American Society for Nutrition Webinar Series

Webinar 2: Measuring and Monitoring Individual Dietary Intake and the Food Environment

January 18, 2017
Faculty

Speakers

Susan Krebs-Smith, PhD, MPH
Branch Chief, Risk Factor Assessment Branch
Division of Cancer Control and Population Sciences
National Cancer Institute, National Institutes of Health

Deborah Galuska, PhD
Associate Director of Science
Division of Nutrition, Physical Activity, and Obesity
Centers for Disease Control and Prevention

Christine Pfeiffer, PhD
Chief, Nutritional Biomarkers Branch
Division of Laboratory Sciences
National Center for Environmental Health
Centers for Disease Control and Prevention

Moderator

Rachel Ballard, MD, MPH
Director, Prevention Research Coordination
Office of Disease Prevention
National Institutes of Health
Learning Objective

At the end of this program, attendees will be able to:

- Describe research gaps and opportunities, including the open funding opportunity announcements, training activities, and research resources related to measuring and monitoring dietary intake and the food environment, as found in the National Nutrition Research Roadmap.
Measuring and Monitoring Individual Dietary Intake

SUSAN M KREBS-SMITH, PHD, MPH
## Disclosures

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Gaps

Resources

Opportunities
Gaps
Key Research Priorities for 2016-2021

- How can we better understand and define eating patterns to improve and sustain health?
- What can be done to help people choose healthy eating patterns?
- How can we develop and engage innovative methods and systems to accelerate discoveries in human nutrition?
Key Research Priorities for 2016-2021

- How can we better understand and define eating patterns to improve and sustain health?
- What can be done to help people choose healthy eating patterns?
- How can we develop and engage innovative methods and systems to accelerate discoveries in human nutrition?
How do we enhance our understanding of the role of nutrition in health promotion and disease prevention and treatment?
How do we enhance population-level food- and nutrition-related health monitoring systems ...?
How can we enhance innovation in measuring dietary exposure, including use of biomarkers?
Resources
# Measures Registry

## Filter options

- **Search**
  - Contains

- **Domain**
  - Individual Dietary Behavior (326)
  - Food Environment (329)
  - Individual Physical Activity Behavior (397)
  - Physical Activity Environment (259)

- **Measure Type**
  - GIS (127)
  - 24-hour dietary recall or food frequency (119)
  - Electronic monitor (121)
  - Environmental observation (153)
  - Questionnaire (486)
  - Record or log (97)
  - Other (200)

- **Age**
  - 2 – 5 Years (233)
  - 6 – 11 Years (506)
  - 12 – 18 Years (442)
  - Adult (311)

## Results

Showing 1–25 of 1186 matching measures

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<thead>
<tr>
<th>Measure Name</th>
<th>First Author</th>
<th>Year Published</th>
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<tr>
<td>21–Item Dietary Fat Screener for Adolescents</td>
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<td>24-Hour Recalls for 7 to 17 Year Olds</td>
<td>Offerling NJ</td>
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<td>24-Hour Dietary Recall Interviews of Students</td>
<td>Fulker JN</td>
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<td>24-Hour Dietary Recall Using EPIC-Soft for 7 to 13 Year Olds</td>
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<td>24-Hour Dietary Recall for 10 Year Olds</td>
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<td>Hajduk CL</td>
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https://tools.nccor.org/measures
# Dietary Assessment Primer Roadmap

<table>
<thead>
<tr>
<th>What would you like to do?</th>
<th>Visit this section</th>
<th>Components</th>
</tr>
</thead>
</table>
| Learn about self-report dietary assessment instruments. | Instrument Profiles | • 24-hour recall (24HR)  
• Food record (FR)  
• Food frequency questionnaire (FFQ)  
• Screeners |
| Learn about key concepts in dietary assessment. | Key Concepts | • Measurement error  
• Validation |
| Choosing an Approach for Dietary Assessment | Choosing Dietary Assessment Instruments | • Principles Underlying Recommendations  
• Details of Recommendations and Further Considerations |
PhenX Toolkit

Browse Measures

Browse through Measures to view Protocols.

