ORIGINAL ARTICLES

VALIDATION OF A FOOD FREQUENCY QUESTIONNAIRE IN OLDER SOUTH AFRICANS

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Objectives. To assess the validity of a 213-item semi-quantified food frequency questionnaire (FFQ) in estimating habitual energy and protein intake in a sample of older South Africans. Repeatability of the FFQ was assessed by comparison of reported intakes after a 6-month period.

Design. Cross-sectional analytic study.

Methods. Twenty-one subjects were selected from a baseline sample of 200 non-institutionalised subjects aged 65 years and over in Cape Town, who had previously been randomly selected for a nutrition and health survey using a two-stage cluster design. Reported dietary energy and protein intakes, estimated by means of the FFQ method, were compared with 24-hour energy expenditure, measured by the heart-rate monitoring technique and 24-hour urinary nitrogen excretion, respectively.

Results. Spearman correlation coefficients for reported energy intake (using the FFQ) versus measured energy expenditure were 0.31 ($P = 0.482$) and 0.36 ($P = 0.345$) for men and women, respectively. Men tended to underreport energy intake, while women tended systematically to overestimate energy intake by 21% and 25%, respectively. In men, reported protein intake using the FFQ closely matched urinary protein excretion and a good association between the two measures was found ($r = 0.62$; $P = 0.061$). In women, no association was found between reported protein intake and urinary nitrogen excretion. The FFQ resulted in a twofold overestimate of protein intake, based on urinary nitrogen excretion. In women, correlations between 6-month repeated measures of energy and protein intake using the FFQ were 0.69 ($P = 0.067$) and 0.61 ($P = 0.053$), respectively; however a poor between-measure association was found in men.

Conclusions. The study findings demonstrate that the semi-quantified FFQ method underestimated food energy intake in older men and overestimated both energy and protein intake in older women.

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A dietary assessment method undoubtedly requires some measure of validity (whether relative validation with another dietary method or validation against a biomarker) for use in a target population. Dietary assessment in elderly people of low socio-economic status entails particular methodological problems because of possible memory loss, poor visual acuity and low literacy and numeracy skills. The weighed dietary record method has been shown to be the most accurate method of dietary assessment in British women aged 50 - 65 years;[1] however, this method requires a high degree of respondent co-operation and assumes basic literacy. For epidemiological studies, a single 24-hour recall method is rapid and simple to administer, but does not take into account day-to-day dietary variation.[2] Recently, good agreement was demonstrated between the food frequency questionnaire (FFQ) method and a direct observation of foods purchased and consumed in the homes of 3 000 elderly Australians.[3]

In 1993, a nutrition and health survey was undertaken of 200 South Africans aged 65 years and older in Cape Town, in which a semi-quantified FFQ was used to assess dietary intake.[4] Six months following the main survey, a validation study was undertaken to assess: (*i*) the validity of a 28-day food frequency questionnaire by comparing reported energy and protein intakes with measured 24-hour energy expenditure and urinary nitrogen excretion, respectively, and (*ii*) to assess the repeatability of the FFQ after a 6-month period.

METHODS

In 1993, a sample of 200 non-institutionalised subjects (104 women; 96 men) aged 65 years and older, resident in the Cape Flats, was recruited for a cross-sectional analytic study, using a two-stage cluster sampling technique based on 1991 population census data.[5] The study formed part of the International Union of Nutritional Sciences (Committee on Nutrition and Ageing) cross-cultural studies on food habits and health in later life.[6] Exclusion criteria included mental confusion, assessed on the basis of a subject's inability to answer three questions relating to his/her name, address and the current year.

Six months after the main survey, a convenient subsample of 21 subjects (11 women; 10 men) was drawn from the original sample to validate the dietary methodology of the FFQ used in the main survey. Written informed consent was obtained from all participants and the study was approved by the Ethics and Research Committee of the University of Cape Town and Allied Teaching Hospitals.

Main survey

Dietary assessment

Four trained fieldworkers visited subjects in their homes and administered a pretested semi-quantified FFQ comprising 213 food and drink items, including composite dishes and popular traditional dishes, such as *biryani, roti, salomi, vetkoek, samoosa,* *stamp-en-stoot* and *snoekkopsop*.* The FFQ included items on the types of foods and drinks consumed, the frequency of consumption and the quantity consumed at a meal. The reference period was the previous month, which has been shown to be of sufficient duration to allow accurate assessment of nutrient intakes while accounting for day-to-day variation.[7-9] Standard household measuring utensils, foam food models and actual food items were used to quantify food portion sizes. The reported monthly food intake was quantified using the National Research Institute for Nutritional Diseases *Food Quantities Manual*[10] and divided by 28 to yield daily food intake in grams. Average daily nutrient intake was calculated using the SAS computer package.

