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A Video Repository for Innovative Methods of Dietary Assessment and Analysis

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Citation

Bromage, S., Fung, T.T., Kirkpatrick, S.I., Willett, W.C. A Video Repository for Innovative Methods of Dietary Assessment and Analysis. *J. Vis. Exp.* (192), e64958, doi:10.3791/64958 (2023).

Date Published

February 3, 2023

DOI

10.3791/64958

URL

jove.com/video/64958

Abstract

ARTICLES DISCUSSED:

Lasschuijt, M. P. et al. Concept development and use of an automated food intake and eating behavior assessment method. *Journal of Visualized Experiments*. (168), e62144 (2021).

Chung, J. et al. Design and evaluation of smart glasses for food intake and physical activity classification. *Journal of Visualized Experiments*. (132), e56633 (2018).

Lucassen, D. A., Brouwer-Brolsma, E. M., van de Wiel, A. M., Siebelink, E., Feskens, E. J. Iterative development of an innovative smartphone-based dietary assessment tool: TRAQQ. *Journal of Visualized Experiments*. (169), e62032 (2021).

Boronat, A. et al. Mobile device-assisted dietary ecological momentary assessments for the evaluation of the adherence to the Mediterranean diet in a continuous manner. *Journal of Visualized Experiments*. (175), e62161 (2021).

Meroni, A., Jualim, N., Fuller, N. 'Boden Food Plate': novel interactive web-based method for the assessment of dietary intake. *Journal of Visualized Experiments*. (139), e57923 (2018).

Mezgec, S., Seljak, B. K. Deep neural networks for image-based dietary assessment. *Journal of Visualized Experiments*. (169), e61906 (2021).

Bromage, S. Integrated spreadsheets for nutritional analysis of population diet surveys. *Journal of Visualized Experiments*. (188), e64327 (2022).

Discussion

In the context of clinical and epidemiological research, dietary intake is a particularly complex exposure to measure, given the vast diversity of foods consumed globally, with variations in consumption patterns across eating occasions, days, seasons, and the life cycle. Assessing intake is challenged by measurement error arising from various sources, including imperfect recall of foods consumed in retrospective assessments (e.g., 24 h diet recalls and food-frequency questionnaires) and reactivity associated with real-time recording in the case of food records. In analysis and interpretation, further complexity is introduced by the diversity of dietary components often of interest in a given study, related to the growing recognition of the need to account for the multidimensionality of intake to holistically characterize and translate the effects of dietary patterns on health and disease risk. These challenges, resulting in gaps in the quantity and quality of dietary intake data available for populations globally, as well as deficits in time-relevant and evidence-based strategies for improving dietary patterns, continue to inspire innovative approaches that attempt to surmount challenges faced by conventional dietary assessment methods.

As of October 2022, this methods collection includes seven articles describing the development, evaluation, and/or application of innovative dietary assessment and analysis methods and tools that researchers may consider applying in their own work. Three of the articles describe a protocol for developing a method to assist interested researchers in creating similar methods tailored to specific settings or populations. The methods incorporate aspects of nutritional, behavioral, and computer science, coupled with mechanical, electrical, and software engineering, highlighting the importance of broad interdisciplinary and integrative perspectives to innovation in this field.

Measurement devices

Lasschuijt et al.[1] have engineered an apparatus consisting of a weight-sensitive dining tray and a linked camera system to extract information on eating behaviors, including the number of chews, the bite size, and the eating rate for different foods in a meal, to provide feedback on what, how much, and how quickly foods are eaten. This apparatus provides a potentially minimally burdensome method of describing modifiable eating behaviors without relying on self-reporting or self-monitoring.

Chung et al.[2] present a pair of 3D-printed smart glasses capable of objectively detecting patterns of activity in the temporalis muscles during eating and different physical activities, using specialized circuit boards on the left and right hinges. The protocol describes how to construct the glasses and circuitry and how to output collected data into machine learning software to distinguish eating behaviors from other behaviors, as a way of tailoring interventions to reduce excessive food consumption.

Software-based assessment methods

Lucassen et al.[3] have developed the TRAQQ mobile app, a user-friendly tool for collecting food records and dietary recalls, incorporating data on food composition, portion sizes, and customizable recipes that account for cooking yield and nutrient retention. The app backend allows researchers to invite and remind participants to complete

assessments according to customizable sampling schemes, and automatically reschedules non-responders. The paper provides a protocol for formative research, app design and evaluation, study management, and app implementation to assist users interested in developing and using similar tools.

Boronat et al.[4] describe the development of technologically assisted ecological momentary assessments (EMAs) that provide repeated real-time sampling of eating behaviors in natural environments, in this case, to measure adherence to the Mediterranean diet pattern through daily and weekly prompts. Use of the technology-assisted EMA platform also provides participants with weekly reports that summarize healthy and unhealthy aspects of their diets and promote behavior change.

Meroni et al.[5] present the Boden Food Plate, a method of entering food intake data that involves identifying foods in an embedded food composition database and positioning them on a visual representation of a plate for each meal, producing estimates of nutrient intake. This provides an engaging interactive method of assessing food and nutrient intake, with similarities to food-based dietary guidelines that use a model of a plate to recommend appropriate proportions of different food groups.

Software development

Mezgec and Seljak[6] describe the development of deep neural network architectures for processing images of meals by distinguishing among different foods and drinks ("segmentation") and accurately identifying each. The protocol serves as a resource to help machine learning experts select deep learning methods and data augmentation steps for undertaking food segmentation and classification, including selection and cleaning of the datasets used to train and implement these analyses.

Bromage[7] presents a system of Integrated Spreadsheets for Nutritional Analysis of Population Diet Surveys (ISNAPDS), which uses simple formulas to calculate nutrient and food group intakes and the contributions of food groups to nutrient intakes. The system flexibly accommodates quantitative, semiquantitative, and nonquantitative food consumption data collected using prospective and retrospective assessment methods, employing different reference periods and portion size estimation methods, and a user-supplied food composition table.

These examples provide an exciting window into the future of dietary assessment, while underscoring important challenges that the cutting edge of the field is contending with to provide feasible and timely solutions to extant global data gaps. Despite advancements in technology for recording food consumption, accurately capturing usual long-term intake remains a challenge that will not be entirely addressed through novel technological approaches for prospectively measuring food intake. It is thus necessary to continue to explore how self-reported and objective measures of dietary intake and nutrition may be aggregated to improve the capacity to understand dietary patterns in relation to health and disease. Such efforts may be enhanced by integrating advances in the measurement of other facets of health, including physical activity, sleep, and body composition.

The diversity of technological advancements is impressive, and it is important to identify the most promising approaches to be incorporated into standardized and well-evaluated methods and tools, which can be integrated into research

and surveillance systems to promote systematic monitoring and international comparisons. In the Global South, where the need for actionable and high-quality data on population diets is arguably the greatest, and where the capacity for collecting such data is generally low, implementation science is warranted to ensure that technological innovations are viable and beneficial.

Disclosures

The authors have nothing to disclose.

Acknowledgments

S.B. received support from the National Institutes of Health (T32 DK 007703).

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