Browse » Domains »

DOMAIN: Nutrition and Dietary Supplements  050000
Release Date: 1-Oct-15
View scope of domain »  View Working Group Roster »
View Supplemental information »  View Archived Protocols »
View Expert Review Panel Roster »

Add to My Toolkit: #050100 Breastfeeding »  Add to My Toolkit: #051300 Iodine »
Add to My Toolkit: #050300 Caffeine Intake »  Add to My Toolkit: #050800 Percent Energy from Fat »
Add to My Toolkit: #050200 Calcium Intake (Daily) »  Add to My Toolkit: #050900 Selenium »
Add to My Toolkit: #050400 Dairy Food Intake (Daily Servings) »  Add to My Toolkit: #051400 Sodium »
Add to My Toolkit: #050500 Dietary Supplements Use »  Add to My Toolkit: #051000 Sugar Intake (added) »
Add to My Toolkit: #050600 Fiber Intake »  Add to My Toolkit: #051200 Total Dietary Intake »
Add to My Toolkit: #050700 Fruits and Vegetables Intake »  Add to My Toolkit: #051100 Vitamin D »

https://www.phenxtoolkit.org/
ASA24
Automated Self-Administered 24-hour Recall

2,874 studies
272,062 recalls or records

Number of studies registered and number of diet recalls or records collected from June 2009 to December 2016.

Researchers register a study
Respondents complete dietary recalls or records
Researchers monitor responses and obtain data analysis

https://epi.grants.cancer.gov/asa24/
The NCI method can be used to estimate:

• the distribution of usual food or nutrient intake for a population or subpopulation;

• food or nutrient intake for use in a disease model; and

• the effects of individual covariates on food or nutrient consumption.

SAS macros are currently available to facilitate modeling.
United States Department of Agriculture
Agricultural Research Service
USDA Food Composition Databases

[Website Link]

Select Source: All Data Sources...  
Enter one or more terms: For example: raw broccoli  
Select Food Group: All food groups...  
Select Manufacturer:  

77,055 foods found. Click on a food name to view details.

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<th>NDB No.</th>
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<td>ABBEY FARM, RHUBARB &amp; GINGER PRESERVE, UPC: 763242039022</td>
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<td>45103127</td>
<td>ABBOTSFORD FARMS, CAGE FREE 100% LIQUID EGG WHITES, UPC: 014616221100</td>
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<td>45049278</td>
<td>ABC, CREAMY PEANUT BUTTER, UPC: 837991211289</td>
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<td>45091765</td>
<td>ABC, JELLY SNACK, TARO, UPC: 4711269687135</td>
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<td>45044776</td>
<td>A&amp;B FAMOUS, OLD FASHIONED HOMESTYLE GEFILTE FISH, UPC: 732973000212</td>
<td>Branded Food Products Database</td>
</tr>
<tr>
<td>09427</td>
<td>Ablyuch, raw</td>
<td>Fruits and Fruit Juices</td>
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https://ndb.nal.usda.gov/ndb/search/list
1. **Parent Company** (Manufacturer, Subsidiary, signature line) or **Private Label** (signature line)
   - Enhanced database will allow for more specific data collection and analysis in NHANES, allowing for more specific assessment of foods eaten by the population.

2. **Nutrition Facts Panel** (NFP) and **Expanded Facts Panel** (when available)
   - Information available “as packaged” and “as prepared”, with added ingredients
   - No longer will a nutritional value be based on an averaged or generic database value.

3. **Product name and generic descriptor**

4. **Weights and measures**

5. **Serving size and servings per package**

6. **Date Stamp** associated with most current formulation (effective date of change/introduction)
   - Historical data on food products will allow for tracking dietary trends.

7. **Ingredient list and sub-list** (hierarchical and in descending order)
   - This information has never been captured before in the National Nutrient Database. Having this information available will allow for analysis that has never been done.

8. **GTIN Number**
   - Specific nutrient composition directly from the food product, correlated to this number, will be available.
HEI-2010

ADEQUACY

• Total fruit (5)
• Whole fruit (5)
• Total vegetables (5)
• Greens & beans (5)
• Whole grains (10)
• Total protein foods (5)
• Seafood & plant proteins (5)
• Dairy (10)
• Fatty acids (10)

MODERATION

• Refined grains (10)
• Sodium (10)
• Empty calories (20)

Total score (100)

https://www.cnpp.usda.gov/healthyeatingindex
Opportunities
“...even a small insect is much more complicated than a star, and... everything about humans is very complicated...”

Considering the confusion about diet: “It’s not that the people working in those fields are less competent, it’s that anything to do with humans and their behavior ... is far more complicated than the cosmos...”

