

Dr. Siega-Riz next reported on relevant studies that used the following methods to measure dietary intake during pregnancy:

- FR
- 24HR
- FFQ
- DH
- Biomarkers.

She pointed out that most large epidemiological trials have used an FFQ. These questionnaires usually take 30–45 minutes to complete, with 70–90 percent completion rates. Dr. Siega-Riz explained that the national evaluation of WIC and the CPEP trial are the only large-scale studies that have used two 24HRs. Also, most studies combine a dietary tool with biomarkers.

Dr. Siega-Riz described both the strengths and weaknesses of using biomarkers as an assessment tool. She explained that biomarkers:

- Do not rely on memory or literacy
- Do not change an individual's behavior
- May represent immediate or usual intake
- Take into account bioavailability and supplement use.

Moreover, technology is developing that makes biomarkers more practical to use in the field; in some cases, requiring very small quantities.

Dr. Siega-Riz also acknowledged that biomarkers also have inherent limitations. She explained that biomarkers:

- Do not necessarily reflect intake
- Are nutrient-specific
- Require a biological specimen
- May not be practical
- Contain measurement errors.

Furthermore, Dr. Siega-Riz pointed out that other factors besides intake can alter biomarker levels.

Dr. Siega-Riz reported that one study using an FFQ included questions about supplement use. Other studies ask about supplement use separately. Dr. Siega-Riz noted that current U.S. data on adherence to prenatal supplements (PNS) are based on self-reports. She cautioned that according to studies in developing countries, self-reports tend to overestimate adherence.

Dr. Siega-Riz next discussed a study that compared measures of prenatal supplement use based on self-reports, pill counts, and the Medication Event Monitoring System (MEMS). A randomized controlled clinical trial tested the effectiveness of routine versus selective supplementation among a group of low-income pregnant women receiving prenatal care.

Dr. Siega-Riz reported that a validation substudy was conducted among 100 women. Self-reports from questionnaires, pill counts from returned pill bottles, and MEMS were used to measure adherence. She explained that the MEMS cap records the time and date every time the bottle is opened. Dr. Siega-Riz summarized test results as follows:

- Compared with MEMS, pill count and self-report both overestimated adherence.
- Pill count correlated better with MEMS than with self-reports.

Dr. Siega-Riz identified several research gaps, as well as questions that should be considered when structuring future research concerning dietary intake during pregnancy:

- Are pregnant women subject to the same reporting bias as non-pregnant women?
- Limited use of DLW with other dietary tools.
- How well do FFQs (such as the Harvard and Block versions) compare against DLW?
- How many 24HRs are needed to represent of the entire pregnancy?
- How does the 24HR compare to DLW in each trimester?

In closing, Dr. Siega-Riz described two major implications for the Study:

- The method of dietary collection will depend on when recruitment begins (for example, during pregnancy or at delivery)
- Research questions will help determine the appropriate timing of data collection, as well as the methods used to collect the data.

Assessment of Dietary Intake During Lactation

Mary Fran Sowers, Ph.D., University of Michigan

In her opening remarks, Dr. Sowers pointed out that there is a significant gap in information on the nutritional status of women, including the dietary intake of lactating women. She also summarized the rationale for the American Academy of Pediatrics (AAP) position encouraging breastfeeding:

- Breastfeeding promotes optimal growth and neurodevelopment by:
 - Reducing the risk of acute and chronic infection
 - Protecting against allergies
 - Providing adequate water for hydration

- Promoting bonding and development.
- Additional health benefits from breastfeeding include:
 - Reduced incidence of intestinal, respiratory, and ear infections
 - Reduced risk of sudden infant death syndrome (SIDS)
 - Reduced incidence of childhood diabetes, obesity, hypertension, Crohn’s disease, and certain cancers (leukemia, lymphoma).

Dr. Sowers noted that the AAP policy ties directly to the Healthy People 2010 goal of increasing the number of all women who breastfeed to 75 percent in the early postpartum period and to 50 percent at 6 months. She then discussed various issues that should be considered when assessing diet in lactating mothers:

- Methodology
 - Conduct interviews
 - Multiple 24-hour intake (modifications)
 - FFQ (modifications)
 - Diaries
 - Collect physical samples
 - Use maternal biochemical markers (affected by volume)
 - Record behavior (for example, supplement use, dieting practices, use of low carbohydrate foods, and sunlight exposure)
- Select an assessment method that is most appropriate for what is being measured.

Dr. Sowers presented an overview of recent studies that are relevant to Study topics:

- **Neurodevelopment and behavior:** Studies in this area include an assessment of heavy metals—lead, mercury, cadmium; secondary arsenic, copper, and aluminum; B12 deficiency among vegetarians; caffeine; antioxidants (vegetables, polyphenols, cruciferous vegetables, ascorbic acid, tocopherols); and long-chain fatty acids.
- **Asthma:** Studies in this area have examined maternal dietary antigen avoidance and maternal dietary antigen consumption. At least one study found that long-chain n-3 fatty acids are associated with increased, not decreased, risk of atopy (predisposition to produce IgE) in breastfed infants.
- **Physical development:** These studies have dealt with adequate intakes of calories, protein, vitamins, and minerals; other studies have examined the dependency of nutrient adequacy on maternal dietary adequacy (specifically B6 and folate). Still other studies have been conducted on inadequate vitamin D intake, as well as on alcohol intake.

Dr. Sowers presented dietary recommendations, noting that breastfeeding women should consume between 2,300 and 2,700 calories a day. She cautioned that intakes of less than 1,800 kilocalories per day may not yield adequate amounts of calcium, magnesium, zinc, vitamin B6, or folate. She also presented recommendations regarding intake levels for protein, vitamins, minerals, and fluid intake for lactating mothers.

Dr. Sowers summarized the rationale for selecting a methodology that would most accurately assess dietary intake in lactating women:

- An FFQ will not capture the nutrition elements needed.

- A diary will not capture the nutrition elements needed.
- Using three 24HRs will require frequent administration (probably every 6–8 weeks)
- Interviews will require frequent administration (probably every 6–8 weeks for 6 months).

Dr. Sowers ended her remarks by suggesting an alternative strategy:

- Ask Study subjects to take a photo of every food/beverage ingested for 24 hours (over a 6–8-week timeframe).
- Ask Study subjects to save food samples (in bar-coded, vacuum-sealed plastic bags) for a 24-hour period.
- Ask Study subjects to put plastic bags with foods samples in a designated repository.
- Conduct a random sampling of food/nutrient biochemistry to establish normative characteristics.
- Establish additional food/nutrient biochemistry for case control studies.

Assessment of Breast Milk and Formula Intake in Infants

Alan S. Ryan, Ph.D., Ross Products Division, Abbott Laboratories

To provide some insight into infant feeding practices in the United States, Dr. Ryan began with an overview of the Ross Laboratories Mothers Survey (RLMS), a national mail survey on breast milk and formula intakes. Begun in 1954 as a modest study of 500 infants, currently 1.4 million questionnaires are mailed each year, 115,000 questionnaires each month. Dr. Ryan noted that the 2002 response rate was 30 percent. He also explained that while the RLMS collects information on milk feeding, it does not collect information on solid foods.

Dr. Ryan presented breakouts of RLMS data showing breastfeeding by several variables:

- Race
- Parity
- Birth weight
- Employment
- Maternal education
- Maternal age
- WIC participation
- Geographic distribution.

Dr. Ryan pointed out that since 1990, there has been a dramatic increase in breastfeeding throughout the United States. In 1990, the prevalence of breastfeeding (human milk alone or with a supplement of formula or cow's milk) in the hospital was 51.5 percent. In 2002, the rate of in-hospital breastfeeding was 70.1 percent. Although the rates were lower at 6 months, trends in breastfeeding at 6 months of age were similar to those seen in the hospital. In 1990, the rate of breastfeeding at 6 months of age was 17.6 percent. In 2002, the rate was 33.2 percent. In 2002, the rates of exclusive breastfeeding were 46.1 percent in the hospital and 7.4 percent at 6 months of age. RLMS findings also show that more mothers are using a combination of breast milk and formula. Dr. Ryan further emphasized that there is a great variance in breastfeeding among racial/ethnic groups. In fact, certain ethnic groups have already reached the Healthy People 2010 goals for breastfeeding: 75 percent in the hospital and 50 percent at 5–6 months postpartum.