Anthropometric assessment

Body mass was measured to the nearest 0.5 kg with the subject standing barefoot, wearing light clothing, on a calibrated I.I. Hanson bathroom scale. Standing height was measured to the nearest 0.5 cm, with the subject barefoot and the head held in the Frankfurt horizontal plane, using a headboard placed at right angles against a wall. Body mass index (BMI) was calculated as mass (kg)/height squared (m^2). Whole-body bio-electrical impedance was measured at 50 kHz using a standard tetrapolar bio-impedance monitor (Bodytrak), with the subject lying supine, as described by Lukaski *et al.*[11]

Validation study

Subjects who had fasted overnight were collected from their homes by fieldworkers in the early morning and taken to the laboratory. Weight and height measurements were repeated by a single observer.

Assessment of habitual physical activity using 24-hour heart rate monitoring

Resting metabolic rate (RMR) was measured in the post-absorptive state, after a minimum of 30 minutes of supine rest. Respiratory exchange measures were collected for a 30-minute period and the mean oxygen consumption (VO_2), carbon dioxide production (VCO_2) and the respiratory exchange ratio (RER) were determined. VO_2 was measured using a ventilated-hood, open-circuit system for indirect calorimetry. Mixed, expired air was sampled continuously for oxygen and carbon dioxide content using an Ametek S-3A/1 oxygen analyser and Ametek CD-3 carbon dioxide analyser (Pittsburgh, Pennsylvania), respectively. Analysers were calibrated before and after each test using analytical grade gases of known concentration. VO_2, VCO_2 and RER were then calculated each minute for the duration of the trial using computer software (Craig Mason-Jones, Lateral Alternative, Cape Town). Respiratory exchange data were used to calculate energy expenditure and substrate utilisation by means of conventional conversion equations.[12] The coefficient of variation for three replicate measures on separate days in weight-stable persons for this technique is 3.4% in this laboratory.

Two hours after the determination of resting energy expenditure and a light breakfast, the oxygen consumption and heart rate of the subjects were measured at rest, while lying down, while sitting and while standing, and in response to controlled, light, moderate and vigorous treadmill walking. These determinations was made using a one-way Hans-Rudolf valve and on-line determination of oxygen consumption, as reported previously.[13] From these measurements, individual regression equations were determined for each subject, to predict energy expenditure at any given heart rate above the resting heart rate. This method has been described by Spurr *et al.*[13] and Livingstone *et al.*[14] Following the estimation of individual heart rate/ oxygen consumption regression equations, the subjects were fitted with a heart rate monitor (Polar Advantage XL, Polar USA, Stanford, Conn.). These heart rate monitors were attached by a lightweight elastic belt worn around the chest and the transmitter was worn as a 'watch' on the wrist. Heart rate was recorded each minute for 24 hours. From these data and from the regression equations, total daily energy expenditure was estimated for each subject. Energy expenditure during daily activities was determined by calculating the energy expenditure corresponding to a given heart rate using the heart rate/energy expenditure regression equations generated for each subject. The relationship between heart rate and energy expenditure is curvilinear, with little change in energy expenditure associated with postural changes in heart rate from lying down to sitting and standing. Therefore, the individual linear regression equations were only used to predict energy expenditure for heart rates above the previously determined 'flex' heart rate.[15] Flex heart rate in the present study was defined as the mean of the highest heart rate while standing and the lowest heart rate during the first stage of treadmill walking. For sedentary activities below the flex heart rate, the mean energy expenditure for lying, sitting and standing was used to predict energy expenditure.