Lord Martin Rees, Cosmologist and Astrophysicist; *On Being*, Nov 21, 2013
Food Stream

- Loss-adjusted food availability data
- Fast food restaurant menus
- Grocery store circulars
- Typical grocery baskets
- Food pantry offerings
- Usual diets
- Food consumed from various sources/times of day
Multidimensionality

Food groups

- Fruit
- Vegetables
- Whole grains
- Legumes
- Nuts
- Fish
Multiple dimensions compound complexity

SYNERGY

INTERACTIONS
Short-term dynamism
Long-term dynamism

| In Utero | Infancy and Childhood | Adolescence | Adulthood | Older Adulthood |
Putting it all together

<table>
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<tr>
<th>In Utero</th>
<th>Infancy and Childhood</th>
<th>Adolescence</th>
<th>Adulthood</th>
<th>Older Adulthood</th>
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<tr>
<td>Prevention</td>
<td>Screening</td>
<td>Diagnosis</td>
<td>Treatment</td>
<td>Survivorship through end of life</td>
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Core values:

Participation is open to all.

Participants reflect the rich diversity of the U.S.

Participants are partners.

Participants have access to their information.

Data will be accessed broadly for research purposes.

Security and privacy will be of highest importance.

The program will be a catalyst for positive change in research.
Diet and Physical Activity Assessment Methodology

PAR-15-171 (R21) & PAR-16-167 (R01)

Encourages innovative research to enhance the quality of measurements of dietary intake and physical activity. Includes development of:

- novel assessment approaches
- better methods to evaluate instruments
- assessment tools for culturally diverse populations or various age groups, including children and older adults
- improved technology or applications of existing technology
- statistical methods/modeling to improve assessment and/or to correct for measurement errors or biases
- methods to investigate the multidimensionality of diet and physical activity behavior through pattern analysis
- integrated measurement of diet and physical activity along with the environmental context of such behaviors.

One area that’s likely to get some attentions in the plan is dietary assessments that rely on patient recall—a notoriously unreliable method of data collection. “This is currently the state of the art, so we’ve not been able to measure accurately what and how much we’re eating,” Rodgers said. He added that researchers are currently developing innovative smartphone apps and other technologies that could lead to more objective and accurate ways to measure food intake and physical activity.

**Dr. Rodgers:** An emerging and very interesting area in terms of food intake relates to the timing of the meal. Studies in mice suggest that restricting eating to shorter periods during the day might lead to metabolic benefits that could promote weight loss even if you don’t reduce the calories. We know from several studies that healthy metabolism is tied closely to circadian rhythms and that our bodies more effectively process and digest foods during the day.
Thank you!
Assessing the food environment

Deb Galuska, MPH, PhD
Centers for Disease Control and Prevention
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Changing nutrition behaviors

Change individual knowledge, attitudes and skills
Making the healthy choice the easy choice

Early Care and Education

Health care

Schools

Communities

Worksites
Changing nutrition behaviors

Change individual knowledge, attitudes and skills

Provide supportive environments
Tools for assessing the food environment

• Methods for obtaining information
• Types of information collected
• Use of the tools
• Examples
• Research challenges and opportunities
Methods for obtaining information

• Reports
  – Persons affected by the place
  – Staff, managers or key informants in the place

• Audits
  – Self
  – Outside
Reports

• Advantages
  – Less labor intensive
  – Easier to incorporate into existing surveys

• Disadvantage
  – Perception may not be reality
Audits

• Advantages
  – More objective
  – Can be more comprehensive

• Disadvantages
  – Labor intensive
  – Standard tools may not work in all environments
Types of information

• Policies (what’s planned)
  – Presence
  – Quality

• Environment (what’s being done)
  – Foods/beverages present
  – Pricing
  – Practices
How are instruments used?

- Identify and track population-wide problems
- Inform place based planning
- Examine associations between supports and dietary behaviors
Examples
Medical Setting: Maternity Practices in Infant Nutrition and Care (mPINC)

- Approximately 60 items
- Census survey of maternity care facilities
- Self-report of key informant
- 7 domains of hospital policies and practices related to maternity care
- Used for tracking, association research and place based interventions
Example of use: Place-based planning
Child care: Environment and Policy Evaluation and Observation

• Audit
  – Day long observation of provisions and practices related to nutrition and physical activity
  – Document review of policies
• Developed for use in a child care intervention (NAP SACC)
• Modified to be self-report and shorter (EPEO-SR)
Worksites: CDC Worksite Health Score Card

- Assesses evidence based strategies in worksites to prevent chronic disease
- Self-report of key informant team
- Includes 13 questions on nutrition
  - Types of foods served in venues
  - Labelling and promotion
  - Pricing
- Used as first step in worksite interventions
Community Food Retail: Nutrition Environment Measures Surveys (NEMS)