Rates of breastfeeding were highest among mothers who were older in age, better educated, White or Asian, living in the western portion of the United States, and not participating in the WIC program. Breastfeeding duration was negatively affected by employment status (employed full-time) and participation in the WIC program.

Dr. Ryan summarized several studies that have examined milk intake in infants, noting that all current methods for measuring milk intake are subject to error. He emphasized that there is no standard for validating a new procedure. Considering some of the larger surveys that have been conducted, there is no consistency of the methods used to assess milk intake.

Dr. Ryan briefly reviewed surveys of dietary/nutrient intake:

- **CSFII and NHANES:** New Automated Multiple Pass Method 24HR
- **Feeding Infants and Toddlers Study (FITS):** 4-day FRs in one study, 3 telephone 24HRs in another study. Consumption of breast milk was estimated by using published intakes of infants of the same weight or age range.
- **Avon Longitudinal Study of Pregnancy and Childhood (ALSPAC):** 3-day unweighed FRs at 6-9 months of age. For breast milk, the duration of each feed was used to estimate the likely volume of milk intake. A feeding lasting 10 minutes or longer was assumed to be 100 ml in volume.
- **Dortmund Nutritional and Anthropometric Longitudinal Designed Study (DONALD):** 3-day WFRs and test weighing for human milk every 3 months for infants and children between 3 and 36 months of age.
- **The Norwegian Infant Nutrition Survey:** Semi-quantitative food-frequency questionnaire for infants 6 months of age.

Dr. Ryan then discussed the advantages and disadvantages of various methods for measuring dietary/nutrient intake and how they may relate to the needs of the National Children's Study:

- **24HR:** Although useful once solid foods have been introduced, this method does not accurately estimate breast milk intake.
- **Test weighing:** Involves weighing the infant before and after each feeding without a change of clothing or diapers.
- **DLW:** Indirectly estimates milk consumption by measuring the infant's energy expenditure.
- **Weighing food:** Seems to be the most accurate standard for validating various infant feeding measures.
- **Direct observation:** Estimates the volume of breast or formula milk consumed by visually assessing the infant during feeding.
- **FFQ** Can be designed to focus on certain foods, for example, infant formula/infant food intakes, but cannot be used to measure milk intake from the breast.
- **Dietary records:** The 7-day format is the most comprehensive and provides reliable estimates for individuals, but cannot be used to measure milk intake from the breast.

Dr. Ryan ended his presentation with several observations:

- Measuring breast milk intake will be a significant challenge. It may be necessary to use test weighing in a selected sample.

- Dietary record may be an appropriate tool for assessing dietary/nutrient intake in younger formula-fed infants.
- The collection process in the integrated survey used in NHANES and CSFII is the best method available for older infants fed a combination of formula, cow's milk, and solid foods.
- Dietary vitamin and mineral supplement intake should be collected during the 24HR.

Assessment of Dietary Intake in Infants and Toddlers (Age 0–2 Years)

Lene Frost Andersen, Ph.D., University of Oslo

Dr. Andersen began her presentation by pointing out that the greatest changes in food habits and food intake occur between birth and age 2. She also noted that there are specific challenges in studying dietary intake in this age group. For example:

- Dietary habits change rapidly (affecting the frequency of dietary assessments).
- Information about food intake is required from several adults (parents, other caregivers).
- Wasted food should be measured.
- Significant amounts of food may be left on plates or in glasses.
- Amounts of breast milk will not be constant or consistent.

She pointed out that a distinct advantage to studying this age group is that most eating is supervised.

Dr. Andersen presented an overview of recent U.S. and international validation and large-scale studies using current standard methods of dietary assessment:

- FR, using both estimated and weighed intake
- DH
- 24HR
- FFQ.

Dr. Andersen also summarized possible advantages and disadvantages of each methodology within the context of the Study.

FR. An advantage of FRs is that they provide detailed information on foods and supplements (a basis for calculating nutrient intake). The disadvantages of FRs are that they:

- Involve a high respondent burden
- Are relatively expensive
- Involve multiple sample days (group/individual data level).

24HR. In addition to also providing detailed information on foods and supplements, the 24HR method has been widely used in large U.S. samples. Also significant is that the 24HR method places less burden on the respondent than the FR methodology. However, there are several disadvantages to the 24HR:

- These studies require multiple days (group/individual data level).
- There are sparse validation data in this age group.

FFQ. The FFQ format has been used extensively in large samples among U.S. adults. Another advantage of FFQs is that they are relatively inexpensive (once fully developed). Also, because only one FFQ is needed, this format is less burdensome for the respondent. Dr. Andersen pointed out that a disadvantage to the FFQ method is that this format uses a closed food list—a potential challenge in estimating food intake, supplements, and nutrient intake.

Dr. Andersen also emphasized that both the FR and 24HR methods provide detailed information on food level and supplements. However, estimating food intake may require more “recording days” than estimating nutrients. Furthermore, most validation studies have focused on the validity of nutrient intake compared to food intake.

Dr. Andersen noted that information on supplements could be collected using FR, 24HR, or FFQ methods. She cautioned that it may be necessary to develop an additional questionnaire specifically for supplements.

She described several issues that should be considered when determining the methodology to assess dietary intake in the 0–2 age group:

- **Ethnicity:** Only a few validation studies in this age group have included several ethnic groups, although several of large U.S. studies using 24HR (e.g. NHANES, CSFII) are ethnically diverse.
- **Caregiver effect:** Other than the CSFII and the study of feeding infants and toddlers, few studies report on how data from caregivers other than parents are collected.
- **Knowledge gaps in the 0–2 age group:** There is little information about the validity of the FR and FFQ methods; validation studies of 24HR (and DH) are lacking; currently, there is no specific focus on validation of supplement intake (and food intake); and there are almost no studies of the effect of ethnicity and multiple caregivers on validity.

In closing, Dr. Andersen listed areas for further study in the age 0–2 age group:

- Timing and frequency of dietary assessment
- Larger validation studies
- Representative sample of the target group
- Biomarkers
- Portion size aides
- The impact of ethnicity, parental body mass index (BMI), education, and the “caregiver effect.”

Assessment of Dietary Intake in Preschoolers (Age 2–5 Years)

Gladys Block, Ph.D., University of California, Berkeley

Dr. Block began her discussion by listing methods used in studies assessing dietary intake in this age group:

- 24HR
- Diet record (DR), weighed or measured
- DR, including those using tape recordings
- FFQ

- Short tools.

Dr. Block emphasized that regardless of which methodology is used; there are several problems and issues inherent in studying this age group:

- A proxy respondent is needed. Because many children are in daycare or in preschool, other caregivers may be involved as well as parents.
- Children in this age group undergo rapid growth and development, and are not in energy balance.
- Children grow in spurts (rather than linearly). This randomness will even out the group mean, but not at individual level.
- Children have dietary fixations that change over time.

Dr. Block next discussed studies capturing group mean intake using DLW. These studies used DLW versus WFRs, DLW versus multiple recalls, and DLW versus DH. Dr. Block indicated that results have been mixed for validation of WFRs, multiple recalls, and DH. Also, these studies have focused solely on energy. Another concern may be the accuracy of formulas used in these studies. Dr. Block suggested that even if there were consistent underestimates or overestimates, these results could still be useful.

When reviewing studies using FFQs, Dr. Block reminded participants that comparisons of the means should not be used to assess the validity of an FFQ. She pointed out that the Harvard adult FFQs generated large overestimates if unadjusted. However, these data were comparable to recalls if adjusted for energy. The Harvard Kids FFQs were interviewer-administered, using a low-income target population. The original version resulted in large over-estimates (unadjusted). The modified version, however, was comparable to 24HR (once adjusted). The Block WICKids FFQ, using a self-administered format among a low-income population, yielded slight overestimates.

