Perspectives of food intake estimation using digital photography

International Symposium on
Ambient Intelligence and Embedded Systems
AmiEs-2023

Georgios A. Fragkiadakis, Department of Nutrition & Dietetics, School of Health Sciences, Hellenic Mediterranean University (HMU), Tripitos Area, 72300 Sitia, Crete, Greece, fragkiadakis@hmu.gr, tel. +30 2843020016

25th – 29th | 2023 September | Sitia
https://1stathenatf.hmu.gr

1st ATHENA TECHNOLOGY FORUM

ATHENA
EUROPEAN UNIVERSITY

HELLENIC MEDITERRANEAN UNIVERSITY

Perspectives of food intake estimation using digital photography

Accurate measurement of food intake in free-living conditions poses methodological and analytical challenges. Commonly used methods include self-report documentation of food intake (i.e., food diaries, 24-hour dietary recall, and food frequency questionnaires), although these methods are associated with limitations that have been described previously: laborious procedures, subjective recordings, omission of recordings, memory issues, etc.).

Martin, C K et al. “Measuring food intake with digital photography.” Journal of Human Nutrition and Dietetics: The official journal of the British Dietetic Association vol. 27 Suppl 1.0, 1 (2014): 72-81. doi:10.1111/jhn.12014.

- The availability of digital cameras and wireless communication devices (as Smartphones) has led to the development of food intake quantification methods that use images of food choices and dish waste, but also corresponding necessary software. Digital video cameras at the food location are used to capture images of the food selection, as well as any food left over after the meal (leftovers).
- Images of accurately weighed typical portions of the foods served are also collected, and these food images are linked to a detailed and current database (i.e., the Food and Nutrient Database for Dietary Studies) or a customized recipe, which allows calculation of energy and nutrient intake. These facilities are available for decades now.

- Naaman R, Parrett A, Bashawri D, Campo I, Fleming K, Nichols B, Burleigh E, Murtagh J, Reid J, Gerasimidis K. Assessment of Dietary Intake Using Food Photography and Video Recording in Free-Living Young Adults: A Comparative Study. J Acad. Nutr. Diet., 2021 Apr;121(4):749-761.e1.

- **The method can be used to calculate the food intake of adults and children under dietetic/medical guidance/monitoring. Dieticians apply this method, to keep in contact and guide patients/clients; still, can be applied in community-nutrition services, to support public health. For community reasons a platform may be developed for participants to receive nutritional recommendations; achieve weight loss and health promotion goals.**

- **Naaman R, Parrett A, Bashawri D, Campo I, Fleming K, Nichols B, Burleigh E, Murtagh J, Reid J, Gerasimidis K. Assessment of Dietary Intake Using Food Photography and Video Recording in Free-Living Young Adults: A Comparative Study. J Acad Nutr Diet. 2021 Apr;121(4):749-761.e1.**

- **Images of the actual food plates before and after the meal are recorded and transmitted using mainly cell phones or tablets, or computer applications; to be further analyzed and compared to standard pre-calculated meals. Applications are developed, to calculate energy and nutrient intake, including macronutrients, as protein, lipids.**

- **Data may be transferred and analyzed in various ways, it can be done retrospectively, in near real-time, or even in real time under optimal conditions.**

- **Naaman R, Parrett A, Bashawri D, Campo I, Fleming K, Nichols B, Burleigh E, Murtagh J, Reid J, Gerasimidis K. Assessment of Dietary Intake Using Food Photography and Video Recording in Free-Living Young Adults: A Comparative Study. J Acad Nutr Diet. 2021 Apr;121(4):749-761.e1.**

- On real time, or later, trained raters use a custom computer program, software application, i.e., the "Food Photography App©" to simultaneously display images of the subject's food choice, leftovers, and typical portion size for each food item consumed.
- The rater (operator) estimates the percentage of the typical portion that the person chose, as well as the percentage of the typical portion that remains on the plate (leftovers). The software application then automatically calculates the energy-nutrient content of the selection and remains (as the difference between selection and remains).

- Martin, C K et al. “Measuring food intake with digital photography.” Journal of Human Nutrition and Dietetics: The official journal of the British Dietetic Association vol. 27 Suppl 1.0, 1 (2014): 72-81. doi:10.1111/jhn.12014.

- Such an application can calculate energy and nutrient content from reference values in a database. The next Figure shows images of a participant's food choice (Image A), leftovers (Image B), and an image of a typical portion (Image C).
- Food intake is i.e., estimated with the Food Photography© app by comparing images of participants' food selection (A) and leftovers (B) to an image containing a known amount of food (C), to estimate portion size. The app then automatically calculates the energy and nutrient content of your food choice, leftovers and food intake.