- Audits
- Original tools
  - Restaurant (NEMS-R)
  - Stores (NEMS-S)
- Modified for use in other settings and venues
- Assess availability, pricing, promotions, facilitators and barriers
- Used to:
  - Document health environment in communities
  - Link to health outcomes
  - Information for place based interventions
Communities:
National Survey of Community-Based Policy and Environmental Supports for Healthy Eating and Active Living

- Approximately 25 item questionnaire
- Policy supports for diet and physical activity in local governments
- Diet supports
  - Nutrition standards
  - Public transportation
  - Healthy food retail
- Report of city manager or person with similar expertise
- Used in national survey to assess current state of municipal governments
Challenges

• Defining key constructs

• Validity and reproducibility
  – Usual practices
  – Multiple data collectors
  – Accuracy of self report

• Translation of findings
Research opportunities

• Constructs
  – Link policy and environment to behaviors
  – Feasibility of different strategies
  – Effectiveness of different strategies

• Instruments
  – New instruments
  – Modify existing instrument

• Innovative data sources and linkages

• Translation and communication
Summary

• **Supportive environments** are needed.

• **Instruments** to assess these environments are needed.

• **Research** to develop and use these instruments is needed.
Funding and Resources

• Funding (www.grants.gov)

• Resources
  
  **CDC**
  – Worksite Health Scorecard
  – School Health Index
  – Maternity Practices in Infant Nutrition and Care (mPINC) Survey
  – Healthy Hospital Food and Beverage Environment Scan

  **NCCOR**
  – Measures Registry
Biomarkers of dietary status

Christine M Pfeiffer, PhD
Chief, Nutritional Biomarkers Branch


Measuring and monitoring individual dietary intake and the food environment

January 18, 2017
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Presentation outline

- Biomarker measurement and interpretation: research gaps/needs vs. research advances/innovations
  - Folate
  - Vitamin D
  - Sodium
- Available resources and tools
- Future opportunities
The ideal nutritional biomarker

Represents intake, function, and status

Can be easily measured:
- Inexpensive assay
- Need only small amount of biological specimen
- Compound is stable
- Assay is widely available, accurate, precise, sensitive, and specific

Does not have large biologic variation

Is not confounded:
- Lifestyle (smoking)
- Physiologic condition (fasting, pregnancy)
- Disease (kidney function)
- Use of drugs

Laboratory results can be interpreted (cutoff values, reference ranges)

Source: Pilankasambad.blogspot.com
Folate
Folate biomarkers

- Serum folate – short-term status, recent intake
- Red blood cell folate – long-term status, tissue stores
- Plasma homocysteine – functional status marker; not specific for folate
- Serum unmetabolized folic acid – marker of folic acid intake?

“Folate” – generic term for a group of folate derivatives
- Susceptible to oxidation, decomposition, and interconversions

Reduction to dihydro- and tetrahydrofolates

Polyglutamation in cells

Different substituents at N-5 and N-10
Folate – Research gaps and needs (1)

- Clinical methods (different platforms represented by colored bars in figures) for serum and red blood cell (RBC) folate produce widely different results.

Source: UK NEQAS Haematinics PT Program 2012 (with permission)

- Lack of certified reference materials for total folate and of accuracy-based proficiency testing (PT) programs.
Folate – Research gaps and needs (2)

- Data from different studies or different study periods cannot be easily compared; to evaluate long-term trends, data need to be adjusted if different assays have been used.

![Graph showing serum folate levels over NHANES survey periods](image)

- BioRad RIA adjusted to microbiologic assay
- Post-fortification
- Microbiologic assay

Pfeiffer et al. JN 2012
Folate – Research gaps and needs (3)

- Confusion about cutoff values used to estimate prevalence of low folate status
  - Type of deficiency (megaloblastic anemia, metabolic abnormality, risk of NTD)
  - Assay used to derive cutoff (microbiologic assay, BioRad RIA)

NHANES 1988-1994

![Graph showing risk of megaloblastic anemia for serum folate and RBC folate with assay-matched and assay-mismatched cutoffs]

Pfeiffer et al. AJCN 2016
Folate – Research advances and innovations

- Highly specific LC-MS/MS methods to measure individual folate derivatives; low-tech/field-friendly methods under development
- New cutoff value for RBC folate concentrations for risk of NTD in women of childbearing age
- Certified reference materials for serum folate under development
- Discussions on meaning of cutoffs and impact of applying inappropriate cutoffs on prevalence
Vitamin D
Vitamin D – Research advances and innovations

