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Research and Practice Innovations

Computerized Portion-Size Estimation Compared to Multiple 24-Hour Dietary Recalls for Measurement of Fat, Fruit, and Vegetable Intake in Overweight Adults

DEBORAH J. TOOBERT, PhD; LISA A. STRYCKER, MA; SARAH E. HAMPSON, PhD; ERIKA WESTLING, PhD; STEVEN M. CHRISTIANSEN;
THOMAS G. HURLEY, MS; JAMES R. HÉBERT, ScD, MSPH

ABSTRACT

Validated self-report methods of dietary assessment exist and might be improved in terms of both accuracy and cost-efficiency with computer technology. The objectives of this preliminary study were to develop an initial version of an interactive CD-ROM program to estimate fruit, vegetable, and fat intake, and to compare it to multiple 24-hour dietary recalls (averaged over 3 days). In 2009, overweight male and female adults (n=205) from Lane County, OR, completed computerized and paper versions of fruit, vegetable, and fat screening instruments, and multiple 24-hour dietary recalls. Summary scores from the 10-item National Cancer Institute Fruit and Vegetable Scan and the 18-item Block Fat Screener were compared to multiple 24-hour dietary recall−derived fruit/vegetable and fat intake estimates (criterion measures). Measurement models were used to derive deattenuated correlations with multiple 24-hour dietary recalls of paper and CD-ROM administrations of Fruit and Vegetable Scan fruit intake, vegetable intake, and fruit and vegetable intake, and Block Fat Screener fat intake. The computerized assessment and paper surveys were related to multiple 24-hour dietary recall−derived fruit/vegetable and fat intake. Deattenuated correlation coefficients ranged from 0.50 to 0.73 (all $P \leq 0.0001$). The CD-ROM−derived estimate of fruit intake was more closely associated with 24-hour dietary recall ($r=0.73$) than the paper-derived estimate ($r=0.54$; $P<0.05$), but the other comparisons did not differ significantly. Findings from this preliminary study with overweight adults indicate the need for additional enhancements to the CD-ROM assessment and more extensive validation studies.
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D. J. Toobert and S. E. Hampson are senior research scientists, L. A. Strycker is a senior research associate, and E. Westling is a research associate, all at Oregon Research Institute, Eugene, OR. S. M. Christiansen is President, InterVision Media, Eugene, OR. T. G. Hurley is a senior biostatistician and manager of the Diet Assessment Unit and J. R. Hébert is a Health Sciences Distinguished Professor, Cancer Prevention and Control Program and Department of Epidemiology and Biostatistics, Arnold School of Public Health, University of South Carolina, Columbia.

Address correspondence to: Deborah J. Toobert, PhD, Oregon Research Institute, 1715 Franklin Boulevard, Eugene, OR 97403-1983. E-mail: deborah@ori.org

Validated self-report methods of dietary assessment might be improved in terms of accuracy and cost-efficiency with computer technology (1,2). Accurate dietary measurement is necessary for developing and testing dietary interventions to reduce obesity and to address other diet-related medical concerns. Traditional dietary assessment techniques are subject to portion size and other inaccuracies (3-6), and studies using biomarkers indicate that self-report instruments generally result in under-reporting of energy intake (7-14).

Given the known inaccuracies in serving-size estimation (15), various methods have been used to verify serving sizes, including weighed food records (16), special plates and bowls (17-19), direct or covert observation (20,21), matching foods to models (22), two- or three-dimensional realistic or abstract aids (23-27), portion-size photographs (28,29), food models plus photos (4), and portion-size photographs compared to self-served foods (30). Nelson and colleagues (2) showed that using multiple photographs was more accurate than a single, average-portion photograph. However, Beasley and colleagues (31) found that a Web-based dietary history questionnaire using food photographs had comparable reliability and validity as the paper version, but did not improve the relationship of the diet history questionnaire to other food intake measures (eg, 24-hour dietary recalls, food records).

A few serving-size estimation trials have used computer technology (30,32-34). A Web-based serving-size estimation program by Riley and colleagues (35) shifted under- to overestimation. An interactive serving-size assessment by Foster and colleagues (36) produced estimates closer to the actual weight of the food compared to food models and photographs. A key advantage of computerized dietary assessment is that users can adjust the size of on-screen servings to match intake (2,37-39). Other potential benefits are multilingual and low-literacy

capacity (40), increased engagement (41), and accessibility for ethnically diverse subgroups (42-46). Existing validations of standard dietary assessment methods indicate that <50% of the variability in the true criterion method is accounted for by standard test methods, including doubly labeled water (47,48). Reporting accuracy depends on estimating portion sizes of food consumed, as well as bias, forgetting, and other sources of inaccuracies. Therefore, opportunities exist for potentially improving the accuracy of brief screeners and other frequency methods with the use of interactive visual information. Because rates of overweight and obesity among adults are especially troublesome, there is a need for accurate dietary estimation and effective dietary interventions in this population.