Sleeping energy expenditure was estimated by subtracting 10% from measured resting metabolic rate and multiplying the estimated sleeping metabolic rate by total minutes of sleep. Thus, total daily energy expenditure (TEE) in kJ/day was calculated as follows (adapted from Ceesay et *al.*[15]): [(RMR -(RMR x 10%)) x ST] + (BFEE x BFT) + (Flex EE x Flex ET), where: ST = minutes of sleep; RMR = measured resting metabolic rate (kJ/day); BFEE = average energy expenditure

* *Biryani* is a dish consisting of rice, lentils, meat or vegetables, potato, boiled egg and exotic spices. A *roti* is a flat unleavened Indian bread similar to a savoury pancake, fried in sunflower oil. A *salomi* is a roti filled with savoury or curried mince, frequently sold by street vendors. A *vetkoek* is a deep-fried dough ball. A *samoosa* is an Indian pastry triangle with a curried mince/vegetable and onion filling deep fried in sunflower oil. *Stamp-en-stoot* is a thick soup consisting of samp (crushed corn kernels), sugar beans, stock cubes, meat bones, onions, carrots and tomatoes. *Snoekkopsop* is a soup made by simmering the head of a snoek (an oily fish) with onion, tomato, green pepper and seasoning.

(kJ/day) for those activities below flex heart rate (lying down, sitting, standing); BFT = number of minutes excluding sleep during which the heart rate is below flex heart rate; flex EE = average energy expenditure (kJ/day), calculated from the regression equations for all minutes at or above the flex heart rate; flex ET = number of minutes excluding time spent below the flex heart rate or sleeping.

The energy expenditure associated with physical activity (kJ/day) was calculated by subtracting the daily resting metabolic rate from the total daily energy expenditure. The ratio between total daily energy expenditure and resting metabolic rate and the ratio between reported daily energy intake and resting metabolic rate were calculated. These ratios provide an indication of: (*i*) the daily energy requirement of free-living older persons in relation to their resting metabolic rate; and (*ii*) the portion of total daily energy expenditure which may be attributed to activities of daily living and other physical activities. The measured resting metabolic rates were compared with the predicted resting metabolic rate values for men and women aged 60 years or more.[16]

Dietary assessment

Each subject was interviewed by the same fieldworker as in the main survey to assess food energy and protein intake, using the original FFQ. Foam food models and household measuring utensils were used to quantify portion sizes in both methods.

24-hour urinary nitrogen excretion

Subjects were instructed to collect all urine passed during the 24-hour period for which the heart rate monitor was worn (i.e. the day prior to attending the laboratory) and were provided with funnels and 2-litre collection bottles. Total urinary urea values (g/day) were analysed using an enzymatic rate method. Daily urinary nitrogen (N) excretion was calculated as urea (g) x 0.560. Daily protein excretion (g) was calculated as: (N (g) x 6.25) + (estimated average non-urinary losses of N (i.e. 2.0 g) x 6.25).[17]

Statistical analyses

Results are given as means and standard deviations. Differences in reported energy and protein intake, estimated using the FFQ were compared with estimates using biomarkers. The standard deviation of the mean differences between the two measures, in each case, was given as a measure of dispersion of the differences. Wilcoxon signed rank test (for non-parametric data) was used to test these differences ($\alpha = 0.05$). Spearman's correlation coefficient was used to investigate the association between reported food energy and protein intake and measured energy expenditure and urinary protein excretion, respectively. Reproducibility of the FFQ was assessed by comparing the reported energy and protein intake at the second interview (FFQ2) with that reported during the main survey (FFQ1) using the Wilcoxon signed rank test.

RESULTS

Complete energy expenditure data were obtained for 6 men and 8 women in the subsample of 21 subjects. Of the remaining 7 subjects, the laboratory data on 5 subjects were uninterpretable as a results of subjects' excessive anxiety associated with the novelty of the task, while in 2 subjects heart-rate monitoring was unsuccessful. All subjects completed a food frequency questionnaire and provided 24-hour urine collections for analyses of urinary nitrogen. To investigate the association between reported energy intake and energy expenditure, only the data on 14 subjects with reliable energy expenditure measurements were used, while in all other analyses, the records of all 21 subjects were used. The mean age of the subjects was 74.9 (7.5) years. The mean anthropometric characteristics of the subjects at baseline are shown in Table I and were not statistically different from the mean values for the total sample of 200 subjects. No significant difference was found between body mass at baseline and at the validation study 6 months later (difference = 0.08 (SD = 3.9) kg and –0.86 (SD = 2.3) kg for men and women at follow-up, respectively).