- Martin, C K et al. “Measuring food intake with digital photography.” Journal of Human Nutrition and Dietetics: The official journal of the British Dietetic Association vol. 27 Suppl 1.0, 1 (2014): 72-81. doi:10.1111/jhn.12014.

Participant's food selection image.

Participant's leftovers image.

Image of a standard portion from the Archive.

Martin, C K et al. "Measuring food intake with digital photography." Journal of Human Nutrition and Dietetics: The official journal of the British Dietetic Association vol. 27 Suppl 1.0, 1 (2014): 72-81. doi:10.1111/jhn.12014 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4138603/

- **The method may be incorporating computer automation to improve accuracy. However, reliability and validity of food intake measurement must be examined, in each case of integrated applications, since the technical aspects of the recording, as well as the transfer and analysis software may affect the overall results.**

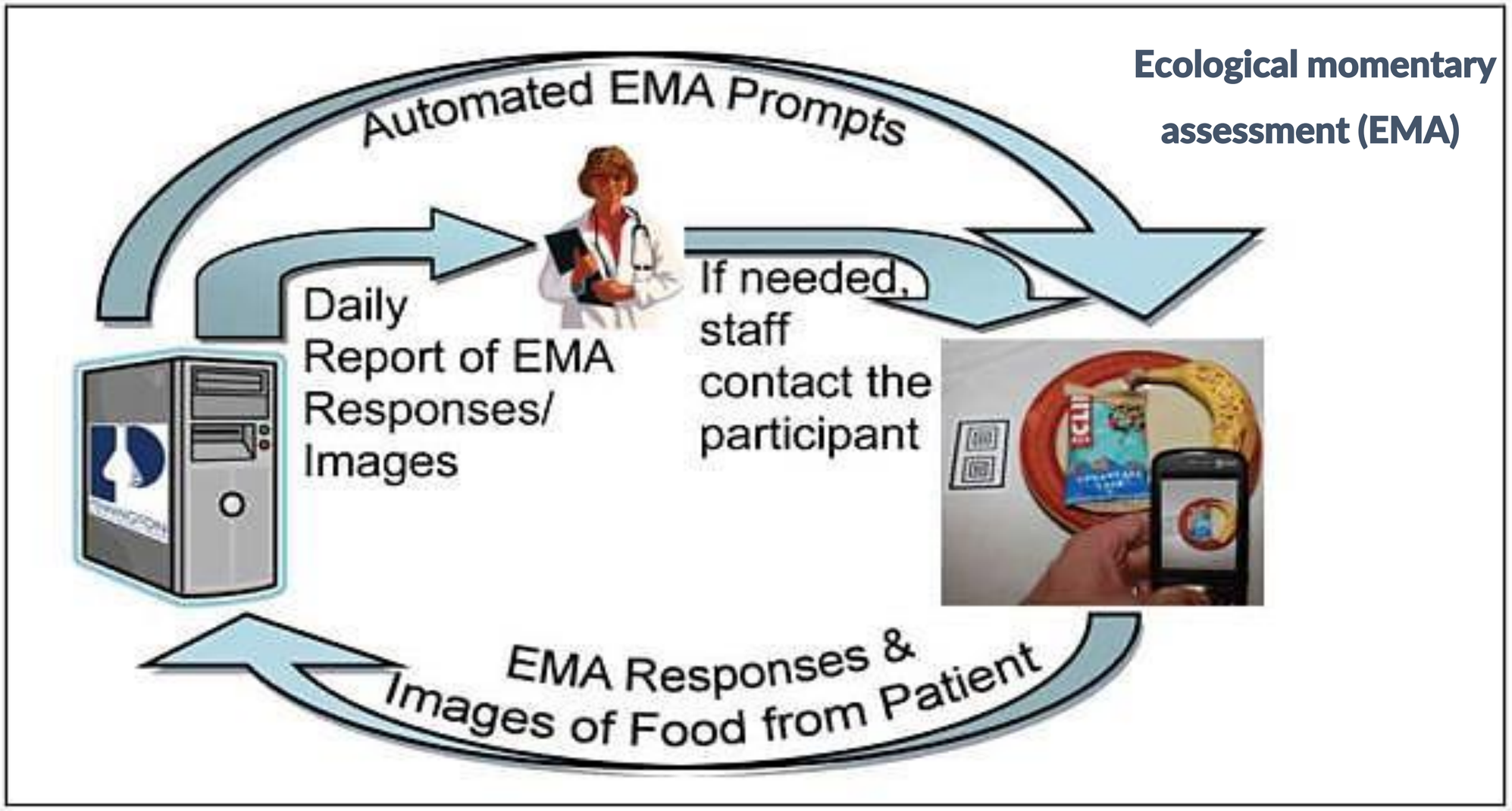
- **Among food categories, the average error from digital imaging varies. For example, digital imaging may overestimate beverage intake by 7.6 ± 3.07 g (mean ± SEM) or 4.3%, and condiment intake by 4.9 ± 1.63 g (mean ± SEM) or 16.6%.**