Next, Dr. Block described studies that assessed group mean intake using 24HRs. Several studies used weighed records; other researchers used the observation method. Dr. Block pointed out that there has been virtually no validation of 24HRs among Hispanics and Blacks. However, there has been generally good agreement on mean energy and nutrients, if the parent was with the child. Again, even if there were systematic underestimating or overestimating, this information could be useful at the group mean level.

Dr. Block also described studies that examined means versus correlations to assess validity. She then discussed various methodologies used in ranking/categorization. Several studies used recalls/records versus DLW; others used self- or interviewer-administered FFQs. Still others used brief tools. Dr. Block noted that FFQs administered by parents had poor-to-moderate correlations among low-income families. Interviewer-administered FFQs had modest correlations if adjusted for energy and measurement errors.

Dr. Block remarked that few studies have addressed food group intake. She also mentioned that while she could identify no studies of vitamin supplement intake, this information could be collected through using recalls or FFQs.

In closing, Dr. Block offered sample copies of FFQs and FRs currently being used with children and parents of preschool children.

Assessment of Dietary Intake in Elementary School Children (Age 6–11 years)

Suzanne Domel Baxter, Ph.D., R.D., F.A.D.A., University of South Carolina

Dr. Baxter began by pointing out that when working with elementary school children, parents are often asked to provide information regarding the child's intake. However, validation studies raise concerns about parents' ability to do this.

In two recent studies that described parent-child interactions during children's parent-assisted 24-hour dietary recalls (24-hour DRs), parents contributed primarily by adding food details, and secondarily, by prompting children. There was concern that parents may:

- Make unwarranted extrapolations from their previous experiences
- Use their answers to advance culturally motivated presentations of themselves
- Contradict their child to present themselves as more knowledgeable about the child's diet than may be the case.

These same researchers offered the following recommendations to improve the accuracy of data regarding children's intake:

- Expectations regarding parental participation should be clarified at the start of the interview, and interviewers should intervene, as needed, to limit parental participation.
- Interviewers should consistently probe to determine if the child agrees with each addition by the parent and consistently query parents regarding the basis for each addition.
- Because the caretaker's presence may limit the child's participation, the interviewer should conduct the final portion of the interview with the child alone.

Validation studies are needed to determine the impact of these recommendations on reporting accuracy.

In a review of current methods for assessing dietary intake of elementary school children, Dr. Baxter noted that while youth have completed FFQs for numerous studies, researchers have found that elementary school children may lack the cognitive skills required to complete certain FFQs.

She reported that several studies have found that the quality of FRs is questionable among children in this age group. A common problem is remembering to complete the records, so that instead of being completed at the time of intake, the FR may be completed later (thereby relying on the child's memory). In addition, recording what is eaten may lead to changes in eating behavior.

Researchers have noted the following with respect to the use of 24-hour DRs to assess dietary intake in elementary school-aged children:

- The 24-hour DR is a useful dietary assessment method, particularly with children, because the respondent does not need to be literate, and the procedure is unlikely to alter intake.

- Children's 24-hour DRs are commonly used to evaluate nutrition education interventions.
- Multiple 24-hour DRs from children are often used to assess the relative validity of children's FFQs.

Dr. Baxter summarized 72 validation studies of dietary assessment among 6–11-year-olds. In 31 studies, recall was the method validated. The validity or relative validity of FFQs was the method validated in 24 studies. Food record/diet history was the method validated in 16 studies. One study examined recalls of amounts consumed as the method being validated. The review of findings from these studies was based on:

- Who provided the dietary information (child, adult, or both)
- Reference method used (that is, observation, total energy expenditure [TEE] by DLW, record, or other) for each of the methods being validated.

Given the lack of clarity in reporting accuracy in parent-assisted reporting, the remainder of the validation study review focused on the 38 validation studies for which children provided dietary information without assistance from their parents. It was noted that the same lack of clarity holds for differences in reporting accuracy by age, gender, race/ethnicity, BMI status, social desirability, body image, and self esteem.

There is both underestimation and overestimation of energy intake within and across the 24 validation studies of recalls provided by children, 2 validation studies of FR provided by children, and the 11 validity or relative validity studies of FFQs provided by children.

The 38 validation studies in which children provided dietary information without assistance from parents provided limited, and sometimes conflicting, information regarding the relationship between children's reporting accuracy and:

- **Age:** Six studies found that reporting accuracy improved with age among 6 to 12-year-olds; however, two other validation studies found no improvement in reporting accuracy with age.
- **Gender:** One study found that girls' accuracy in reporting medium fat exchanges was better than for boys. Another found that omission rates for boys were better for reverse order recalls than forward order recalls, but the opposite was true for girls. However, three validation studies found no difference in reporting accuracy by gender.
- **BMI:** There were no differences in children's reporting accuracy by BMI in the two validation studies found.
- **Race/ethnicity:** One study of 102 Chinese, Hispanic, Filipino, and Cambodian children found wide variation in reporting accuracy.

A summary of findings from several recent validation studies using observations of school breakfast and school lunch to validate these portions of children's dietary recalls suggests that when interviewed in the *morning* about the *previous day's intake*:

- Children failed to report 51 percent of items observed eaten; of what they reported, 39 percent was not observed eaten.
- Individual children were inconsistent in recall accuracy from one interview to the next, but overall accuracy improved slightly between the first and third recalls.

- Boys were more accurate when prompted to report in reverse order, while girls were more accurate in forwards order, but accuracy was still poor.

When interviewed in the *evening* about *that day's intake*:

- Children failed to report 33 percent of items observed eaten; of what they reported, 18 percent was not observed eaten.
- Children's recall accuracy did not depend significantly on whether interviews were obtained in-person versus by telephone.
- Interview format influenced children's reporting accuracy; in particular, providing meal cues elevated false reports.

In one validation study regarding target period, recall accuracy was significantly better for children interviewed about the prior 24 hours' intake compared to children interviewed about the previous day's intake. In another validation study, specific prompting (preference, food category, or visual) after free recall hurt more than helped recall accuracy among first graders; among fourth graders, prompting for food category after free recall yielded small gains in recall accuracy with minimal losses.

In her concluding remarks, Dr. Baxter defined several issues that should be considered when determining the dietary assessment component of the Study:

- Accuracy of child versus parent versus joint reports has not been studied sufficiently; furthermore, recommendations for improving accuracy during children's parent-assisted reports have not been validated.
- Validation studies are needed regarding the assessment of children's use of dietary supplements.
- The interview format of the 24-hour DR should be addressed. Does children's reporting accuracy differ significantly when 24-hour DRs are provided using a "time" interview format (for example, NDS-R) or an "open" interview format (such as, Integrated CSFII-NHANES)?
- The target period and time that the interview is conducted need to be considered. Should children be asked to report about the previous day's intake or the prior 24 hours' intake? Should interviews be conducted in the morning, afternoon, or evening?
- Potential correlates of children's reporting accuracy that need to be included in validation studies include social desirability, self-esteem and body image, BMI, race/ethnicity, gender, and memory/cognitive ability.
- Dietary assessment methods that require training limit the ability to use them without scheduling/notifying subjects in advance.
- The reliability (consistency) of children's reporting accuracy needs to be studied.
- Observation should be considered as the validation method of choice instead of DLW because observation can identify intrusions (false reports) but DLW cannot; furthermore, observation can determine if underreporting is due to inaccurate reporting of items, amounts, or both, but DLW cannot.

Item omission rates and item intrusion rates are separate constructs; therefore, they should be evaluated separately in validation studies.

Dietary Assessment in Adolescents/Young Adults (Age 12–20 Years)

Thomas Baranowski, Ph.D., Baylor College of Medicine

Dr. Baranowski began by pointing out the limitations of the scientific literature:

- Very few validation studies—particularly those analyzing factors such as age, ethnicity, education, or socioeconomic status—have been conducted.
- Different studies may use the same methods in different ways.
- There is no common indicator of validity.
- Authors seem to allow their biases to influence their methods.
- No validation studies (based on the Domel Baxter model) have been conducted in this age group.

Dr. Baranowski summarized the strengths of the FFQ. This method:

- Assesses the entire diet in regard to specific nutrients or food groups
- Averages across a year (avoiding the problem of day-to-day variability)
- Takes a relatively small amount of time (usually less than 1 hour) to cover a long period of time (for example, 1 year)
- Requires no special expertise to administer
- Allows for relatively simple and straightforward conversions to nutrients and food groups
- Requires infrequent updating of detailed food-nutrient database.

