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Original article

Reproducibility and comparative validity of a food frequency questionnaire for Australian adults

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SUMMARY

Background: Food frequency questionnaires (FFQ) are used in epidemiological studies to investigate the relationship between diet and disease. There is a need for a valid and reliable adult FFQ with a contemporary food list in Australia.
Aims: To evaluate the reproducibility and comparative validity of the Australian Eating Survey (AES) FFQ in adults compared to weighed food records (WFRs).
Methods: Two rounds of AES and three-day WFRs were conducted in 97 adults (31 males, median age and BMI for males of 44.9 years, 26.2 kg/m^2, females 41.3 years, 24.0 kg/m^2. Reproducibility was assessed over six months using Wilcoxon signed-rank tests and comparative validity was assessed by intraclass correlation coefficients (ICC) estimated by fitting a mixed effects model for each nutrient to account for age, sex and BMI to allow estimation of between and within person variance.
Results: Reproducibility was found to be good for both WFR and FFQ since there were no significant differences between round 1 and 2 administrations. For comparative validity, FFQ ICCs were at least as large as those for WFR. The ICC of the WFR-FFQ difference for total energy intake was 0.6 (95% CI 0.43, 0.77) and the median ICC for all nutrients was 0.47, with all ICCs between 0.15 (%E from saturated fat) and 0.7 (g/day sugars).
Conclusions: Compared to WFR the AES FFQ is suitable for reliably estimating the dietary intakes of Australian adults across a wide range of nutrients.

1. Introduction

Accurate assessment of dietary intake is critical to examining associations between food intake, obesity and risk of chronic disease mortality.[1] The prevalence of obesity has almost doubled in men (4.8%–9.8%) and women (7.9%–13.8%) over the past 30 years.[2] Given that obesity precedes development of many chronic conditions, it is important to examine current food patterns, using current and valid tools to assist in monitoring intake.

A number of methods have been used to measure usual dietary intake at the population level, however the accurate assessment of diet still presents on-going challenges, including substantial burden for both individuals and researchers, particularly in large population samples.[3] Although 24-h recalls and weighed food records (WFRs) have been used successfully, the resource burden and economic constraints of these methods make them unsuitable for most large scale studies.[4] Food frequency questionnaires (FFQs) have a lower respondent burden, are relatively inexpensive, do not require trained interviewers and can be semi-automated using technological administration, rendering them practical for large epidemiologic studies.[5] Frequency data can explain much of the variation in dietary intake and FFQs can provide sufficient accuracy to rank individuals in terms of risk for subsequent health outcomes.[6] FFQs have been used in adults to predict associations

Abbreviations: FFQ, food frequency questionnaire; AES, Australian Eating Survey; WFR, weighed food record; ICC, intra-class correlation coefficient; ACAES, Australian child and adolescent eating survey; CSIRO, Commonwealth Scientific Industrial Research Organisation; ACCV, Australian Cancer Council of Victoria; BMI, body mass index; %E, percent energy; CI, confidence interval.

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between dietary intake and disease specific mortality and morbidity including, colon cancer, heart disease and diabetes.[7]

In Australia, the Commonwealth Scientific Industrial Research Organisation (CSIRO) developed a FFQ in the early 1980s[8] and the Australian Cancer Council of Victoria (ACCV) developed a FFQ for adults in the late 1980s.[9] However, evaluation of the performance of the CSIRO FFQ showed it had limited validity and the ACCV FFQ, also known as the dietary questionnaire for epidemiological studies (DQES) was designed for a specific population of 40–69 year old men and women living in Australia but born in Greece, Italy or Australia.[9] Both of these instruments are now over 25 years old and the Australian food supply has changed significantly over that period. While an Australian study reported the reproducibility, of a FFQ in adults with a mean age of 60 years,[10] it did not evaluate validity, nor did it consider nutrient intakes. The Australian Eating Survey (AES) was developed in response to these gaps. Therefore the aim was to assess the reproducibility and comparative validity of nutrient intakes derived from a semi-quantitative, self-completed FFQ designed for adults residing in Australia.

2. Materials and methods

2.1. Participants and recruitment

The population of interest was healthy adults living full-time with at least one child aged 8–10 years, living in the Hunter and Great Lakes regions of New South Wales, Australia, so as to potentially extend the age range and use of a previous FFQ validated for use in children aged 9–16 years.[11] Potential participants were recruited through a range of avenues, including newspapers, community notice boards and school newsletters.

