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ORIGINAL ARTICLE

Nutrition in advanced age: dietary assessment in the Newcastle 85+ study

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Background/Objectives: Assessing food choice and/or nutrient intake in older people, particularly the oldest old (85 years and over), presents particular challenges. In some cases the respondent may have little or no involvement in food acquisition or preparation, in others, cognitive/memory impairment may restrict the ability to recall intake, or physical limitations may affect the ability to record intake. The assessment may therefore need to involve whoever provides care for the older person, of whom there may be more than one. For these reasons, there is a need for validated methods for dietary assessment in large populations within this age range. The need is particularly acute in view of the secular increase in the numbers of older people and the interest in the role of nutrition in maintaining health and ameliorating age-related decline. This paper describes a comparison of two different methods of dietary assessment within the Newcastle 85+ Study; a UK cohort study of health and ageing in the oldest old.
Methods: Two methods, the food frequency questionnaire (FFQ) (based on broad recall of the previous 12 months intake) and the repeated multiple pass recall (MPR) tool (based on detailed recall of the previous day's intake on two separate occasions), were applied in two different groups of approximately 85 individuals aged 85 years. FFQ data were collected during a pilot study conducted between 2003 and 2004, MPR data were collected in the main Newcastle study in 2006. Relative validity was measured by calculation of the ratio of reported energy intake to estimated basal metabolic rate (EI/BMR) and by comparison with dietary intakes reported for subjects of similar age in the UK National Diet and Nutrition Survey.
Results: EI/BMR ratios for MPR were 1.56 and 1.39 for men and women, respectively, and for FFQ were 2.18 and 2.14. The FFQ was found to overestimate energy and nutrient intake considerably. The MPR gave more realistic estimates of energy and nutrient intakes, and was found to be acceptable for use in this population group. However, use of this tool required greater investigator (nurse) time, extra resources for training and quality assurance and additional time and expertise in data processing.
Conclusions: In the Newcastle 85+ Study, where the overall aims include detailed investigation of diet in relation to many variables describing biological, clinical and psychosocial status, we concluded that MPR was the preferable method, although there remains a need for non-subjective methods for assessing dietary intake, that is, biomarker approaches, which can give a comprehensive and objective assessment of dietary exposure.
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Introduction

The usual aim of dietary assessment is to collect a true record of the habitual food intake of an individual or a group of individuals. When dietary assessment is not the sole or principal research aim of a study, it is not uncommon to have requests for 'two or three questions, which will give an assessment of dietary intake'. Progress in the development of biomarkers may mean that, in the future, such questions can be addressed by the collection and analysis of biological samples, but meanwhile dietary assessment remains labour intensive and therefore is costly. The weighed dietary intakes, estimated weight food diaries, food records and food frequency questionnaires (FFQs) require varying levels of commitment, time and cognitive ability from the respondent and time and skill of the researcher.

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Dietary assessment at any life stage presents challenges. The method of choice must be driven not only by the question to be answered but also, with equal importance, by the population group to be assessed. Assessing food choice and/or nutrient intake in older people, particularly the oldest old (85 years and above), presents particular challenges: the respondent may have no knowledge of, or involvement in, food acquisition or preparation; lack of involvement in food preparation or unfamiliarity with foods may limit the ability to accurately name or describe the foods consumed; impaired cognition and/or poor memory may prohibit or restrict the ability to recall intake; ability to record intake may be limited by physical limitations imposed by age as well as by sensory impairment and communication difficulties. The reporting may need to rely on a carer as a proxy reporter, and this may then be compounded by the fact that a number of individuals or carers may be involved in the care of the respondent on any given day.

Data on the dietary intake of the oldest old are scarce. The UK National Diet and Nutrition Survey (NDNS) of people aged 65 years and over (Finch *et al*., 1998) included dietary data collected by 7-day weighed intakes from 459 people aged 85 years and over. No retrospective methods of dietary assessment had been used earlier in this age group in the United Kingdom.