- **Martin CK, Correa JB, Han H, Allen HR, Rood J, Champagne CM, Gunturk BK, Bray GA. Validity of the Remote Food Photography Method (RFPM) for estimating energy and nutrient intake in near real-time. Obesity. 2012; 20: 891–899.**

- **An additional limitation is the fact that current computer imaging algorithms are not advanced enough to correctly recognize food and accurately estimate the amount of food in images, with 100% accuracy. Therefore, data analysis processes remain semi-automated and a human operator oversees the process. However, the integration of barcode scanning codes and Price Look Up (PLU) codes for automatic food identification has greatly improved the efficiency and user experience of food identification.**

- **Lili Zhu, Petros Spachos, Erica Pensini, Konstantinos N. Plataniotis. Deep learning and machine vision for food processing: A survey, Current Research in Food Science, Volume 4, 2021, Pages 233-249, ISSN 2665-9271, https://doi.org/10.1016/j.crfs.2021.03.009.**

Ecological momentary assessment (EMA)



Martin, C K et al. "Measuring food intake with digital photography." Journal of Human Nutrition and Dietetics: The official journal of the British Dietetic Association vol. 27 Suppl 1.0, 1 (2014): 72-81. doi:10.1111/jhn.12014 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4138603/

- **Multiple raters can use the method to estimate food intake and that estimates do not differ significantly between and among raters evaluating the images. This is important when the method is used to estimate food intake of large study samples when multiple raters are required. Evaluators/raters include Registered Dietitians, Research Associates with relevant degrees and student workers practicing.**
- **Therefore, it appears that people with at least some college experience can be trained to accurately estimate food intake using the method.**

- **Reuben G. Stables, Andreas M. Kasper, S. Andy Sparks, James P. Morton, and Graeme L. Close. An Assessment of the Validity of the Remote Food Photography Method (Termed Snap-N-Send) in Experienced and Inexperienced Sport Nutritionists. International Journal of Sport Nutrition and Exercise Metabolism. In Print: Volume 31: Issue 2, Page Range: 125–134, DOI: https://doi.org/10.1123/ijsnem.2020-0216.**

- **The ability to compare a participants' dietary intake, first with the reference food (i.e., the accuracy of these food composition); the comparisons within a group or between groups etc., represent major challenges. Furthermore, the benefit as well as the limits of the involvement of experts that cooperate with integrated intelligent systems, on the basis of not only the nutritional analysis but the nutritional guidance and even clinical nutrition support also, remains an area of applied dietetics to be further studied.**

- **Reuben G. Stables, Andreas M. Kasper, S. Andy Sparks, James P. Morton, and Graeme L. Close. An Assessment of the Validity of the Remote Food Photography Method (Termed Snap-N-Send) in Experienced and Inexperienced Sport Nutritionists. International Journal of Sport Nutrition and Exercise Metabolism. In Print: Volume 31: Issue 2, Page Range: 125–134, DOI: https://doi.org/10.1123/ijsnem.2020-0216.**

McClung, Holly & Champagne, Catherine & Allen, H. & Mcgraw, Susan & Young, Andrew & Montain, Scott & Crombie, Aaron. (2017). Digital food photography technology improves efficiency and feasibility of dietary intake assessments in large populations eating ad libitum in collective dining facilities. Appetite. 116. 10.1016/j.appet.2017.05.025.

McClung, Holly & Champagne, Catherine & Allen, H. & Mcgraw, Susan & Young, Andrew & Montain, Scott & Crombie, Aaron. (2017). Digital food photography technology improves efficiency and feasibility of dietary intake assessments in large populations eating ad libitum in collective dining facilities. Appetite. 116. 10.1016/j.appet.2017.05.025.

McClung, Holly & Champagne, Catherine & Allen, H. & Mcgraw, Susan & Young, Andrew & Montain, Scott & Crombie, Aaron. (2017). Digital food photography technology improves efficiency and feasibility of dietary intake assessments in large populations eating ad libitum in collective dining facilities. Appetite. 116. 10.1016/j.appet.2017.05.025.

- Digital image-based approaches have several advantages, including reduced participant burden and the ability to quantify food intake at a group and individual level. Work is ongoing to further automate digital imaging approaches.

- **WHAT SHOULD WE TEACH, HOW WE SHOULD PREPARE OUR STUDENTS TO COPY AND UTILISE WITH THESE NEW TECHNOLOGIES FOR THE 21st CENTURY?**

- **HOW CAN WE, AS A UNIVERSITY DEPARTMENT UTILIZE THESE METHODS IN COMMUNITY NUTRITION?**

- **THANK YOU FOR YOUR ATTENTION**