Next, Dr. Baranowski presented the strengths of the 24-hour DR method. This method:

- Assesses one day with reasonable accuracy
 - Most children do reasonably well in recalling previous day's intake
 - Day-to-day variability can be overcome by assessing multiple days
- Provides a much richer data source for understanding what and why people eat, by recording:
 - Food groups or nutrients
 - Times eaten
 - Meal/snack intake (quantity)
 - Whether meals/snacks eaten
 - Who was present
 - Whether TV was on
 - Environments in which the food was eaten
 - Sources of foods
 - Food practices and add-ons
 - Food preparation methods.

Dr. Baranowski then summarized the limits of the 24-hour DR method. This method:

- Is very complicated to administer, requiring a Registered Dietician or Nutrition Data System (NDS) certification
- May require multiple quality control reviews
- Requires multiple non-contiguous days of measurement
- May involve social desirability biases
- Takes 20–45 minutes per day to assess
- Benefits from computer system to assure appropriate prompts

- Requires complex program to estimate nutrient intake
- Requires continual updating of the nutrient intake program to accommodate 20,000–30,000 new foods per year.

Dr. Baranowski also discussed assessing the merits of the FFQ using cognitive task/response analyses.

In describing the developmental characteristics of teens, Dr. Baranowski suggested dividing this cohort into two groups—middle schoolers (6th–8th grades, 12–14-year-olds) and high schoolers (9th–12th grades, 15–18-year-olds). Other significant characteristics that potentially affect dietary assessment of this age group include:

- Rapidly changing eating habits
- Unstructured eating (snacks, meal skipping)
- Peer influence exceeding parental influence
- Eating away from home (31 percent of foods eaten).

Dr. Baranowski next discussed factors related to age and their impact on assessing dietary intake within this age group. He reported that researchers have found:

- Increased underreporting with age
- Difficulty with time reference
- High level of restrained eating
- Greater underreporting among the obese
- Dietary assessment methods are geared to the patterns of this age group
- Research in school is difficult.

Dr. Baranowski noted that three methods have been used in validation studies among teens:

- FR and DH
- 24-hour DR
- FFQ.

Validation of FR and DH Methods. Dr. Baranowski explained that there has been only limited attention paid to validation studies among adolescents. Two studies found that TEE was underestimated by 18–24 percent, while another found a 10–14 percent underestimate. In another study, researchers reported that obese teens underestimated TEE by 42 percent. One study reported no differences in TEE.

Validation of 24-hour DR. Among the studies reviewed, Dr. Baranowski reported that the findings indicated no difference in TEE at the group level. There was, however, substantial individual variability. TEE parent-assisted 24-hour DR was underestimated by 12 percent against a 3-day FR.

FFQ validation. Dr. Baranowski noted that one study assessing TEE versus DLW found close agreement at the group level. However, half of those in the study population misreported intake. Another review found limited validity in FFQs.

Dr. Baranowski concluded his presentation by suggesting that the FFQ is appropriate when:

- Determining a person's position in a distribution on intake of a particular food group/nutrient
- Time and resources are limited
- The instrument has been validated for the variable of interest.

Review of Automated Dietary Assessment Systems

Suzanne McNutt, M.S., R.D., Westat

Ms. McNutt presented an overview of the four tools likely to be used by the Study to assess dietary intake:

- Food Frequency Questionnaire (FFQ)
- Diet History (DH)
- Food Records (FR)
- 24-hour Dietary Recall (24HR).

She summarized the applications and features of each method and cited examples of each format.

Ms. McNutt displayed screen shots of several automated versions of FFQs currently being used:

- **NCI Web-based dietary history questionnaire (DHQ):** Housed on USDA CSFII database; Web-based; 124 food items; imbedded questions
- **Block Online FFQ—Nutritionquest:** Uses the NHANES III database; Web-based; based on Block FFQ 98; includes 106 food items; graphic portions; reports
- **Hutch VioFFQ:** Housed on the NCC database; Web-based; includes 130 food items; reports.

Next, Ms. McNutt defined DH, citing the University of North Carolina (UNC) DietHistory as an example of an automated version. She displayed several screen shots from the UNC DietHistory, explaining how subjects use the visual prompts to respond. The UNC DietHistory is a Web-based application, using USDA databases and other public sources. It is meal-based and includes 5,000 food images. It has been designed primarily for adults.

Ms. McNutt discussed the FR instrument, describing three examples of this format:

- **BalanceLog:** Built on the CSFII 1994–1996 and 1998 databases; Web-based; meal-based; amounts are automatically entered; designed primarily for adults
- **DINE Healthy 4.2:** Uses USDA SR15; Web-based; also meal-based; amounts are automatically entered; geared to adults
- **Interactive Healthy Eating Index (IHEI):** Uses CSFII 1994–1996 and 1998 databases; Web-based; specific amount is entered; free-form entry format; designed for adults.

Ms. McNutt concluded her discussion with a description of applications of 24-hour DHs:

- **USDA AMPM:** Uses the FNDDS database; interviewer-driven; multiple pass method; designed for all age groups; FMB
- **Baylor FIRSSt:** Uses CSFII 1994–1996; self-administered; designed specifically for children; uses substantial numbers of graphics and photos
- **CSU Bilingual IMCFR:** Also uses CSFII 1994–1996 database; self-administered; multiple pass method; designed for Hispanic audiences, as well as low-income populations; uses photos to enhance presentation.

Demonstration of Electronic 24-Hour Recalls

Alanna Moshfegh, Beltsville Human Nutrition Research Center, USDA; Richard Buday, Archimage; Susan Gould, Ph.D., R.D., Colorado State University

Ms. Moshfegh presented an overview of the USDA Automated Multiple-Pass Method (AMPM) 24HR instrument. She explained that AMPM has five main components or “steps”:

- **Quick List** is a respondent-driven listing of all foods and beverages consumed over the previous 24 hours.
- **Forgotten Foods** uses nine categories of food and a set of standardized questions to probe the respondent about foods that people typically forget to report.
- **Time & Occasion** asks respondents to indicate when they ate a particular food; they are also asked to name the meal when the food was consumed (for example, breakfast, lunch, supper, or dinner).
- **Detail Cycle** includes standardized probes and questions probing for more detail for each food consumed in the 24-hour period.
- **Final Probe** provides a last opportunity for the respondent to offer information that may have been overlooked earlier.

Ms. Moshfegh also described the format for interviewing children:

- For children younger than age 6, a proxy respondent is used.
- For children 6–8 years of age, a proxy respondent is used, although the child can be present.
- For 9–11-year-olds, the child is the respondent, although an adult caregiver may be present to assist the child.
- For children age 12 and older, the child or young adult is the respondent.

Ms. Moshfegh further explained that the sequence of questions begins with beverages because these types of food tend to be those most often overlooked or under reported. She also emphasized that the respondents are continually reinforced that it is acceptable to forget and then go back to add information. She added that “don’t know” is an acceptable response.

Ms. Moshfegh noted that the AMPM takes 20–30 minutes to administer, with 13–15 foods typically reported. Throughout the process, the interviewer continually attempts to confirm the information. She concluded by pointing out that because foods consumed are reported at each of the five steps, it has not been possible to shorten the FR format to date.

Next, Mr. Buday described the Baylor College of Medicine FIRSSt (Food Intake Recording Software System) originally developed for the Squires Quest game. Now in its third generation, this PC-based application is being developed for self-guided 24-hour dietary recall and is targeted to children. The accuracy rate was 55 percent.

He further explained that the first generation of FIRSSt included illustrations of 300 foods; the third version contains photographs of 9,000 foods. He emphasized that this FR is very age appropriate and that it has been designed to be entertaining and interesting. The system uses speech synthesis and text bubble.

Mr. Buday then displayed screen shots and demonstrated how a child would enter information. He pointed out that the respondent is always able to return to a previous screen to correct or add information, and that the child can also review answers at the end of the session. Children are queried about what they ate, when, who they ate with, where they ate, and if the television was on and watched during the meal. Mr. Buday showed that a response record is continually being built for the individual respondent. He also emphasized that the system attempts to use humor as much as possible. Typically, this FR requires 20 minutes to complete.