Yet, older people now represent the fastest growing sector of our population, with the largest increase predicted for those aged 85 years and over (Vaupel *et al*., 1998; Wilmoth, 2000; ONS, 2003). Over the next 20 years, the population of the United Kingdom and Wales will increase by almost 10%; in comparison, the number of people aged 85 years and above will increase by around two thirds (Wanless, 2006). In addition to the policy priority assigned to improving the healthcare of older people within the United Kingdom, principally through the National Service Framework for Older People (Department of Health, 1999 and 2001), there is great scientific interest in studying the health of the oldest old and the exposures that modulate individual health trajectories such as nutrition.

The Newcastle 85+ study is a population-based longitudinal study of a cohort of 800 85-year-olds from Newcastle upon Tyne and North Tyneside, UK, which was commenced in 2006. (Collerton *et al*., 2007). Jointly funded by the Medical Research Council and the Biotechnology and Biological Sciences Research Council, the Newcastle 85+ study will assess, in unprecedented detail, the spectrum of health in people aged 85 years and over and examine the associations of health trajectories with biological, medical and psychosocial factors as the cohort ages.

This study describes our experience of using two methods of dietary assessment in two different groups of very old people within the Newcastle 85+ study; the FFQ in 82-pilot study participants (conducted in 2003–2004) and the repeated multiple pass recall (MPR) tool in 89 participants in the main study in 2006.

Participants and methods

In the Newcastle 85+ study, all individuals born in 1921 (that is, who turned 85 years in 2006) and registered with a participating general practice in Newcastle or North Tyneside were eligible for recruitment, whether living at home or in an institution and regardless of their state of health (except for exclusion by the general practitioner as end stage terminally ill). Recruitment took place in 2006–2007. In 2003–2004, in preparation for the main study, a pilot study was undertaken with 89 individuals aged around 85 years who were recruited from a convenience sample of four general practices in Newcastle.

In both the pilot and main studies, participation entailed a detailed multidimensional health assessment, with data collected by means of questionnaires, measurement/function tests and blood tests, all conducted in the participant's home setting by a research nurse. Information was gathered during three interviews at approximately weekly intervals; each interview lasted about 90 min, together with a brief visit to obtain fasting blood samples. Nutrition was identified as a key domain within the Newcastle 85+ study, and it was essential that an established and widely accepted dietary assessment method, which had been shown to be valid in the collection of habitual dietary intake, was used. In addition to dietary assessment, markers of body composition (demispan, weight, waist and hip circumference) were measured and biological markers of nutritional status collected.

Limitations guiding choice of method

As the total time for participant assessment could not be increased, and, with competing demands from other study domains, the method of dietary assessment chosen had to be suitable for administration within strict time constraints, a maximum of 40 min was available.

All data were collected by research nurses, and therefore the dietary assessment method had to be suitable for administration by a non-nutritionist, after appropriate training.

No data recording was to be required of the participants outside of the visits by the research nurse; therefore, the dietary assessment method to be used had to rely on retrospective reporting.

In addition to a limitation on nurse time for data collection, there were also limited resources for data processing that needed to be time efficient and ideally would not require specialist-data processing.

Method 1:

FFQ

Given the constraints outlined above, an FFQ was the first method of choice for use in the pilot study. FFQs collect individual level dietary intake data and have been used

