



Applied nutritional investigation

Comparison of single questions and brief questionnaire with longer validated food frequency questionnaire to assess adequate fruit and vegetable intake



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ARTICLE INFO

Article history:

Received 8 September 2014

Accepted 14 January 2015

Keywords:

Fruit

Vegetables

Short food frequency questionnaire

ABSTRACT

Objective: The aim of this study was to determine if a single question (SQ) for fruit and a SQ or five-item questionnaire for vegetable consumption (VFQ) could replace a longer food frequency questionnaire (FFQ) to screen for inadequate versus adequate intakes in populations.

Methods: Participants (109) completed three test screeners: fruit SQ, vegetable SQ, and a five-item VFQ followed by the reference 74-item FFQ (version 2 of the Dietary Questionnaire for Epidemiological Studies [DQESv2]) including 13 fruit and 25 vegetable items. The five-item VFQ asked about intake of salad vegetables, cooked vegetables, white potatoes, legumes, and vegetable juice. The screeners were compared with the reference (DQESv2 FFQ) for sensitivity, specificity, and positive and negative predictive powers (PPV, NPV) to detect intakes of two or more servings of fruit and three or more servings of vegetables. Relative validity was examined using Bland-Altman statistics.

Results: The fruit SQ showed a PPV of 56% and an NPV of 83%. The PPV for the vegetable SQ was 30% and the NPV was 89%. For the five-item VFQ, the PPV was 39% and the NPV was 85%. Bland-Altman plots and linear regression equations showed that although the screener showed good agreement for fruit (unstandardized b_1 coefficient = 0.04) for vegetable intake the difference between methods increased at higher intake levels (unstandardized b_1 coefficients = -0.3 for the SQ, $b_1 = -0.6$ for five-item VFQ).

Conclusion: The fruit SQ and the five-item VFQ are suitable replacements for longer FFQs to detect inadequate intake and assess population mean but not individual intakes.

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Introduction

It is widely known that fruits and vegetables are essential components of a healthy diet and help to prevent weight gain and chronic diseases such as hypertension, coronary heart disease, stroke, and possibly some cancers [1]. The World Health Organization (WHO) recommends a minimum of 400 g/d of fruit and vegetables to prevent chronic diseases [2]. Despite concerted efforts to increase public awareness and change behaviors, intake remains low globally. Fruit is ranked third and vegetable intake seventeenth among 67 modifiable risk factors for the burden of disease [3].

The definition and assessment of what constitutes a vegetable serving is a source of confusion by both the public and researchers. National dietary guidance tools usually recommend that a given number of serving are required each day and specify what constitutes a serving. For example, in the United States it is suggested that women consume 2.5 cups of vegetables and 1 cup is seen as a serving [4]. In Australia, it is recommended that women consume five servings of vegetables, however one serving is half a cup [5]. Some foods are considered a vegetable serving in some countries but not in others. For example, potato is included as a vegetable in Australia but not in the United Kingdom. Legumes are included in the United States but not the United Kingdom. These differences result in the heterogeneity of tools to assess vegetable intake and makes international comparisons problematic [6]. Even within a country, dietary

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assessment methods may not reflect national guidelines. For example, short questions used in the Australian Health Survey 2011–2013 to measure vegetable intake did not include legumes, yet the Australian Guide to Healthy Eating includes these foods within the “vegetable and legumes” core food group [5,7]. Additionally, many dietary assessment tools assess fruit and vegetable intake concurrently, but because fruits and vegetables exhibit differing nutrient profiles and evidence suggests they should be promoted separately [8,9], dietary assessment should measure and monitor the intake of these foods independently.

Valid and reliable tools to measure fruit and vegetable intake are required to monitor populations and, to screen participants to determine eligibility for health programs and evaluation of interventions. Brief measurement tools that can assess adequacy of fruit and vegetable intake in line with the national guidelines and further differentiate vegetables into subgroups to allow comparisons between countries is suggested.

The aim of this study was to design and investigate whether new brief instruments could replace a longer FFQ (version 2 of the Dietary Questionnaire for Epidemiological Studies [DQESv2]) to assess population fruit and vegetable intake. The sensitivity/specificity and positive and negative predictive values to detect inadequate versus adequate intakes and the comparative validity and reliability of a single question (SQ) for fruit intake, and both a single question and a five-item questionnaire for vegetable intake (VFQ) was determined.

Methods

Participants

Participants ages 18 to 39 y were recruited from June to August 2012 from two Australian universities and their surrounding areas using Twitter broadcasts, on-campus posters, advertisements in e-newsletters, and announcements in lectures. Volunteers were excluded if they were on a special diet for medical purposes, or if they were studying or working in the field of human nutrition. The study was approved by the University of Sydney Human Ethics Research Committee (approval no. 14601) and the University of Technology Sydney Human Research Ethics Committee (UTS HREC 2012-194 N). Participants were reimbursed with a gift voucher and given the option of receiving nutritional feedback. Informed, written consent was obtained from all eligible study participants.

Study design and instruments

In this study, each participant completed an online sociodemographic questionnaire and anthropometric data (height and weight) were collected from participants in light clothing, without footwear. Tanita digital scales (Model HD-327; measured to the nearest 0.1 kg) and a fixed stadiometer (measured to the nearest 0.1 cm) were used.