Mr. Buday acknowledged that this system does not allow for spontaneous follow-up probing for more details that is possible with a dietician conducting an interview of the respondent. He also noted that this system has never controlled for low-literacy respondents. However, a benefit of the system is that because it uses voice synthesis, it can be readily adopted for other languages and dialects. The system is also designed to be streamed over the Web.

Dr. Gould then reported on developing and evaluating a bilingual interactive multimedia (IMM) dietary assessment tool. She described that this project involved several key objectives:

- Eliminate reading, writing, and data entry skills
- Collect data to determine food choices
- Develop a corresponding nutrient database
- Determine an effective format
- Validate with the target population (that is, low socioeconomic status Hispanics in Colorado)
- Determine a preferred method for reporting dietary intake.

Dr. Gould explained that the first pilot (breakfast) used a very basic “yes”/“no” written FR. When a multimedia recall was used, respondents reported 20 percent greater fat and fiber intake than in the self-administered written version.

Dr. Gould explained that food choice of the target audience was determined by examining the 1982–1984 Hispanic Health and Nutrition Examination Survey (HHANES) along with 191 24-hour recalls from Colorado’s Expanded Food and Nutrition Education Program (EFNEP). Foods reported by greater than 2 percent of the sample from one or both sources were included, resulting in 164 foods or 98 percent of food choice. She then summarized two formative evaluation phases of the Colorado study:

- **Phase I (N= 6):** Determined format from three prototypes; identified major format, food groupings, and content issues
- **Phase II (N = 25):** Used a 5-point Likert scale to determine strong and weak areas, as well as more specific suggestions.

Dr. Gould then presented several screen shots depicting the design and format used in the Colorado study. She pointed out that the respondent had the option of selecting either an English or Spanish version. While many respondents reacted favorably to audio prompts, others indicated that they also would like written prompts.

In the Colorado 24-hour FR, Dr. Gould demonstrated the touch-activated options for first selecting specific meals. Once the meals are selected, the respondent is prompted to select particular foods eaten at each meal. After selecting all of the foods eaten, respondents are asked to indicate portion size (based on growing and shrinking visual prompts), variety of food choice (such as regular, low-fat, or fat-free), and cooking method.

Dr. Gould explained that the data for 20 dietary constituents (14 nutrients and 6 USDA Food Guide Pyramid groups) were housed in the IMM Dietary Recall Database.

Dr. Gould described the research design used to validate the study, as well as study results. She concluded by summarizing the results of the exit survey, including preferred format for reporting food intake (that is, interview—37 percent, paper/pencil—9 percent, or computer—54 percent).

(Related Publication: Zoellner J, Anderson J, Gould SM. Comparative validation of a bilingual interactive multimedia dietary assessment tool. *Journal of the American Dietetic Association*. (Accepted September 2004))

Checklist Methodology

Frances Thompson, Ph.D., NCI, NIH, DHHS

Dr. Thompson described the checklist method and pointed out that it is a type of food record. A checklist instrument is composed of a finite number of predefined food categories; the respondent checks off the number of times each food is eaten throughout the day. While the checklist and fully quantitative food record methods share some advantages, the checklist instrument avoids some of the disadvantages of the fully quantitative food record. Namely, the checklist method places lower burden on both the respondent and the investigator, especially if using a machine scannable form. She then provided new data about reactivity in the checklist method.

Dr. Thompson described the NCI Checklist Study, which collected 30 consecutive days of checklist information from about 600 adults in the Washington, DC, metropolitan area. Analyses of these data showed that there was little change in reporting various foods over the entire time period, and thus that the checklist method is not reactive, that is, the measuring instrument does not itself affect the answers. This contrasts with high reactivity for the fully quantitative food record.

Dr. Thompson pointed out that a checklist could be used as a stand-alone instrument or in conjunction with another instrument (for example to calibrate an FFQ). She illustrated this latter use by showing analytical results from the 1999 Observing Protein and Energy Nutrition (OPEN) Study. This study of 484 adults in suburban Maryland measured energy expenditure and protein intake with doubly-labeled water and urinary nitrogen, respectively, and self-reported dietary intake with 24-hour dietary recalls and a food frequency questionnaire (FFQ). While the study individuals did not complete a checklist instrument, their two 24-hour recalls were coded to mimic frequency-type responses on a checklist. In order to calibrate an FFQ, a series of steps are performed:

- Define broad food groups (individual items are substitute foods, that is, they are used interchangeably in the same meal, e.g. beef or chicken)
- Compute the average daily food group frequency from both the FFQ and the checklist instrument
- Compute the ratio of the checklist to the FFQ, for each food group
- In FFQ, apply the ratio to the reported frequency of each individual food item in the food group
- Re-estimate intake from FFQ.

When this type of analysis was implemented in the OPEN study, mean energy and protein estimates from the pseudo checklist-adjusted FFQ were more accurate (that is, closer to the biomarkers) than estimates from the FFQ by itself.

After extensive cognitive testing, a checklist instrument has been developed and was used recently in a follow-up of the OPEN Study (Re-OPEN). Analyses will examine whether the checklist-adjusted FFQ is superior to the unadjusted FFQ.

Dr. Thompson concluded by suggesting that the checklist method had potential applicability for the National Children's Study:

- As a stand-alone instrument (to assess frequency of use of specific foods, food groups, dietary patterns, and dietary supplements)
- With other instruments (for example, 24-hr recalls, FFQs)
- As a screening tool to identify individuals for additional, more detailed assessment.

Report on the Danish National Birth Cohort

S. F. Olsen, Maternal Nutrition Group, Danish Epidemiology Science Centre, Statens Serum Institut

Dr. Olsen discussed coordinating the National Children's Study with other large international studies. He pointed out that generating comparable data across studies and combined analyses would yield greater power and exposure variations, as well as make it possible to replicate findings. He also acknowledged that differences in study design and methodologies increase the chance for reliability and validity among disparate studies. Dr. Olsen recommended ensuring that at least some components of the Study are compatible with other large-scale international studies, such as the Danish National Birth Cohort (DNBC) and the Norwegian Mother and Child Cohort (NMCC).

Dr. Olsen then presented an overview of the DNBC, a cohort of 100,000 pregnant Danish women. The DNBC is sponsored by the Danish National Board of Health, the Ministry of Health, Association of Counties, and several other national institutions. The dietary component of the study is funded by a number of Danish and international foundations. Dr. Olsen noted that the cost to date of the study is approximately \$12 million (U.S.).

Dr. Olsen explained that the study extracts information from several sources:

- Enrollment form

- Four telephone interviews
- A self-administered questionnaire on diet
- Three blood samples.

He further explained that information can be accessed through linkages to national registries that store records identified by means of a unique ID number assigned to every Danish citizen.

The DNBC collects information on the mother, including:

- Health/diseases
- Medicine
- Occupational factors
- Lifestyle factors (alcohol and tobacco consumption, substance use, and diet).

Information on developmental milestones, diseases, and nutrition is collected on the infant.

Dr. Olsen next addressed information specific to diet collected by the DNBC. He explained that sources of information include:

- Dietary questionnaire administered in week 25
- A recruitment form
- Interviews.

The 19-page dietary questionnaire includes questions on food frequency, identifying approximately 300 food items. Respondents are queried about dietary intake for 1 month previous to the interview, based on fixed time categories and fixed names for each food item.

The questionnaire includes items on food supplements, including:

- Name of product
- Name of manufacturer
- Nutrient content for every daily dose
- Number of doses per day over a 1-month period.

The questionnaire also includes items on food aversions, pregnancy-related dietary changes and eating habits, vegetarianism, fast food, and water consumption. DNBC interviews ask respondents about food supplements and seafood consumption during the prepartum period. During the postpartum period, women are asked questions related to breastfeeding and infant food.