extensively in nutritional epidemiology (Bingham *et al*., 2001; Liu *et al*., 2003). As with all retrospective methods, FFQs have advantages and disadvantages, which have been described earlier (Bingham, 1987). Table 1 represents these advantages and disadvantages along with comments on considerations relating to the use of FFQs for the Newcastle 85+ pilot study. If FFQs are used to assess intake of a specific nutrient, for example, iron intake, only questions that cover the major dietary sources of that nutrient need to be included. If, however, as in the Newcastle 85+ study, the aim is to assess total diet (foods, energy and a wide range of nutrients), the number of foods included in the FFQ has to be extensive. The European Prospective Investigative Study of Cancer (EPIC) FFQ was chosen as an extensively validated (Bingham *et al*., 2001) and widely utilized FFQ designed to assess dietary intake (Lamont *et al*., 2000; Titan *et al*., 2001; Cade *et al*., 2007; Linseisen *et al*., 2007). In doing so, it was recognized that although the EPIC FFQ had been validated in a UK-adult population, this had not included adults aged 85 years and above. The EPIC FFQ lists 134 items and asks respondents to indicate the frequency (in the past 12 months) with which each item has been consumed (frequencies range from 6+ per day to never or less than once a month). No individual level assessment of portion size is included, and the method relies on predetermined standard portion sizes. In the Newcastle 85+ pilot study, a slightly modified EPIC FFQ was used with additions of some food items, for example, Yorkshire pudding, and exclusion of others, for example, taramasalata, based on local food preferences. The local food habits and standard portion sizes were derived from a dietary survey of 367 adults aged 16–62 years and living in Newcastle during 1998–2000 (Adamson *et al*., 2000). Although designed to be self-completed, the EPIC FFQs were administered by research nurses to all respondents or respondent proxy reporters according to the protocol of the Newcastle 85+ study.

Method 2: repeated multiple pass 24 h recall

The UK NDNS (Gregory *et al*., 1990, 1995; Gregory and Lowe, 2000; Finch *et al*., 1998 and Henderson *et al*., 2003a, b) have been conducted under the auspices of the UK Department of Health and the Food Standards Agency focusing on different age groups in each survey. To date, all NDNS have used either 4- or 7-day weighed dietary intakes; this method is very resource intensive and imposes a large burden on participants. A review of NDNS showed that those from lower socioeconomic status and minority ethnic groups were under-represented (Henderson *et al*., 2003a, b). To address this gap, the Food Standards Agency planned a survey of those living on a low income, and between 2000 and 2002 a method comparison study was carried out to determine the most appropriate method to collect dietary data from these participants (Nelson *et al*., 2002). A method was sought that would minimize respondent burden and thus increase response rates, but that would be suitable for individual level assessment of dietary intake including portion size. As a result, the repeated ($\times 4$) multiple pass 24h recall (MPR) method was used in the Low Income National Diet and Nutrition Survey (Nelson *et al*., 2007). The MPR method had been developed and used extensively for national surveys by the US Department of Agriculture but had not been used earlier in national surveys in the United Kingdom.

Following concerns about the utility of the modified FFQ in the Newcastle 85+ pilot study and concurrent

Table 1 Retrospective methods in dietary assessment—adapted from Bingham, 1987 (with reference to application of Food Frequency Questionnaires (FFQ) in the Newcastle 85+ study)

Advantages	*Disadvantages*
Quick *(In principle yes but this may not be the case for extensive interviewer administered FFQs)*	Reliant on memory *(Potentially a major limitation in the population to be studied particularly if assessment requires recall over a long-time period)*
Cheap *(Pre-coded with rapid data entry requires minimal researcher time once analysis systems are established)*	Conceptualization skills needed *(May be a problem for some in the 85+ study population)*
Low subject motivation required *(This is potentially a problem in any method of dietary assessment. FFQ attempts to limit respondent burden)*	Observer bias is possible *(Not a problem if FFQ are self administered but potentially an issue in interviewer administered questionnaires; training is essential)*
Low literacy and numeracy skills required *(A positive advantage in this population)*	Reported diet may be distorted *(This may be either by selective memory or reporting but also by social desirability bias when interviewer completed)*
Good cooperation from respondents *(This would usually follow when respondent burden is reduced as in FFQ)*	Requires regular eating habits *(May not be a problem in the older population)*

developments in NDNS methodology for the Low Income National Diet and Nutrition Survey, a small number of the Newcastle 85+ pilot study participants ($n=8$), who were already completing the FFQ, also completed an assessment using the MPR method. The findings of this small study (results not shown), together with a preliminary analysis of the FFQ results from the pilot study, led to the decision that the MPR method should be used instead of the FFQ in the main Newcastle 85+ study.

