

Biomarkers of food intake

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Relevance of biomarkers of food intake for health

Most of the existing evidence on relationships between diet and health is based on epidemiological studies, which have several limitations. Traditionally, dietary assessment has been measured with self-reported dietary recalls, food frequency questionnaires or diet diaries, which have a considerable source of error (1). For example, detailed information on the food or beverage consumed (brand, variety, etc.) and the way it was cooked or processed is not usually documented in dietary records. It is also common for subjects participating in observational studies to under-report their true habitual food intake, or change their diet, during the period of the survey (2). In addition, food composition databases are limited and often inaccurate, in particular, in low and middle income countries (3). The 24-h food recall is the most widely used dietary assessment method in low-income countries, but very few studies have assessed its validity in their study settings (4). A systematic review of 16 studies investigating the accuracy of self-reported dietary intake (using doubly labelled water or basal metabolic rate) in low and middle-income countries found that almost half of the studies found underreporting in over 50% of the sample size, while 7 out of the 16 studies found evidence of over-reporting (5).

In recent years, extensive efforts have been made to develop more reliable dietary assessment techniques, in particular, on the discovery and validation of dietary biomarkers of food intake as a more objective method of dietary exposure (6). A small number of biomarkers of intake of food or food components have been identified through the analysis of correlations of the biomarkers with

dietary intake in epidemiological studies (6). Such biomarkers are usually plasma, serum or urinary food-derived metabolites or catabolites identified by analytical techniques such as GC–MS or HPLC–MS. The reliability of such biomarkers over time needs to be assessed carefully, to ensure that they reflect habitual exposure, especially when samples are collected at a single point, which is usual in epidemiological studies. Currently, very few biomarkers of dietary intake have been fully validated, and to our knowledge, no study has been conducted in low income countries using validated biomarkers of food intake. This represents an innovative research opportunity.

Methods for measurement of biomarkers of food intake

Biomarkers of food intake are typically measured in human urine, plasma or serum.

The most used methods are untargeted and targeted metabolomics using liquid chromatography-mass spectrometry or/and NMR (7,8). Few studies have used stable isotope ratios as nutritional biomarkers (9).

Several factors influence the use of these techniques:

- Blood and urine samples need to be collected and immediately stored at -20°C - or ideally - 80°C.
- Metabolomic analysis using LC-MS is generally expensive and in many cases such technology is not available onsite.

Development of more cost effective and practical techniques for samples collection and storage such as dried blood spots in the context of metabolomics and dietary biomarkers are needed, and is a research priority in order to further develop the potential of this innovative method to improve outcomes in global health.

Useful links

The **Food Biomarkers Alliance (FOODBALL)** is an initiative aimed at identifying and quantifying dietary biomarkers in order to improve the capabilities of nutritional assessment and research.
<http://foodmetabolome.org/>

Biomarkers in Food and Nutrition Research – collection of articles related to biomarkers of food intake as part of a special issue in the journal “Genes and Nutrition”
<https://www.biomedcentral.com/collections/bfnr>

Proposed guidelines on validation of biomarkers of food intake:
<https://genesandnutrition.biomedcentral.com/articles/10.1186/s12263-018-0603-9>

FoodDB - is the world’s largest and most comprehensive resource on food constituents, chemistry and biology. It provides information on both macronutrients and micronutrients, including many of

the constituents that give foods their flavor, color, taste, texture and aroma.

<http://foodb.ca/>

Exposome explorer -is the first database dedicated to biomarkers of exposure to environmental risk factors for diseases, including biomarkers of dietary exposure. It contains detailed information on the nature of biomarkers, populations and subjects in which biomarkers have been measured, samples analysed, methods used for biomarker analyses, concentrations in biospecimens, correlations with external exposure measurements, and biological reproducibility over time.

<http://exposome-explorer.iarc.fr/>

Further reading

Arevström, L., Bergh, C., Landberg, R., Wu, H., Rodriguez Mateos, A. M., et al. Freeze-dried bilberry (*Vaccinium myrtillus*) dietary supplement improves walking distance and lipids after myocardial infarction. An open-label randomized clinical trial. 17 Nov 2018, NUTRITION RESEARCH. 62, p. 13-22

Kolot, C., Rodriguez Mateos, A. M., Feliciano, R. P., et al. Bioavailability of Naringenin Chalcone in Humans after Ingestion of Cherry Tomatoes, 6 Nov 2018, (Accepted/In press) International Journal For Vitamin and Nutrition Research.

Rodriguez Mateos, A. M., Weber, T., Skene, S., et al. Assessing the respective contributions of dietary flavanol monomers and procyanidins in mediating cardiovascular effects in humans: Randomized-controlled, double-masked intervention trial. 24 Oct 2018. Am J Clin Nutr.

Santos, C. N., Gomes, A., Oudot, C., ... Rodriguez-Mateos, A., et al. Pure polyphenols applications for cardiac health and disease. 7 Jun 2018, Current Pharmaceutical Design.

García-Conesa, M. T., Chambers, K., Combet, E., ... Rodríguez-Mateos, A., et al. Meta-analysis of the effects of foods and derived products containing ellagitannins and anthocyanins on cardiometabolic biomarkers: Analysis of factors influencing variability of the individual responses Mar 2018, International Journal of Molecular Sciences. 19, 3, 694.

All of the above texts are available via <https://kclpure.kcl.ac.uk/portal/ana.rodriguez-mateos.html>

References

- 1- Zamora-Ros R, Touillaud M, Rothwell JA, Romieu I, Scalbert A. Measuring exposure to the polyphenol metabolome in observational epidemiologic studies: current tools and applications and their limits. Am J Clin Nutr 2014, 100:11–26.
- 2- Cook A, Pryer J, Shetty P (2000) The problem of accuracy in dietary surveys. Analysis of the over 65 UK National Diet and Nutrition Survey. J Epidemiol Community Health 54:611–616

- 3- Bruyn, Ferguson et al. Food composition tables in resource-poor settings: exploring current limitations and opportunities, with a focus on animal-source foods in sub-Saharan Africa. *Br J Nutr* 2016; 116(10): 1709–1719.
- 4- Gibson RS, Charrondiere UR, Bell W. Measurement Errors in Dietary Assessment Using Self-Reported 24-Hour Recalls in Low-Income Countries and Strategies for Their Prevention. *Adv Nutr*. 2017;8(6):980-991.
- 5- Bell WF, Saltzman E, Coates J. Accuracy of Self-Reported Dietary Intake in Low and Middle-Income Countries: A Review of the Literature. *FASEB J* 2016 1b417
- 6- Scalbert A, Brennan L, Manach C, Andres-Lacueva C, Dragsted LO, Draper J, Rappaport SM, van der Hooft JJ, Wishart DS. The food metabolome: a window over dietary exposure. *Am J Clin Nutr* 2014, 99:1286–1308
- 7- Brennan L, Hu FB. Metabolomics-Based Dietary Biomarkers in Nutritional Epidemiology-Current Status and Future Opportunities. *Mol Nutr Food Res*. 2019 Jan;63(1):e1701064.
- 8- Ulaszewska MM, Weinert CH, et al. Nutrimetabolomics: An Integrative Action for Metabolomic Analyses in Human Nutritional Studies. *Mol Nutr Food Res*. 2019 Jan;63(1):e1800384.
- 9- Kuhnle GGC Stable Isotope Ratios: Nutritional Biomarker and More. *J Nutr* 2018 Dec 1;148(12):1883-1885.