Dr. Olsen described the method used to recruit mothers for the DNBC. He noted that the recruitment form (consent form) includes questions on use of food supplements prior to conception, including the name of the supplement and when it was taken. In addition to the requisite signature, the enrollment form elicits information such as:

- Expected delivery date
- When the woman can be interviewed
- Periconceptional use of dietary supplements
- Periconceptional use of drugs.

A woman is enrolled as soon as the consent form is completed and received the DNBC. Dr. Olsen concluded his discussion, explaining that recruitment for the study relies heavily on collaboration with 3,500 Danish general practitioners.

Summary of Breakout Session Discussions

Participants were assigned to five groups. Based on the presentations from Day 1, literature review findings, and discussion during the breakouts, participants were asked to decide on the most promising methods of measuring dietary intake in a large longitudinal study. Each group was asked to consider the following questions in framing their discussion and recommendations:

- Given the luxury of time, what pilot tests would you deem important before moving forward with a method? What are the most important research/knowledge gaps?
- Given no time, which methods do you consider to be most promising for use in this age for the Study? Why?
- What are the current problems/barriers with using these methods in the Study?
- Do you believe it is possible to overcome these problems/barriers? How?
- What are the implications for the major ethnic groups?
- What are the implications for assessing supplement intake?
- For those instruments that are most promising, what research, additional validation, or substudy within the Study would be needed to make this instrument(s) a viable option for measuring dietary intake in the Study?
- Are these instruments or methods sufficiently developed to provide continuity across time (looking at other methods recommended by the other groups)?

Group: Pregnancy and Lactation

Co-Chairs: Janet Rich-Edwards, Sc.D., Harvard University, and Nancy Potischman, Ph.D., National Cancer Institute, NIH, DHHS

Dr. Rich-Edwards began by mentioning that discussion in this group focused on several issues. These issues included timing of assessments, reliability of assessment instruments, and types of research studies needed.

The group first addressed when assessments should occur—both during pregnancy and postpartum. They concurred that the ideal model would be to get an estimate of preconception diet. They discussed using an FFQ, plus an addition to capture information on supplements. The time referent of this preconception FFQ would be the month before the last menstrual period (LMP). This would have to be recall (unless the Study includes a preconception cohort). The questionnaire would be administered at intake. Dr. Rich-Edwards noted that the group recognized that there would be a need to validate (or at least demonstrate the reliability) of such a questionnaire around recall.

The group also recommended administering a behavioral questionnaire that included pica and, eating patterns (including skipping meals and alcohol use) during early pregnancy. This questionnaire would be administered at the first visit.

The group then discussed administering another FFQ covering second trimester diet and supplements. This FFQ would also update the items from the first behavioral questionnaire. Ideally, this FFQ would be administered at 24–28 weeks, to coincide with the oral glucose test, so that the results of that test would not influence the reporting of diet.

The group recommended administering the questionnaires during the third trimester.

In discussing reasons for collecting information on postpartum diet, the group agreed that it would be important to recognize that maternal diet during lactation may affect child health. To capture that information, the group recommended using the postpartum obstetrical follow-up visit (between 4 and 8 weeks postpartum), even though they acknowledged that not all women come back for that visit. They recommended administering a 1-month FFQ with a component on supplements, as well as a behavioral questionnaire. The latter would include items covering foods that were avoided (because the mother was breastfeeding). Another item would query if the mother had weaned her infant before the office visit, and if her diet was different at this point than it was while she was lactating.

Finally, the group recommended designing a very brief FFQ that would update information on consumption of a specific nutrient, for example vitamin D. Dr. Rich-Edwards pointed out that this information could be elicited through a very few questionnaire items. The group further advocated using a behavioral questionnaire that would include items on foods avoided during lactation, as well as sun exposure.

The group next discussed the limits of the FFQ, principally:

- Making them more appealing
- Cognitive challenge
- Low literacy.

Dr. Rich-Edwards reported that the group discussed issues surrounding designing an FFQ that would accommodate different ethnic-specific diets. For example:

- Would a separate FFQ be required for each ethnic group being sampled?
- How would it be determined which FFQ would be used with a specific respondent?
- Would it be possible to design a Web-based format with “truncated” items branching off from the main questionnaire?

The group reiterated the need to develop the FFQ in multiple languages and to design a low-literacy version. The group strongly advocated using Web-based instruments in a clinic setting so that qualified staff would be available to provide technical assistance. The questionnaire, however, would be self-administered.

The group then discussed the types of studies that would be needed. For the pre-pregnancy diet, they suggested conducting a reliability study. This would involve, for example, administering a preconception FFQ, and then re-administering the questionnaire during pregnancy.

Dr. Rich-Edwards noted that the group felt strongly about the need for a calibration substudy (or substudies) within the cohort itself. The group advocated using four 24-hour dietary recall during the second trimester. They also emphasized the need to oversample minorities and teens. Finally, the group noted a need to pilot and validate questions related to behavioral eating patterns.

Group: Infant Breastmilk

Co-Chairs: Margaret Neville, Ph.D., University of Colorado Health Science Center, and Mary Frances Picciano, Ph.D., Office of the Director, NIH, DHHS

Dr. Picciano reported that this group recommended using a checklist/questionnaire as the measurement method based on the Ross Labs (RLMS) model. The group rationale for this methodology was twofold—it has been tested and it collects sound data.

Two main questions would be posed:

- What kind of milk is the child getting?
- Is the child getting any other kind of milk in addition as well?

Because the Study will be continually assessing body growth as a measure of development, the group advocated using growth as the proxy for adequacy. Two human milk samples would be taken to measure exposure to pesticides and other contaminants. Dr. Picciano pointed out that two samples would be necessary for mathematical modeling.

Ideally, breastmilk samples would be collected at 1, 3, 6, and 12 months using breast pumps in a clinic setting. The group recognized, however, that it would be more feasible to time the sample collection with well-baby visits—at 2 and 4 months to match the immunization schedule.

The group agreed that the cultural appropriateness of the questions will be critical. Dr. Picciano also pointed out that there was considerable overlap on this issue with the Infant Formula and Infant Food Intake group. Most of the research needs are related to the content of the questions, and if those questions are capturing the information.

In response to questions regarding the schedule for collecting samples, Dr. Picciano emphasized that if possible, taking breastmilk samples within the first month and again when the infant is 2 months old would be ideal. She also identified examples of other procedural issues that would need to be addressed:

- Amount of sample to be collected
- If and when to analyze the samples
- How to properly store samples.

Also, Dr. Picciano noted that the group also recognized that Dr. Ryan's experience has been that shorter intervals between sample collections tend to provide more accurate information.

Group: Infant Formula and Food Intake

Chair: Debbie O'Connor, Ph.D., R.D., University of Toronto

Dr. O'Connor summarized the group discussion, noting that if the Study begins in 2005, participants concurred that there would be no time to design new test methods for this age group.

For the first 6 months of life, the group recommended using an estimated 3-day FR. Unlike those used for adults, this format is actually a checklist, given that the child is not using solid foods. This format may be particularly practical with low-literacy groups. The FR would be administered at 1, 6, and 12 months. The group suggested providing bottles to improve measurements and standard calibration. The group also recommended that the FR includes boxes to check for breast milk, formula, spit up, and vomit.

The rationale for using a FR is that this is a critical period, and that not all hypotheses to be tested will be known in advance. Further the FR would provide broad-based information. The group agreed that this format will elicit a graded approach (for example, every time that the infant is fed, whether it is breast milk or formula). There is substantial documented experience in using this approach. Finally, the FR method provides a workable tool when dealing with multiple caregivers.

The group suggested the following timeframes:

- 1 month: Self-administered
- 6 months: Face-to-face (coinciding with well-baby visit, with onsite review of FR, using food models as reference)
- 12 months: Self-administered.

The group also recommended using telephone followup to prompt participants to complete their records. During the telephone call, the mother would be asked if she was still breastfeeding. If she responds that she has stopped breastfeeding, the caller would use standardized prompts to determine when the mother had stopped (for example, 3 months, 6 months, etc.). The caller would also use limited, standard prompts to determine if and when solids foods were introduced. The FR would be reviewed at 6 months.

Dr. O'Connor pointed out that the group had acknowledged that balancing amount of information and level of detail with respondent burden will be a challenge, not only for this age group, but also for the Study overall.