Protocols for the MPR method as used in the Low Income National Diet and Nutrition Survey (Nelson *et al*., 2007) were kindly provided by Dr M Nelson, Kings College, London, with permission from the Food Standards Agency. Limitations in nurse time were allowed for only 2×24 h recalls on separate occasions, whereas the Low Income National Diet and Nutrition Survey had used 4×24 h recalls, otherwise methods were unchanged. Similar to the FFQ, the MPR is a retrospective method, but, unlike the FFQ, the MPR attempts to assess intake for the previous day only. The MPR uses a protocol for interviewing, which involves a number of 'passes' through the previous day's intake:

Pass 1: *Quick list*. The participant was asked to think back to the earlier day, thinking about what they had done and focusing on the food and drink they had consumed over the entire day. After an initial prompt was given for common items omitted, such as sweets, fruit, biscuits and cakes, all of the recalled intake was recorded without interruption from the interviewer.

Pass 2. *Detailed record*. The participant was asked to think back to the beginning of the day and provide more details, as well as the time and occasion (for example, breakfast), for the foods and drinks recorded in Pass 1. Participants were encouraged to think about events on the previous day (for example, meeting with a friend) that might trigger memories of consumption. Any further intakes recalled at this stage were recorded. Portion sizes for each item consumed were assessed with the aid of a photographic food atlas (Nelson *et al*., 1997).

Pass 3. *Review*. The information recorded was reviewed and a final check made to ensure that the participant was confident that all items had been recorded.

Data analysis

The purpose of this study was to assess the relative validity and to compare the utility of the two methods described above for dietary assessment of people aged 85 years and above. Earlier to a detailed comparison of intakes estimated by FFQ and MPR, the two groups of participants were compared to identify any significant differences in factors (such as general health, long-standing illness and living arrangements) that might influence food choice and preparation.

Method comparison between FFQ and MPR included an assessment of (i) energy intake (EI) relative to estimated basal metabolic rate (BMR), (ii) reported mean daily EI and reported mean daily intake of selected nutrients relative to an accepted 'gold standard', (iii) the relative cost in terms of research nurse time in data collection and in nutrition researcher time for data coding and data entry and (iv) the utility and acceptability of each method to individuals aged 85 and above and to the research nurses administering the methods.

Estimated basal metabolic rate was calculated according to standard equations for men and women aged 75 years and above (Department of Health, 1991):

$$\text{Men } 75+ \text{ years} = (0.0350 \times \text{weight kg}) + 3.434$$
$$\text{Women } 75+ \text{ years} = (0.0410 \times \text{weight kg}) + 2.610$$

Nutritional data (mean and s.d.) reported for the random sample of 96 men and 170 women aged 85 years and above (non-institutionalized) in the NDNS of people aged 65 years and above (Finch *et al*., 1998), collected by 7-day weighed food intake, was chosen as being the best available information on dietary intake for men and women of this age group. This is not without limitations, which are discussed below. Two sample *t*-tests were used to test for differences between the mean dietary intake reported by men and women by FFQ and MPR and the NDNS samples (Finch *et al*., 1998). FFQ and MPR data are represented as box plots; the 'box' of the box plot is made up of the values of the first quartile, the median and the third quartile. The ends of the 'whiskers' represent the smallest values that are not outliers (that is, Q1-1.5IQR and Q3+1.5IQR). NDNS mean and s.d. (Finch *et al*., 1998) are also presented.