The purpose of the present study was to develop a preliminary version of an interactive computer program (CD-ROM) to estimate fruit, vegetable, and fat intakes, and then correlate these estimates with multiple 24-hour dietary recalls (averaged over 3 days) in a sample of overweight adults. The CD-ROM−based program was built on methods developed previously and/or tested by Block and colleagues (49), Thompson and colleagues (50,51), and Peterson and colleagues (52). The primary research question was: Can a computer program be designed to provide estimates of fruit, vegetable, and fat intake that are more highly correlated with the multiple 24-hour dietary recall estimates than paper versions?

METHODS
Sample
A total of 207 overweight or obese adults was recruited and enrolled in the study from June 2007 through November 2009. Participants were paid $50. The Oregon Research Institute Institutional Review Board approved the study protocol and all participants provided written informed consent. Power analyses indicated that with 200 individuals, the study had sufficient power to detect medium to small effects ($R^2=0.05$).

Interactive CD-ROM Program
Two widely used dietary screeners were adapted for the CD-ROM program: the National Cancer Institute's revised Fruit and Vegetable Scan (51-55) and the Block Fat Screener (49). The Fruit and Vegetable Scan assesses frequency of eating nine food categories, includes four portion-size options, and estimates daily servings of fruits and vegetables using the 1998 US Dietary Assessment Food Guide Pyramid−defined servings (56). The original Block Fat Screener (49,55,57) consisted of foods from the Second National Health and Nutrition Examination Survey that primarily contribute to fat intake. Fried chicken, pizza, and ice cream were added because of their high fat content and popularity (58). A fourth portion-size option was added to the Block Fat Screener to parallel the Fruit and Vegetable Scan. Respondents reported food intake during the past 2 months.

The computer program featured life-sized color photographs for each portion size of each food on the Block Fat Screener and Fruit and Vegetable Scan. Photographs were taken at an angled perspective similar to that experienced by a person seated at the table. Foods were cooked and styled as they are most commonly prepared and served. Each food serving was shown on the same dining plate, with silverware, napkin, and placemat as size referents (18). Most foods were photographed in multiple forms (eg, mashed or baked potatoes). For each food, users first chose the form in which they wanted to view the food. Then, presented with a full-sized on-screen image of the food, users could use a slider bar to view four different portion sizes before selecting their own serving. To reduce response bias, options were not labeled "small," "medium," "large," and "super-size"; they were shown as four points, with measurement information below (eg, ½ cup, 1 cup, 2 cups, >2 cups).

Study Procedures
Participants completed an informed consent form and demographic and other psychosocial measures, and received materials for their first three telephone-administered 24-hour dietary recalls. Two weeks later, they returned for a second visit, at which they completed the CD-ROM program and paper versions of the Fruit and Vegetable Scan and Block Fat Screener (with order randomly assigned). Three more 24-hour dietary recalls were conducted in the 14 days after this visit, and then participants returned for a third visit to repeat the CD-ROM and paper surveys (data not presented).

Measures
Demographic Data and Participant Characteristics. Variables included height and weight (using a stadiometer and calibrated digital scale), education, employment status, income, marital status, race/ethnicity (categories defined by the investigator), health status, smoking status, living arrangement, whether the participant was currently on a diet to lose weight, where most meals were eaten, who did most of the cooking, who served the food, and how often the participant ate second helpings. The baseline survey included an 18-item version of the impression management scale of the Balanced Inventory of Desirability Responding (59) and two scales from the short Test of Functional Health Literacy in Adults (60).

Dietary Intake. Up to three 24-hour dietary recalls, including 1 weekend day, were obtained by telephone per participant. The interviews were conducted by registered dietitians at the Diet Assessment Research Unit of the University of South Carolina, who were trained in the use of Nutrition Data System for Research software (versions V2007 and V2008, Nutrition Coordinating Center, University of Minnesota, Minneapolis). Final calculations were completed using Nutrition Data System for Research version V2008. Participants were given a validated two-dimensional visual aid to help them estimate the amounts of foods they had eaten (24). Nutrition Data System for Research software generates summary information about food intake that may be compared with Block Fat Screener and Fruit and Vegetable Scan summary variables.

Statistical Analyses
Scores were calculated for multiple-item instruments using procedures previously established for each instru-