Table I. Anthropometric measurements of the subjects at baseline — mean (SD)

	Men (N = 10)	Women (N = 11)	Total (N = 21)
Age (yrs)	74.8 (8.3)	75.0 (7.1)	74.9 (7.5)
Height (m)	1.65 (0.07)	1.53 (0.04)	1.58 (0.08)
Mass (kg)	70.2 (14.4)	70.5 (12.2)	70.4 (12.9)
BMI (kg/m^2)	26.5 (6.1)	29.6 (5.2)	28.1 (5.7)
Fat (%)	35.4 (4.0)	49.0 (2.9)	42.2 (7.7)
Fat-free mass (kg)	45.1 (8.3)	36.0 (4.7)	40.5 (8.1)

Energy expenditure — relationship to indices of physical activity and food intake

Indices of calculated energy expenditure, reported energy intake and the ratios of energy intake and total daily energy expenditure relative to resting metabolic rate (RMR) are shown in Table II. No significant differences were found between men and women for any of these variables. RMR, calculated according to fat-free mass (kJ/kg/day) was higher in women than men ($P < 0.05$) (Table II).

Mean predicted RMR was, on average, 7 - 14% higher than measured RMR for women and men, respectively. The difference between measured and predicted RMR values reached significance in men only ($P < 0.05$). RMR was not associated with reported energy intake ($r = -0.21$; $P = 0.452$) or with fat-free mass.

The mean difference between reported energy intake, estimated using the FFQ, and measured energy expenditure is shown in Table III. Similarly, the mean difference between reported protein intake and 24-hour urinary protein excretion is presented in Table IV. In men, the FFQ underestimated

Table II. Measures of total daily energy expenditure, energy expenditure for activities during which heart rate was elevated above flex heart rate, and energy intake

	Men (N = 6)	Women (N = 8)	Total (N = 14)
RMR (kJ/day)	4 970 (639)	4 945 (903)	4 957 (807)
RMR/fat-free mass (kJ/kg/day)	114 (23)	143 (22)*	130 (27)
TDEE (kJ/day)	9 526 (3 591)	7 850 (1 434)	8 569 (2 608)
PAEE (kJ/day)	4 556 (3 820)	2 905 (1 283)	3 611 (2 688)
(Measured RMR)–(predicted RMR) (kJ)	–915 (869)**	–355 (639)	–593 (769)
Energy intake (kJ/day)*	6 918 (3 561)	9 606 (6 570)	8 452 (5 522)
TDEE/RMR	1.96 (0.88)	1.61 (0.31)	1.76 (0.61)
Energy intake/RMR	1.42 (0.79)	2.05 (1.43)	1.78 (1.20)

* $P < 0.05$: Independent t-test for difference between men and women.
** $P < 0.001$: Wilcoxon signed rank test for difference between means using the two methods.
RMR = resting metabolic rate; TDEE = total daily energy expenditure; PAEE = physical activity energy expenditure; Energy intake = reported energy intake, using a food frequency questionnaire (FFQ2).

Table III. Difference between reported mean energy intakes (SD) and calculated 24-hour energy expenditure

Variable	Men (N = 10)	Women (N = 11)	Total (N = 21)
Mean reported energy intake (kJ)			
FFQ2 method	6 955 (2 938)	9 681 (6 579)	8 385 (5 242)
FFQ1 method	7 470 (2 282)	6 730 (1 981)	7 085 (2 110)
Differences between methods (kJ)			
TDEE - FFQ2*	2 612 (2 993)	–1 756 (6 165)	117 (5 380)
Mean % difference	25.3% (34.5)	–21.2% (48.2)	–1.3% (60.2)
FFQ2 - FFQ1	–514 (3 482)	2 951 (5 806)	1 300 (5 045)
Mean % difference	–22.7% (50.7)	8.2% (44.7)	–6.5% (49.0)

* Data on 14 subjects only (6 men, 8 women).
FFQ2 = food frequency questionnaire (validation study); FFQ1 = food frequency questionnaire (original study); TDEE = total daily energy expenditure.

energy intake by 25% (SD = 34.5); in women the FFQ overestimated energy intake by 21% (SD = 48.2). A moderate association was found between reported energy intake using the FFQ method and measured energy expenditure ($r = 0.31$ and 0.36 for men and women, respectively); however, this did not reach significance. An inverse association was found between error in food intake reporting, expressed as a proportion of energy expenditure, and fat mass for men ($r = -0.88$; $P < 0.05$) and women ($r = -0.74$; $P = 0.057$). A similar, but non-significant, trend was found for BMI in men ($r = -0.57$; $P = 0.237$) and women ($r = -0.52$; $P = 0.103$), which suggests that the more obese subjects under-reported energy intake, whereas the leanest subjects tended to over-report energy intake. Change in weight during the 6-month period between the baseline study and the validation sub-study was associated