Results

Sociodemographics of FFQ and MPR recall samples

The first stage in the analysis was the comparison of the two groups of participants who undertook the FFQ or the MPR. The FFQ group comprised 82 of the 89 people aged around 85 who took part in the Newcastle 85+ pilot study; the remaining seven either dropped out before the FFQ (5) or did not have a weight recorded (2). In all 89 people aged around 85 years made up the MPR group taken from the early recruits to the main Newcastle 85+ study. The number of factors compared between the two groups was restricted to reduce the risk of type 1 errors. The only statistically significant differences between the groups were a very small difference in mean age and in the level of cognition as measured by the Mini-Mental State Examination (MMSE) (Table 2). The FFQ group was on average 0.3 years older than the MPR group and there was a median difference of two in Mini-Mental State Examination score between the two groups. Eight people in the MPR group and three in the FFQ group had a Mini-Mental State Examination score of 19 or below (suggesting moderate or severe cognitive impairment). All but three of these lived with others and the majority were in residential or nursing homes. Proxy reports

Table 2 Comparison of general characteristics of FFQ and MPR groups

	FFQ n = *89* % (n)	*24 h Recall* n = *82* % (n)	*P-value*
Gender			
Female	56.1 (46)	57.3 (51)	0.50[a]
Age in years median (IQR)	85.3 (84.9–85.5)	85.0 (84.8–85.3)	0.01[b]
Years of education median (IQR)	9 (9–11)	9 (9–11)	0.22[b]
Accommodation			0.36[a]
House/bungalow/flat	85.4 (70)	77.5 (69)	
Sheltered with warden	11.0 (9)	14.6 (13)	
Residential or nursing home	3.7 (1)	7.9 (7)	
Number of people lives with			0.18[b]
0	62.0 (49)	51.2 (42)	
1	32.9 (26)	42.7 (35)	
2	3.8 (3)	3.7 (3)	
3	1.3 (1)	2.4 (2)	
General health (self reported)			0.53[b]
Excellent	12.1 (10)	12.4 (11)	
Very good	29.3 (24)	28.1 (25)	
Good	30.5 (25)	40.4 (36)	
Fair	23.2 (19)	18.0 (16)	
Poor	4.9 (4)	1.1 (1)	
Longstanding illness	76.8 (63)	83.0 (73)	0.21[a]
Able to prepare and cook hot meal (self report)			0.44[a]
No difficulty	72.8 (59)	80.9 (72)	
Some difficulty	9.9 (8)	7.9 (7)	
Unable to do alone	17.3 (14)	11.2 (10)	
Problems in eating[c]	25.9 (21)	15.9 (14)	0.08[a]
Mini-Mental State Examination score median (IQR)	29 (27–30)	27 (25–29)	0.01[b]
Geriatric depression scale score median (IQR)	3 (2–6)	3 (2–5)	0.41[b]

Abbreviations: IQR, interquartile ranges; FFQ, food frequency questionnaire; MPR, multiple pass 24 h recalls.
[a]χ^2 test.
[b]Mann–Whitney *U* test.
[c]Indicates positive response to question 'During the past 6 months, have you had any problems eating food because of your mouth, teeth or dentures? ' no examples were given.

were obtained for seven people in the FFQ group and nine in the MPR group. The differences between the groups of this magnitude relative to their age and cognitive ability are unlikely to have any impact on estimates of dietary intake.