2.2. Study design

Participants completed the test measure AES FFQ and the reference measure, a 3-day weighed food record, on two occasions, approximately six months apart. Round 1 occurred from September 2010 to July 2011 and Round 2 between January 2011 and February 2012. A brief assessment session was also conducted at both time points to collect anthropometric measurements.

2.3. AES FFQ

The AES was self-completed during the assessment sessions in Round 1 and 2. The adult AES FFQ was modified from the Child and Adolescent Eating Survey' (ACAES) that had been previously validated for youth[11] by replacing the portion sizes with adult serve size data. Validation studies using biomarkers in conjunction with the ACAES have been conducted using plasma carotenoids as marker of fruit and vegetable intakes,[12] red blood cell membrane fatty acids and dietary fat[13] and doubly labelled water to evaluate validity of reporting total energy intake[14] highlighting its utility in assessing a range of dietary components.

AES is a 120-item semi-quantitative FFQ with 15 supplementary questions regarding age, use of vitamin supplements, food behaviours and sedentary behaviours. Standard portion sizes for adult men and women were determined for each food item using data derived from the most current National Nutrition Survey[15] from unpublished data purchased from the Australian Bureau of Statistics and the 'natural' serving size from standard items such as a slice of bread. AES is designed as a self-administered tool, to collect information about the dietary intake of Australian adults over the previous 6 months. An individual response for each food, or food type, is required, with frequency options ranging from 'Never' to '4 or more times per day' and for some beverages up to '7 or more glasses per day', but varies depending on the item. The FFQ groups food items according to their food group which includes; drinks, breads and cereals, dairy food, main meals, sweets and snacks, fruit and vegetables. The frequency categories for seasonal fruit were calculated by adjusting for the number of months per year the fruit was available.

Nutrient intakes were computed using Australian AusNut 1999 database (All Foods) Revision 17 primarily, and AusFoods (Brands) Revision 5 (Australian Government Publishing Service, Canberra). The estimated mean individual daily intake for 20 macro- and micro-nutrients was calculated using FoodWorks (version 3.02.581, Xyris Software Australia, Highgate Hill, Queensland).

2.4. WFR instrument

The reference method was two three-day WFRs completed in conjunction with the assessment sessions time periods in Round 1 and 2. At the baseline assessment session participants were advised to maintain usual eating habits and detailed instructions and a demonstration of how to weigh and measure foods was given by Accredited Practising Dietician (APD) research assistants. All food and drink consumed was weighed and recorded, not including medications or supplements, using SOENLE Venezia electronic kitchen scales (accuracy $\pm$ 1 g) (Soehnle-Waagen GmbH & Co, Murrhardt, Germany) which were provided to participants. The brand name of products was recorded and detailed recipes recorded for home prepared dishes. The WFRs were completed over three consecutive days and included at least one weekend day. Record sheets with written instructions were provided for Round 1 and 2 and returned in prepaid envelopes. Daily nutrient intakes were estimated from the WFR by entering the itemised foods and beverages into Foodworks (version 3.02.581, Xyris Software Australia, Highgate Hill, Queensland) using the same database as for the AES FFQ nutrient data and following a standardized protocol by one APD research assistant to reduce error.

2.5. Ethics

Procedures followed were in accordance with the Helsinki Declaration of 1975 and as revised in 1983 with the protocol for this study was approved by the University of Newcastle Human Research Ethics Committee (Approval No. H-2010-1170).

2.6. Statistics

Medians and interquartile ranges were calculated for all nutrients. Univariate relationships were assessed using Fisher's exact tests to compare categorical variables by sex within round, and exact symmetry tests to compare categorical variables by sex on paired data. Continuous variables were similarly assessed using Wilcoxon rank-sum tests and Wilcoxon signed-rank tests for paired data.

Reproducibility was evaluated using all participant data in both WFR and FFQ by comparing the two rounds using Pearson correlations (ρ), which were estimated by fitting simple linear regression models to standardized nutrient data and using standard errors clustered on family, given some of the participants were spouses. The normality of the residuals from these models was assessed graphically using normal probability plots and where a lack of normality was observed, square root and cubed root transforms were considered. Comparative validity was assessed using the same methods applied to the difference between FFQ and WFR.

To address the issue of a non- random sample and more than one participant per family, correlation coefficients have also been calculated via a linear regression model and using standard errors

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