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Invited Commentary

Technology in dietary assessment

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Dietary assessment may be described as the science and art of evaluating the dietary intake of individuals or groups for research or as basis for nutrition care(1). While screening and comprehensive assessments have been differentiated(2), both are characterised by phases of varying detail. Data collection and data evaluation are respectively the beginning (input) and endpoint (output). The aim of a particular dietary evaluation will determine the most appropriate tools and techniques in each phase. Using technology should improve at least the efficiency and ideally also the quality of dietary assessments, which are known to be labour-intensive and threatened by concerns about validity(3). Many reviews about the use of technology in dietary assessment have been published(4–15). The current invited commentary aims to place these technologies into the context of dietary assessment viewed as a system.

Informed by the approach of Pennington *et al.*(16), Fig. 1 illustrates the phases (shaded) of dietary assessment as well as some potentially associated tools and techniques which may involve technological innovation. The 'input' refers to the dietary data collected by techniques such as the 24 h recall. The 'processing' includes the coding and analyses, while the 'output' is the final evaluation or judgement of the diet. Not all dietary assessments are quantitative by collecting food portion data; some assessments do not cover the whole diet, and some assessments or screeners focus on food groups, and not on nutrients. Figure 1 outlines the potential complexity of the system, even though not all phases are applicable to all dietary assessments, nor would digital technology necessarily be appropriate in each phase.

When dietary data are collected, technology typically searches for quicker input and standardisation of questioning and probing, all core considerations for efficiency and reliability of a research study. It is, however, important that the cognitive processes inherent to a particular dietary assessment technique are respected. For example, in the case of dietary recalls, the emphasis should be on helping participants in a non-leading way to remember all foods consumed in the reference period, e.g. through the multiple-pass technique. For FFQ, the participant should be supported in recognising relevant items in the given food list. Photographs may serve the purpose. Nesting, branching and/or filtering questions by means of technology can substantially streamline the completion of FFQ. The complexity involved in calculating and reporting frequency of intake according to the requirements of a particular FFQ is often underestimated and presents opportunities for innovation. The participant who needs to keep a diet record would benefit from technology that reduces the burden of diarising all foods consumed. Camera or voice recording and scanning using smartphones or personal digital assistants for data entry – online or offline – are examples. Portion size estimation deserves considerable attention in quantitative assessments. Food recognition, segregation and quantification of images taken by the participant may

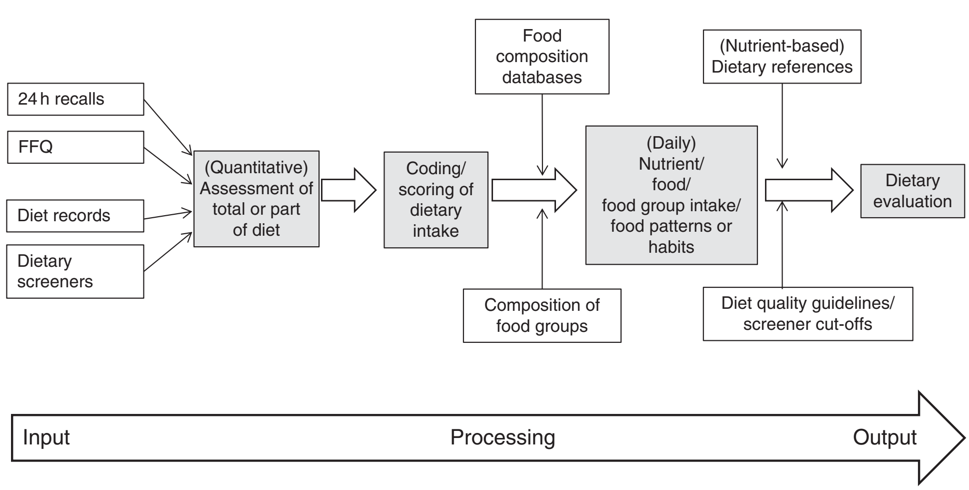

Fig. 1 Dietary assessment as a system

become a viable option to researchers and practitioners in the not-too-distant future.

In addition to applying the principles of science, the art of interacting with the participant in line with the principles of a particular dietary assessment technique should be kept in mind in the development and use of technology in eliciting dietary information. Participant characteristics (e.g. age, socio-economic status and culture) and preferences (e.g. interviewer *v.* self-administration), as well as logistical and resource-related matters, should always direct decisions. In those instances where the dietary assessment is the starting point for responsive nutrition care, it must be remembered that technology cannot show empathy or emotion; often critical for rapport between nutrition professional and client.

Dietary input data need to be analysed. When viewing dietary methodology as a system, this takes place during the 'processing' phase. The first step in an analysis usually requires coding of the reported dietary intake. An article in this issue of *Public Health Nutrition*[17] reports the use of QR (quick response) codes to link the food items reported (selected from a pre-set list) and their portion sizes (from a photographic atlas) to food composition data. This technology largely eliminated human (fieldworker) error during coding, but the compilation of a comprehensive and relevant food list and the portion sizes remain critical, and illustrate how the usefulness of technology depends on sound baseline knowledge of the target population: the integration of art and science. Using technology that is accessible to researchers in resource-limited settings and sharing this, counters costly 're-invention of the wheel'. This approach may also prevent the technological divide between developing and industrialised countries from deepening. The technology used by Harris-Fry *et al.*[17] also appears to be an option for coding of FFQ that are currently not yet scannable.

The ability of technology to eliminate the repetitive tasks associated with calculating intakes of nutrients and other food components has long saved nutrition professionals much time. Increasingly, food composition databases are linked to or are incorporated into the terminals (e.g. mobile phones) which are used in the input phase of the dietary assessment. The challenges of food composition databases cannot, however, be ignored[18]. Missing data, limited representation of culture-specific and branded foods, as well as changes and (regional) differences in food composition and preparation require ongoing attention. Quality control of software packages that are based on the databases needs to be rigorously applied. The impression of modernity and sophistication through the application of technology should not outweigh data quality. This also refers to the reference data included in many software packages for immediate and user-friendly (e.g. graphical) outputs, particularly for clinical settings.

Even though the comparison of calculated intake with dietary reference data can be technology-supported, the final dietary evaluation often requires the expertise of a nutrition professional. This refers particularly to the integration of findings regarding the various dietary components (nutrients) and possibly the various dietary assessment techniques that were part of a diet history, and other data (e.g. anthropometry and biochemistry) from a comprehensive nutritional assessment of an individual. Artificial intelligence in this regard is still in its infancy.

Autonomous robot-driven assessment of usual nutrient intake of individuals is not yet a reality, nor is it desirable among those who accept that art and science are integral to dietary assessment. Nevertheless, appropriate technology can successfully support, improve or take over selected tasks in some of the phases of dietary assessment, particularly of groups and in delimited assessments. In the interest of sound science, the reliability and validity of new technologies should always be established, keeping in mind that dietary intake is a complex human behaviour. Neither blind over-adoption nor avoidance serves the purpose of furthering dietary assessment for ultimately improving nutritional status and health.

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