Energy and nutrient intake

Table 3 represents the mean daily intake and s.d. for energy, EI to BMR ratio and intake of selected nutrients as measured for men and women by MPR and FFQ and the 7-day weighed food intake mean (s.d.) values as reported by non-institutionalized men and women aged 85 years and above in the NDNS (Finch *et al*., 1998). Figures 1–8 represent graphically the EI, EI to BMR ratio and intake of selected nutrients as measured for men and women by MPR and FFQ along with the corresponding mean and s.d. from the NDNS (Finch *et al*., 1998). Two sample *t*-tests were used to compare the means of nutrient variables reported by the two methods with the means as reported by non-institutionalized men and women aged 85 years and above in the NDNS (Finch *et al*., 1998) with *P*-values as reported in Figure 1 and Figures 3–8. The mean daily EI reported by male participants was 42% higher by the FFQ than by the MPR method (12.96 versus 9.12 MJ, respectively) (Figure 1). As a consequence, EI to BMR ratio was considerably lower for the MPR than for the FFQ approach (1.56 and 2.18, respectively) (Figure 2). For women, the mean daily EI was 53% greater by the FFQ than by the MPR method (10.91 versus 7.10 MJ, respectively) (Figure 1) with correspondingly altered EI to BMR ratios (Figure 2). Sedentary activity is represented by a physical activity ratio (PAR) from 1.0 to 1.4 and light activity from 1.5 to 1.8. In calculating estimated average requirements (EAR) for EI for those aged 60 years and above, an average PAR value of 1.5 × BMR was used (Department of Health, 1991). The estimated average requirements for energy is 8.77 MJ and 7.61 MJ for men and women, respectively. The estimates of mean EI and EI/BMR ratios by the MPR method were within the expected range (men 9.12 MJ and EI/BMR ratio or PAR of 1.56; women 7.10 MJ and EI/BMR or PAR of 1.39), whereas mean EI and EI/BMR ratios as reported by the FFQ method was considerably higher than expected (men 12.96 MJ and EI/BMR ratio or PAR of 2.18; women 10.91 MJ and EI/BMR ratio or PAR of 2.14).

Estimates of % energy derived from fat and protein were similar at ~35 and 14%, respectively, by both the MPR and FFQ methods (Figures 3 and 4), suggesting that both methods preformed well in assessing the overall macronutrient contribution to energy content of the diet. However, intakes of fat and protein (g/day) as measured by the MPR compared more favourably with intakes reported by older people in the NDNS (Finch *et al*., 1998) (Table 3). This was also true for non-starch polysaccharide (Figure 5) and for calcium, iron and vitamin C (Figures 6–8).

Utility, acceptability and resource implications

In principle, the FFQ is a simple-to-use tool that is designed for self-completion and requires no nutritional expertise to complete. As the Newcastle 85+ study protocol required the study nurses to complete the questionnaire by interview with the participants, nurses were given training in the application of the FFQ; however, the training needs for delivery of the FFQ were minimal (one 90 min session followed by 10 audiotaped pilot interviews with a further 90 min feedback session). The FFQ interviews took ~30 min to complete. Data were

Table 3 Daily energy intake, energy intake: BMR ratio and daily nutrient intakes for men and women by food frequency questionnaire (FFQ) and repeated multiple pass 24 h recalls (MPR)