Dr. O'Connor then summarized challenges related to formula intake:

- Number and wide variety of formulas
- Multiple novel ingredients (which is likely to increase in the future)
- Changes in the names of formulas
- Homemade modifications to commercial formulas.

The group concurred that assessing solids is the most challenging aspect for children up to 12 months. Currently, there is no validated method for assessing dietary intake in this age group. Although the group noted that an FFQ might be promising, it is unlikely that this method could be finalized and ready within the next 2 years. Furthermore, several current FRs include components on supplements and complementary medicines, as well as solids.

Dr. O'Connor noted that the group advocated using a typical checklist diary. This format should be brief and preferably precoded. They also suggest using visual models for serving sizes. The group pointed out that many different types of infant formulas are now available. Therefore, it will important to collect information on formula nutrient composition and special ingredients.

The group acknowledged that another challenge will be accurate assessment of portion size and actual intake due to spitting and vomiting. Formula intake can be measured; picture prompts can be used to help assess portion size. The group emphasized the need to link amount of solid intake to toddler age.

Dr. O'Connor listed several issues related to studying ethnic groups:

- Introduction of solids
- Separate food lists
- Labeling
- Commercially prepared or homemade formulas and foods.

The group also discussed the implications of using solid food lists:

- Actual process
- Need to be brief
- Inclusion of culturally appropriate items
- Problems using an open-ended format
- Need for cultural sensitivity (that is, definitions of solid may differ).

Dr. O'Connor pointed out several overall issues identified by the group:

- If low literacy is equated with low SES, this group may experience the greatest impact from exposures
- Inclusion of Native Americans in the Study
- Inclusion of migrant workers
- Involvement of grandparents
- Designing (and formally reviewing) assessment instruments for a sixth-grade reading level.

The group recommended conducting a validation study, as part of test weighing, before launch of the Study. The group also suggested reviewing studies such as ALSPAC as possible models for the validation study. The group advocated conducting the validation study at 6 months, to run concurrently with breastfeeding and test-weighing validation, using DLW as the "gold standard."

Items of particular interest identified by the group included:

- Proportion of total energy accounted for
- Iron intake (issue of anemia after 1 year of age).

The group recommended conducting a calibration to check and review assessment methods. They also noted that many of the same issues are pertinent at 12 and 24 months. Therefore, the group recommended combining validation studies for these age groups.

Dr. O'Connor concluded by mentioning that the breast milk group and this group had agreed that it would be beneficial if the schedule for taking blood samples would coincide with the timing for collecting samples of breastmilk.

Group: Toddler and Preschool

Chair: Paula Ziegler, Ph.D., R.D., C.F.C.S., Gerber Products Company, and Co-Chair: Helen Smiciklas-Wright, Ph.D., Pennsylvania State University

Dr. Smiciklas-Wright reported that this group focused on identifying assessment methods that would provide the most comprehensible data, the most flexibility for analysis, and that would most likely be ready for the Study.

This group argued for a multiple method approach, with multiple days of 24-hour dietary recalls and a food behavior questionnaire. The 24-hour recalls would be collected for 3 days within a 2-week period. The group also noted the issues and burdens associated with the recommended approach. The recalls would include questions on dietary supplements, and the food behavior questionnaire (FBQ) would need to be developed. This questionnaire would focus on broad food groups (for example, breakfast versus cereal, fruit versus peaches), as well as some relevant food behaviors. The combined data from 24-hr recalls and FBQ would provide an opportunity for detailed nutrient and meal pattern analyses and allow for reasonable comparison with other data sets.

Given the limited time before Study startup, the group offered the following considerations:

- Pilot test the FBQ in daycare centers and with other child caregivers to determine what is practical and feasible.
- Pilot test instruments in major subgroups (cognitive testing to reliability).
- Provide an opportunity to refine and complete instruments for subgroups within the Study cohort.

Dr. Smiciklas-Wright pointed out that while workshop participants would agree about the challenges of proxy reporting, there were challenges related to proxy reporting that are somewhat unique to this age group. One of the most challenging issues is the amount of food intake that takes place away from the observations of the proxy recorder (generally thought of as the parent)—an issue critical to accurate assessment of dietary intake in this age group.

The group acknowledged the difficulty in overcoming the challenge presented by so much dietary consumption taking place outside the observation of the proxy reporter. The group discussed possibly working with daycare centers or other providers of food to these children to assist the Study in preparing easy-to-use checklists or pamphlets that they and the proxy reporter could use to collect and store information on the child's dietary intake. While recognizing the importance of this issue, the group emphasized that it was not an insurmountable problem.

Other challenges identified by the group included:

- Developing and validating FBQs
- Validating 24-hour DR in toddlers and ethnic age groups

- Selecting appropriate portion sizes aides for other 24HR dietary recalls
- Probing ethnic diversity (foods, recipes)
- Accounting for social desirability.

Dr. Smiciklas-Wright noted that issues related to ethnicity and data collection, reliability, and validity had been previously discussed. The group had discussed these issues including:

- Quantifying foods in the 24HR
- Training interviewers (for example, not making assumptions regarding recipes)
- Recognizing and accounting for cultural behaviors (for example, withholding food from child).

In emphasizing the importance of assessing intake of supplements, the group offered the following recommendations:

- Collect detailed information on supplements that can be separated from food analysis.
- Be sure that information is quantifiable (include questions in FBQ and FR recall to identify trends).
- Refer to NHANES to guide development of the data list.
- Include questions on multivitamins and minerals.
- Include items that probe for information on single nutrients (for example, iron, zinc, or vitamin C).

Dr. Smiciklas-Wright concluded by summarizing group recommendations for optimal timeframes for collecting data, as follows:

- At 18 months: Captures toddler period, compare to European studies
- At 3 years: Begins preschool period
- At 5 years: End of preschool years.

Group: School-Aged Children (6–11 years)

Co-Chairs: Susan Day, Ph.D., University of Texas-Houston Health Science Center, and Suzanne Domel Baxter, Ph.D., R.D., F.A.D.A., University of South Carolina

Dr. Day began by emphasizing that this timeframe will involve the greatest respondent burden because there will be two respondents—the child and the parent (and/or major caregivers).

Therefore, it is likely that several methodologies will be involved. The group advocated conducting a year-long random sample, covering:

- 24HR
- Propensity
- FFQ
- Checklist.

The group decided to examine the entire year, not just the school year. Dr. Day presented an overview of the assessment methods recommended by the group by age and school grade. They recommended that a food insecurity questionnaire would be administered during pregnancy and

when the child reached age 3, when the child entered the first grade, and during the sixth and ninth grades.

Specific to this age group, the workgroup suggested the following data collection methods and times:

Grade	Age	Method 1	Who	Method 2	Who
1st	6	3 nonconsecutive 24hr recalls 2 weekdays & 1 weekend supplements and herbals	Child Parent	Propensity	Parent
2nd	7	FFQ	Parent	Checklist supplements & herbals	Parent
3rd	8	3 nonconsecutive 24hr recalls 2 weekdays & 1 weekend supplements and herbals	Child Parent	Propensity	Parent
4th	9	FFQ	Parent	Checklist supplements & herbals	Child
5th	10	3 nonconsecutive 24hr recalls 2 weekdays & 1 weekend supplements and herbals	Child Parent (optional)	Propensity	Parent

The group advocated using a combination of methods including 24 HR recalls, FFQs, checklists, and propensity. As is indicated above, some would be with both parents and children, some with parents, and some with children only. The 24HR recalls would include supplement and herbal intakes and would be conducted on three days—two weekdays and one weekend day. The first two recalls would be conducted with the parent and child as respondents. The last recall in fifth grade would be conducted with the child, with an option of including a parent. In all instances, input from the school meals should be obtained and included as resource information for increasing the accuracy of the recalls and the food frequency reports.

The group further recommended the following structure for pilot testing these methods:

- For propensity: Review NHANES data on children and then determine appropriate approach
- For the FFQ and checklist: Develop a combination of the two to be completed by parents for second graders and fourth graders
- For the checklist: Allow the child to complete on his/her own by the fourth grade

- For the 24h recalls: Validation studies are needed to determine specific ages of children when recall accuracy is better for child-only recalls, parent-only recalls (of child's intake), or child/parent-joint recalls.