Table IV. Difference between mean reported protein intakes and urinary protein excretion

Variable	Men (N = 10)	Women (N = 11)	Total (N = 21)
Mean urinary protein excretion (g)	55.4 (13.0)	38.5 (10.4)	46.6 (14.3)
Mean reported protein intakes (g)			
FFQ2 method	58.8 (33.0)	71.3 (49.2)	65.3 (41.7)
FFQ1 method	66.6 (22.6)	52.0 (14.0)	58.9 (19.6)
Differences between methods			
Urine (g) - FFQ2 (g)	–3.3 (25.6)	–32.8 (48.5)*	–18.7 (41.2)
Mean % difference	–1.6% (44.4)	–93.8 % (126)	–49.9% (105)
FFQ2 (g) - FFQ1 (g)	–7.8 (29.9)	19.3 (41.6)	6.4 (38.2)
Mean % difference	–10.3% (46.3)	31.4 (67.4)	11.5% (60.8)

* $P < 0.05$: Wilcoxon signed rank test for difference between means using the two methods.
Urine = 24-hour urinary protein excretion; FFQ2 = food frequency questionnaire (validation study); FFQ1 = food frequency questionnaire (baseline survey).

with error in food intake reporting in men ($r = 0.66$; $P = 0.154$), but not in women ($r = 0.12$; $P = 0.770$).

The FFQ significantly overestimated urinary protein excretion by a mean of 32.8 g/day (SD = 48.5) in women and a poor association was found between the two measures (Table IV). No significant difference was found between reported protein intake and protein excretion in men, and a good agreement between the two measures was found ($r = 0.62$; $P = 0.061$).

Six-month reproducibility of the FFQ

In women, repeatability between the two FFQs (FFQ2 v. FFQ1) for both reported energy and protein intake was shown to be good ($r = 0.69$ ($P = 0.067$) and $r = 0.61$ ($P = 0.053$), respectively); however, for men reporting was inconsistent ($r = -0.43$ ($P = 0.338$) and $r = 0.33$ ($P = 0.317$), respectively).

Discussion

Direct and indirect measurements of energy expenditure have been used to assess the validity of reported dietary intake in older adults; however, few studies have found good individual agreement between intake and free-living expenditure in a variety of different populations.[18,19] The reported energy intake of older Dutch subjects, using both 4-day dietary records and an FFQ method, has been shown to underestimate energy expenditure, calculated using the doubly labelled water technique, by about 9%,[20] independent of the dietary method used. Similar underestimates of food reporting, ranging between 5% and 24%, have been shown in studies of younger adults, both obese and of normal weight.[21,22]

In the present study, reported energy intake, estimated using a semi-quantified FFQ, was compared with daily energy expenditure calculated using the heart-rate monitoring technique, a method which has previously been shown to be a valid estimate of free-living energy expenditure compared with the doubly labelled water technique.[14,15] A 16-day weighed record has been shown to be the most accurate method of dietary assessment in British women aged 50 - 64 years;[1] however, the use of weighed methods was not feasible in the present sample because of their low educational status (over half of the sample had received no secondary school education) and inaccessibility to automated equipment which does not require recording or computation by subjects. The FFQ used in the present study referred to the previous month, which is the time period that has been shown to account sufficiently for day-to-day variation, a factor which, in addition to short-term memory loss, limits the use of the 24-hour recall method in older adults.[7-9]

A moderate association was demonstrated between reported energy intake and measured energy expenditure within individuals ($r = 0.31$ and 0.36 for men and women, respectively). The lack of significance of the correlation coefficients is probably related to the small sample size. On average, the FFQ underestimated energy expenditure by about 25% in men and overestimated energy expenditure by about one-fifth in women. The large standard deviations of the mean reported energy intake in both sexes indicate a wide variation in intake across individuals. Similarly, the accuracy of food intake reporting varies widely between subjects, as indicated by the large standard deviations in the differences between the paired observations of reported energy intake and measured expenditure. This finding probably reflects the substantial day-to-day variability in reported dietary energy intake which has been shown by Edholm *et al.*[23] It is commonly assumed that the coefficient of variation for the true day-to-day variability in energy intake reporting is 20%,[24] which is in line with the magnitude of error found in the present study. Consistent with the findings of numerous studies, which have demonstrated under-reporting of food intake by obese subjects,[25-27] in the present study both men and women with higher BMIs and fat mass tended to under-report energy intake, while thinner subjects tended to over-report energy intake. However, the association between the direction of the error in food intake reporting and weight change over the previous 6-month period in men suggests that the discrepancies between reported energy intake and energy expenditure may reflect actual changes in energy balance, rather than inaccuracies in food intake reporting. In women, however, this association was not found. Further interpretation of the data in this regard is hampered by the unavailability of information on present energy balance.