Male participants	*MPR*		*FFQ*		*NDNS*[a]	
	(n = 38) Mean	*s.d.*	*(n = 36) Mean*	*s.d.*	*(n = 96) Mean*	*s.d.*
Body weight (kg)	69.9	(11.2)	71.71	(10.9)	67.3	(10.2)
Energy (MJ)	9.12	(1.57)	12.96	(2.41)	7.20	(1.88)
BMR (MJ)	5.88	(0.39)	5.94	(0.38)	NA	
Energy intake: BMR ratio	1.56	(0.30)	2.18	(0.37)	NA	
Fat (g)	90.1	(25.2)	117.4	(31.0)	69.2	(21.8)
% Energy from fat	37.4	(7.1)	33.6	(5.7)	35.6	(5.3)
Protein (g)	79.9	(20.2)	100.8	(17.7)	61.6	(15.3)
% Energy from protein	15.4	(3.1)	13.4	(2.4)	14.8	(2.5)
NSP (g)	14.2	(7.2)	21.5	(6.6)	11.9	(5.5)
Alcohol (g)	8.5	(14.2)	26.1	(45.6)	7.3	(17.0)
Calcium (mg)	887.9	(319.8)	1081.2	(230.1)	764	(252)
Vitamin C (mg)	95.9	(90.9)	120.9	(48.3)	63.8	(102.7)
Iron (mg)	12.4	(5.8)	18.7	(16.7)	10.6	(4.8)
Female participants	*MPR*		*FFQ*		*NDNS*[a]	
	(n = 51) Mean	*s.d.*	*(n = 46) Mean*	*s.d.*	*(n = 170) Mean*	*s.d.*
Body weight (kg)	62.5	(12.0)	62.1	(12.5)	59.1	(11.5)
Energy (MJ)	7.10	(2.00)	10.91	(2.37)	5.77	(1.50)
BMR (MJ)	5.17	(0.49)	5.16	(0.51)	NA	
Energy intake: BMR ratio	1.39	(0.46)	2.14	(0.53)	NA	
Fat (g)	69.7	(27.1)	107.3	(29.7)	57.6	(19.1)
% Energy from fat	36.5	(7.4)	36.2	(5.1)	36.6	(6.2)
Protein (g)	60.0	(20.2)	90.3	(19.6)	50.8	(15.3)
% Energy from protein	14.9	(3.5)	14.3	(2.7)	15.1	(3.4)
NSP (g)	10.2	(4.4)	20.3	(7.2)	10.0	(4.6)
Alcohol (g)	3.8	(11.2)	5.2	(11.1)	1.5	(3.6)
Calcium (mg)	757.2	(246.5)	972.4	(202.9)	656.0	(261)
Vitamin C (mg)	123.3	(142.3)	134.8	(69.9)	52.4	(39.1)
Iron (mg)	9.9	(5.5)	16.11	(4.3)	7.9	(3.0)

Abbreviations: BMR, basal metabolic rate; NDNS, National Diet and Nutrition Surveys; NA, not applicable.
[a]Mean daily intakes of non-institutionalized men and women in the National Diet and Nutrition Survey (Finch *et al*., 1998).

double-entered from the precoded FFQ forms. During the conduct of the pilot study, the research nurses expressed concerns about the practical application of the FFQ. They reported that some study participants found it difficult to recall their 'usual' intake over the past 12 months. This recall is a complex and cognitively challenging task, and the repetitive nature of the interview required to cover the frequency of consumption of 134 items made it difficult for the nurses to maintain participant interest and concentration throughout the interview process. It is likely that these factors will have had a detrimental impact on the quality of responses and thus on the data collected.

In contrast, the nurses reported that the interactive nature of the MPR interview enhanced participant enjoyment and engagement with the process and thus helped maintain concentration. This is expected to have had a positive impact on the quality of responses. Although the MPR method required recall, participants were asked to recall the previous day only, a less complex task with less reliance on long-term memory than the FFQ. The ability to 'walk the participant through' the previous day aided recall of intake. A further advantage of the MPR over the FFQ was the inclusion of individual level portion size assessment using a photographic food atlas (Nelson *et al*., 1997) rather than reliance on standard portion sizes for each of the 134-food items of the FFQ. The use of the photographic atlas was not without difficulties. A detailed explanation of the scaling of images was required, and the use of white plates on a white