Two separate SQs assessing total daily fruit and vegetable intake over the previous month were developed. The questions were adapted from previous national surveys [7] and asked: “Over the LAST 1 MONTH ONLY, on average, how many serves of fruit did you eat per day?” Participants reported fruit intake using six response options (*None, Less than 1 serving per day, 1 serving per day, 2 servings per day, 3 servings per day, and 4 or more serving per day*). “Over the LAST ONE MONTH ONLY, on average, how many servings of vegetables/legumes did you eat per day?” Vegetable intake was reported using nine response options (*None, Less than 1 serving per day, 1 serving per day, 2 servings per day, 3 servings per day, 4 servings per day, 5 servings per day, 6 servings per day, and 7 or more servings per day*). Participants were provided with a thorough description of what constituted a serving and an explanation of the types of foods and beverages to include or exclude [5]. An important modification was the specification to include 100% fruit juice and legumes in their responses to the fruit and vegetable SQ, respectively. They were incorporated because in Australia they can be classified within their respective core food group [5].

A new five-item VFQ was designed to assess daily vegetable intake (allowing for subgroups) over the previous month. The subgroups were salad vegetables, cooked vegetables, white potatoes, legumes, and vegetable juice. The VFQ used 13 response options: *None, 1 to 3 times per month, 1 time per week, 2 times per week, 3 times per week, 4 times per week, 5 times per week, 6 times per week, 1 time per day, 2 times per day, 3 times per day, 4 times per day, and 5 or more times per day*. Two examples were provided to illustrate how to correctly report

frequency of intake if participants typically ate a different portion size than listed. Participants were provided with specific examples of what to include or exclude for each item to help them distinguish between vegetable subgroups and to avoid duplication (i.e., double counting of items). Following the five-item VFQ, an additional question asked participants “Over the LAST ONE MONTH ONLY, when you ate white potatoes, which is the most frequent way they were prepared/cooked?” with four response options: *boiled/steamed/microwaved, baked/roasted, fried/shallow fried/deep fried, or I never ate white potatoes (over the last 1 mo)*.

The most commonly used FFQ for Australia, the DQESv2 was selected as the comparison for sensitivity/specificity and validation and was adapted to ask participants to respond for intake over the past month (rather than usual 1 y period). The DQESv2 has been previously validated for nutrient intake [10–14]. Further details on the DQESv2 can be found elsewhere but in brief it contains 74 food items with 10 additional questions on consumption of different food groups and 4 questions on portion sizes that are used in the scaling of data [15].

All questionnaires were administered online in the following order; SQs, five-item VFQ, and 74-item FFQ. The test methods were repeated 6 to 8 d later so the responses were pertaining to the “last 1 mo” period.

Fruit and vegetable servings

To allow for comparison between the fruit SQ and 74-item FFQ, the categories *None, Less than 1 serving per day, 1 serving per day, 2 servings per day, 3 servings per day, and 4 or more servings per day* were coded as 0.0, 0.5, 1, 2, 3, and 4 servings/d, respectively. Similarly, the categories *None, Less than 1 serving per day, 1 serving per day, 2 servings per day, 3 servings per day, 4 servings per day, 5 servings per day, 6 servings per day, and 7 or more servings per day* from the vegetable SQ were coded as 0.0, 0.5, 1, 2, 3, 4, 5, 6, and 7 servings/d, respectively.

To calculate vegetable serves from the five-item VFQ, response options were standardized to servings/wk: Within each subgroup the responses “None, 1 to 3 times per month, 1 time per week, 2 times per week, 3 times per week, 4 times per week, 5 times per week, 6 times per week, 1 time per day, 2 times per day, 3 times per day, 4 times per day, and 5 or more times per day” were recoded to 0.0, 0.5, 1, 2, 3, 4, 5, 6, 7, 14, 21, 28, and 35 servings/wk, respectively. For each participant, the five items were then totaled and converted to servings/d. To calculate vegetable servings, excluding white potatoes with added fat, white potato intake was only removed when participants reported most frequently eating white potatoes as “baked/roasted” or “fried/shallow fried/deep fried” (total vegetable was used for remaining participants). For assessment of vegetable intake excluding white potato, all white potato was removed for all participants.

Data from the 74-item FFQ was analyzed by the Cancer Council Victoria for a fee using specialist software to yield daily energy intake and each fruit and vegetable item (g/d) for each participant. The 13 individual fruit items minus the avocado item (which, although being grouped as a “fruit” in the 74-item FFQ, was included as a vegetable for consistency with Australian guidelines) were totaled, then divided by 150 g for whole fruit or 130.9 g for juice to calculate total daily fruit servings. The 25 individual vegetable items plus the avocado item were totaled, then divided by 75 g to calculate total servings of vegetables per day. Servings of vegetables excluding white potato with added fat and all white potatoes were calculated by removing one or two corresponding FFQ items (“Potatoes, roasted or fried [including hot chips]”; “Potatoes cooked without fat”), respectively.

Statistical analysis

Basal metabolic rate (BMR) was calculated using the Schofield equation based on participant age, weight, and sex [16]. Energy intake (EI) was provided from the 74-item FFQ. Participants classed into the lowest and highest 2.5% of the ratio of EI to BMR were recognized as under or overreporters and thus excluded from analyses.

Five relationships were investigated:

1. 74-item FFQ (total fruit) versus SQ (total fruit);
2. 74-item FFQ (total vegetable) versus SQ (total vegetable);
3. 74-item FFQ (total vegetable) versus five-item VFQ;
4. 74-item FFQ (total vegetable without white potatoes with added fat) versus five-item VFQ (total vegetable without white potatoes with added fat); and
5. 74-item FFQ (total vegetable without all white potatoes) versus five-item VFQ (total vegetable without all white potatoes).

All variables satisfied tests for normality using the Kolmogorov-Smirnov test and visual inspection. To assess whether the test instruments could identify participants achieving recommendations (two servings of fruit daily; five or more serves of vegetables daily) sensitivity and specificity analyses were conducted and negative and positive predictive values calculated. However, due to the paucity of participants with a vegetable intake at or above five servings per day,

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