- Accurate and precise LC-MS/MS reference measurement procedures have been developed for 25(OH)D metabolites
- Certified reference materials for serum 25(OH)D are available
- Accuracy-based proficiency testing programs are available
- Long-term vitamin D status of U.S. population described with more confidence (Schleicher et al. 2016 AJCN)

- The NIH/ODS Vitamin D Standardization Program (VDSP) is harmonizing national survey data for serum 25(OH)D among different countries
- The CDC Vitamin D Standardization Certification Program (VDSCP) is improving the accuracy and comparability of clinical and research serum 25(OH)D assays

![Graph showing mean absolute bias, %](Source: CDC VDSCP 2016 (with permission))

**Table 1:**

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<th>Level</th>
<th>2013 Before start of Program</th>
<th>2015 After start of Program</th>
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<td>30 nmol/L (Insufficient Vitamin D)</td>
<td>13.9</td>
<td>5.2</td>
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<tr>
<td>50 nmol/L (Adequate Vitamin D)</td>
<td>11.2</td>
<td>3.0</td>
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Source: CDC VDSCP 2016 (with permission)
Sodium
Sodium intake biomarker

- **Urine sodium from a complete 24-h urine collection** is the recommended biomarker to monitor the population’s sodium intake because ~90% of sodium ingested is excreted in urine
  - 24-h urine collections are challenging, burdensome for the participant, and could negatively affect the quality of samples or the response rate
  - Spot urine samples are more easily accessible
Sodium – Research gaps and needs

- No national information on temporal trends of observed 24-h urine Na excretion as a biomarker of sodium intake
- National trend information in adults is based on spot urine samples and estimated 24-h urine Na excretion (using published equations)
- Increase in BMI from 1988-2010 explained small increase in estimated 24-h Na excretion over that time period
Sodium – Research advances and innovations (1)

- Utility of published equations to estimate 24-h urine Na excretion from spot urine compared to observed 24-h urine Na excretion in young U.S. adults
- INTERSALT equations provided least biased information about group mean Na intake
- Spot urine was an inadequate predictor of individual 24-h urine Na excretion

![Graph showing CDC 24-h urine Na excretion validation study in adults 18-39 y](Cogswell et al. AJCN 2013)
Sodium – Research advances and innovations (2)

- New approach to working with spot urine samples: usual 24-h Na excretion (combination of two spot urine samples: evening and overnight void) provided the least bias compared to the observed 24-h urine collection.
- This could be a low-burden, low-cost alternative to 24-h urine collections in monitoring population sodium intake among healthy young adults.

CDC 24-h urine Na excretion validation study in adults 18-39 y
Available resources & tools
Resources & tools regarding nutritional biomarkers

- NHANES 2003–2006
- 58 biomarkers
- Reference intervals
- Prevalence
- Trends over time

www.cdc.gov/nutritionreport

www.surveytoolkit.micronutrient.org/
Future challenges & opportunities
Challenges & opportunities

- Improve comparability of analytical methods for nutritional biomarkers
- Devise novel and reliable field tools for nutritional biomarkers
- Investigate relationship/interaction of nutritional biomarkers with genetic background
- Develop and validate new biomarkers of function
- Clarify the role of nutritional status with regards to health outcomes
- Find better approaches to gauge nutritional sufficiency than through the use of cutoff values
- Secure resources to ensure a continued monitoring of key nutritional biomarkers in national surveys and a periodic monitoring of lower priority biomarkers
Acknowledgments

Staff of the Nutritional Biomarkers Branch
Colleagues at NCHS/NHANES, NIH/ODS, NIST

Questions?

For more information please contact Centers for Disease Control and Prevention

1600 Clifton Road NE, Atlanta, GA 30333
Telephone: 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348
Visit: www.cdc.gov | Contact CDC at: 1-800-CDC-INFO or www.cdc.gov/info

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.
<table>
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<th>Title</th>
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<td>PAR-13-365</td>
<td>Evaluating Natural Experiments in Healthcare to Improve Diabetes Prevention and Treatment</td>
<td>R18</td>
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<td>PA-08-192</td>
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Questions & Answers

- Please email any questions you have to info@nutrition.org. Please include “Webinar” in your subject line.

- We will review questions and post “Frequently Asked Questions” on our webinar page on nutrition.org.
Thank you for joining us!

Make plans to participate in our next webinar:


Wednesday, February 1, 2017
3:00 pm - 4:00 pm (ET)

Visit www.nutrition.org for details.