Differences between men and women in respect of accuracy of food intake reporting may reflect gender differences in food preparation and therefore awareness of the types and quantities of food eaten. In the 1993 baseline sample, more than two-thirds (67%) of the women prepared meals for the household, whereas over half (56%) of the men had their meals prepared for them by their spouse.[4]

The energy intake/RMR ratio has been suggested as a means of assessing the validity of group estimates of energy intake. In weight-stable individuals this ratio should approximate the total energy expenditure/RMR ratio.[28,29] In the present study, the energy intake (using the FFQ/RMR ratio) was lower than the expenditure/RMR ratio in men (1.42 v. 1.96) and higher in women (2.05 v. 1.61), which further suggests that the FFQ underestimated energy intake in the men and overestimated intake in the women. The physical activity ratio (PAR) considered to be a minimal acceptable measure of daily energy requirements in this age group is 1.5 times the RMR.[30] However, recent studies on daily energy expenditure in older people have suggested a PAR higher than the recommended 1.5. values for PAR of 1.75[31] and 1.81[32] have been reported for elderly men and women, respectively, in studies using methodology similar to that of the present study. Consistent with the findings of Visser *et al.*,[33] which demonstrated that prediction equations overestimate RMR by about 10% in elderly men and women, the values for predicted RMR were about 7 - 14% higher than measured RMR in women and men, respectively, in the present sample. These findings highlight the inherent error that may be associated with the validation of one dietary method relative to another in elderly samples, using standard prediction equations in the absence of energy expenditure data.

The FFQ method accurately assessed urinary protein excretion in men and the association yielded a similar correlation coefficient ($r = 0.62$) to that reported for the association between 16-day weighed dietary records and urinary nitrogen in a study of 156 middle-aged women.[1] Gross misclassifications were, however, found in women in the present study. The importance of using a urine collection marker, such as para-amino benzoic acid, when attempting to validate dietary assessment methods for protein intake estimates has been highlighted by Bingham *et al.*[1] Various authorities suggest that 1 g/kg body weight is the intake necessary for maintaining plasma protein levels and tissue protein content at the minimal inevitable rate of loss associated with ageing in older adults.[34,35] Based on this criterion, the estimated daily protein requirements using measured urinary nitrogen excretion in the present study falls far below crude estimates using body weight, particularly for women, which suggests that 24-hour urine collection was incomplete in some subjects. This finding highlights methodological problems associated with dietary assessment validation studies in older free-living adults.

Observer bias was minimised in the assessment of the 6-month reproducibility of the FFQ by intensive training of the interviewers before the original survey and retraining of interviewers before the validation survey, and by ensuring that each subject was re-interviewed by the same fieldworker as in the main survey. Repeated measures of both energy and protein intakes were comparable in women but not in men, which suggests that the error in food intake reporting is systematic in women. The findings suggest that in men changes in energy balance had occurred since baseline, indicated by the association between weight change and the difference between food-intake reporting and energy expenditure. The gender difference in reproducibility of the FFQ may further reflect differences in involvement in food purchasing and preparation. Thus, it may be argued that in men the FFQ yielded a valid measure of energy and protein intake; however, repeatability of the questionnaire (the reasons for which warrant further investigation) was poor, while in women food reporting is consistent over time, but is not accurate.

CONCLUSIONS

Although the sample size was small, conclusions about the validity of a semi-quantified FFQ in estimating the habitual energy and protein intake of older South Africans are as follows: (*i*) daily energy requirements are higher than would be expected, using standard prediction equations which include a PAR factor of 1.5; (*ii*) differential sex differences in food intake reporting are evident — men tended to under-report energy intake while women tended to overestimate energy intake by about 21 - 25%; (*iii*) the FFQ accurately estimated protein intake in men; however, assessment of the validity of the FFQ to assess protein intake was limited in women because of the apparent incomplete 24-hour urine collection; and (*iv*) 6-month repeatability of the FFQ was good for women, indicating a systematic error in overestimation of food intake; however, poor between-measure association was found in men in this sample, which may reflect changes in energy balance during the 6-month follow-up period.

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