Dr. Day reported that the group had identified several issues surrounding pilot testing:

- Once the Study defines which ethnic groups will be included, all methods must be evaluated for cultural appropriateness.
- Automated methods may be more difficult for low-literacy groups within the overall Study cohort.
- Pilot tests should be conducted on multiple modalities for inclusion of all subgroups.
- Translations should be included.
- Food lists should be developed for each subgroup/population to be sampled.

Dr. Day noted that in their discussion of supplements, the group had listed several considerations for the Study:

- Using the NHANES methodology as a model
- Including vitamins and minerals, as well as culturally specific herbals
- Including supplements taken as health/sports enhancements and as home "remedies" or treatments.

Dr. Day ended her summary of this group's discussion noting that the group had also discussed the issue of food insecurity as an important component of obesity risk. Further, the group had emphasized the need for designing a pilot that would be conducted for each ethnic group that is to be included in the Study.

Group: Dietary Assessment for Adolescents

Co-Chairs: Deanna Hoelscher, Ph.D., University of Texas School of Public Health, Houston and Johanna Dwyer, Sc.D., R.D., Tufts University New England Medical Center

Dr. Hoelscher opened the discussion by listing issues identified by the group as relevant to this age group:

- Supplements to improve athletic performance
- Alcohol consumption
- Whether to allow for assistance from parents; if yes, how to structure that assistance
- Other environmental information, such as where the food was eaten or who the food was eating with (peer influences)
- Ethnic/racial differences
- Age-related compliance
- Covariates that affect dietary intake, such as BMI, social desirability, restrained eating
- Tracking adolescents (using current technologies such as Instant Messenger [IM], e-mail, cell phones)
- Rapidly changing eating habits
- Unstructured eating/eating patterns
- Difficulty with time reference.

Dr. Hoelscher further summarized issues relevant to current methodologies:

- Dietary assessment methods are not designed for teens.
- Research in schools is difficult.
- Noncompletion may be greater due to time constraints, boredom, and lack of interest in the Study.
- Interviewing must include portions, especially large portion sizes.
- Assessment of dietary supplements should include nonnutrients as well as nutrients.

Dr. Hoelscher noted that the group identified several issues relevant to pilot tests or substudies of dietary assessment within this age group:

- Consider new methods and technologies as well as how they fit with what was collected in the past.
- Some measure of usual food intake is critical; differences in methods over time are less important.
- Conduct calibration or bridging studies among various groups to be sure that measures are compatible with each other.
- There may be a need to tailor methods for different ethnic groups.
- Explore using checklists in more detail.

Dr. Hoelscher also pointed out that the group recommended conducting a validation study that would include all of the proposed methods. The group also advocated that Study should convene special working groups to conduct methodological tasks for assessment of this age group.

Dr. Hoelscher reported that the group recommended using multiple FRs with overlap of an FFQ. Because there are significant developmental differences in the 12 to 16-year-old age groups, ideally, the data instrument should be administered each year. However, the group recognized the burden of such a schedule, and so alternately, suggested administering the questionnaire at junior high and then again during high school.

The group recommended that the 24-hour FR should be designed in Web-based format with print backup; the FFQ also should be Web based, if possible.

The group also identified several key issues related to this approach:

- The teens themselves will be the respondents.
- It is vital to determine the priority of the Study objectives (for example, obesity, antioxidants total diet, or glucose metabolism) for final determination of which method to use, as well as for frequency of administration.
- Because assessment of this age group will not occur for 12–14 years, conduct formative research to determine which methods can be used for these purposes.
- Recruitment and retention of the cohort is vital during adolescence, especially when dealing with diet.
- The assessment method must be user-friendly and designed especially for teens, with appropriate incentives.
- Preferably public use, but may need to use proprietary tools.

Dr. Hoelscher summarized several problems/barriers that the group identified in use of these methods in the Study:

- Lack of methods that are highly valid for identifying food and sizes and that are likely to be used by respondents on a continuing basis
- The need to make the assessment method novel, fun, and interesting
- The need to test automated systems with assessment methods
- The need for early validation in the Study
- Concerns related to Institutional Review Board (IRB) human subjects (for example, once a subject is 18 years old, he or she may not wish to be included, resulting in many incomplete questionnaires).

When considering how to overcome these barriers, the group proposed several recommendations:

- Convene a methods working group.
- Recognize that developmental work is crucial.
- Establish close working relationships with experts in current technologies (e.g., Internet-based, digital cameras, etc.).
- Solicit the support of media and marketing groups with expertise in targeting teens.
- Use only validated methods.
- Establish partnerships with children in the Study early on so that they will be motivated to participate as teens.

In discussing implications for major ethnic groups, Dr. Hoelscher listed several issues:

- Social issues related to diet (who teens eat with, where they eat meals, what meals they eat, etc.)
- Teen knowledge of names of foods
- Language (although most teens speak English)
- Mixed dishes and variation among various ethnic groups
- Contents of ethnic-specific foods
- Appropriateness of some assessment instruments for use with certain ethnic groups.

Dr. Hoelscher pointed out that the desired level of detail will determine supplement assessment. She presented several issues discussed by the group related to supplement intake:

- Without data on total dietary intake, it will be difficult to associate diet with health outcomes. (Nutrient-containing supplements contribute to the total intake of some nutrients).
- It is unclear how various non-nutrient dietary supplements are used in this age group.
- Approximately 20–30 percent of teens use dietary supplements; within that group a number of teens use multiple supplements and supplements other than nutrients.
- Some supplements may be contaminants; others may interact with nutrients and should be considered.
- The degree of precision needed for nutrient-containing supplements needs to be determined.
- A method is needed for combining supplement and food information.
- The level of detail collected for each respondent will depend on the specific goals of the Study. Anticipate needing data on the use of antioxidants, iron, calcium, vitamins C and E and multivitamins.

Dr. Hoelscher presented several suggestions from the group for making the 24HR methodology viable for the Study:

- Conduct more early developmental research.
- The “5 pass” or similar system may need to be examined to determine which passes are most important and if this method works in a self-administered format.
- Conduct validation versus observation studies.
- Ensure that this format works in all ethnic groups and in all ages.
- Include a portion on nutrient-containing supplements.
- Develop in Web-based format that is user-friendly and compatible.
- Ensure that the format is interesting and entertaining.

The group also listed several recommendations for making the FFQ/checklist method a viable option for measuring dietary intake among teens enrolled in the Study:

- Conduct more developmental background research early on.
- Design the FFQ in a self-administered, user-friendly Web-based format.
- Validate the FFQ against observation and other criteria.
- Ensure that the questionnaire works in all age and ethnic groups.
- Include a portion on nutrient-containing supplements.
- Ensure that the questionnaire is fun and interesting.

The group further recommended several requirements to sufficiently develop the recommended assessment methodology:

- Establish a nutrition coordinating center to conduct calibration or bridging studies.
- Use multiple 24HRs.
- Allow for altering the FFQ over time.
- Include contextual material on social and physical environment in which eating occurs (place, time, etc.).
 - Obesity and insulin resistance:
 - Need physical activity as well
 - Asthma may be linked to obesity
 - Energy total but FFQ does not get it, and unclear that the 24 hr recall does either with differential underreporting of energy
 - Causes of obesity, whatever they may be
 - Number of eating occasions, food patterns, milieu, who person eats with, where they eat, etc.
 - Get social desirability scales (several are available) and see if this is feasible and related to food intake
 - Asthma:
 - Antioxidants
 - May need to be able to get down to botanical families for allergies with cross reactivity issues; need to know specific allergies of interest that are highly associated with asthma.

Dr. Hoelscher concluded by summarizing issues emphasized during the group discussion:

- No one method can be used for all ages with all people.
- The most appropriate method may be a combination of an automated 24HR and checklist FFQ.
- A Web-based, self-administered format is currently optimal for use with teens.
- The Study should capitalize on the lag time available before startup of the teen component of the Study.
- Physical activity and other family and social covariates should be included in the dietary assessment.

Offer entertaining and appealing incentives to ensure teen participation.

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