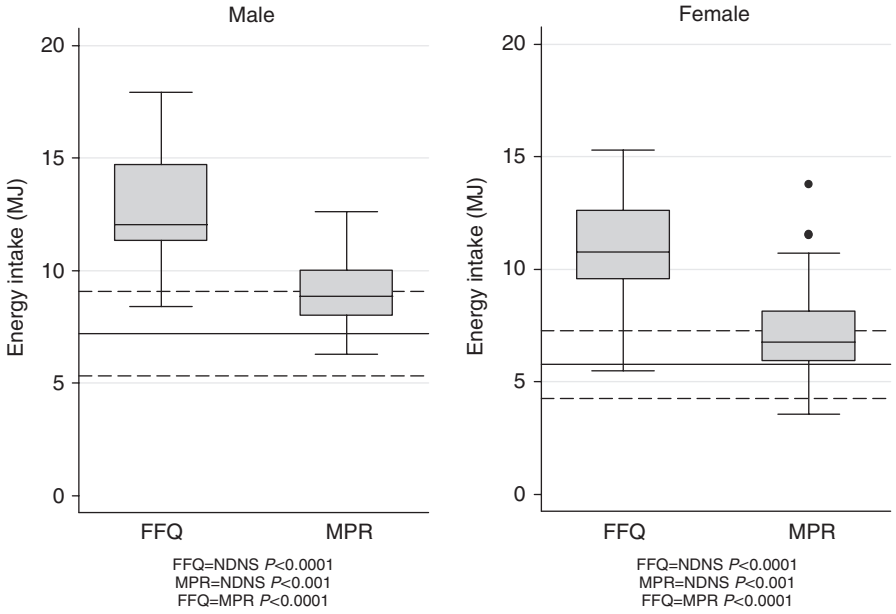

Figure 1 Mean daily energy intake (MJ) as measured by food frequency questionnaire (FFQ) and repeated multiple pass recall (MPR) for men and women. Horizontal solid and broken lines indicate National Diet and Nutrition Survey (NDNS) mean and s.d., respectively (Finch *et al.*, 1998). In the following box plots (Figures 1–8) *P*-values = results of two sample *t*-tests hypothesizing that the mean intake of nutrients collected by repeated multiple pass 24-h recalls and FFQ in Newcastle 85+ study are equal to mean nutrient intake as reported by the NDNS (Finch *et al.*, 1998). A *P*-value below 0.05 indicates that the mean of the MPR or FFQ variable is significantly different from the corresponding NDNS mean. Points above and below the box plots are outliers.

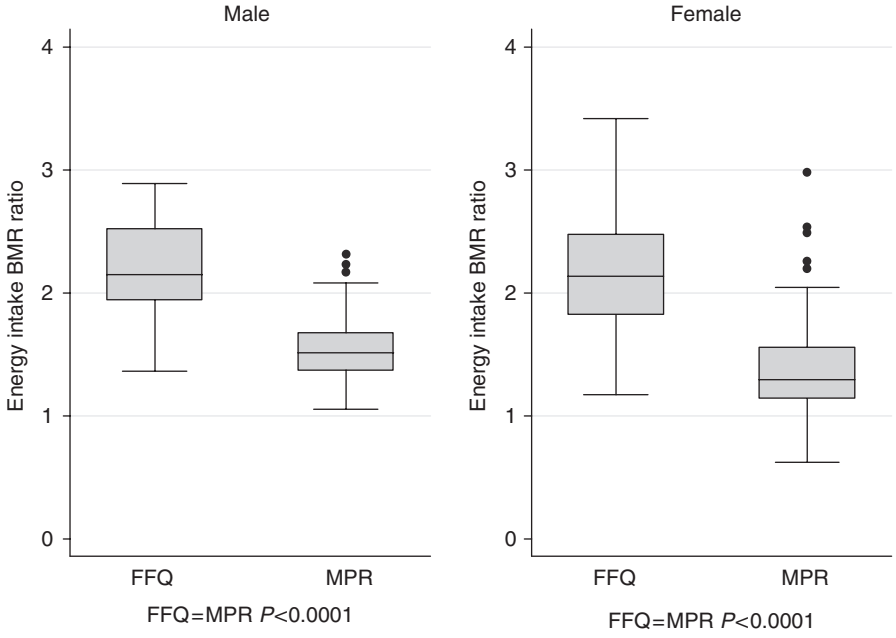

Figure 2 Energy intake to basal metabolic rate ratio for food frequency questionnaire (FFQ) and repeated multiple pass recall (MPR) groups for men and women.

background to display the images was difficult for some to see. Household measures were used with participants who were visually impaired. Disadvantages of the MPR over the FFQ included considerably increased training needs to ensure that nurses could obtain sufficient details on dietary intake at the interview to facilitate accurate coding. The MPR

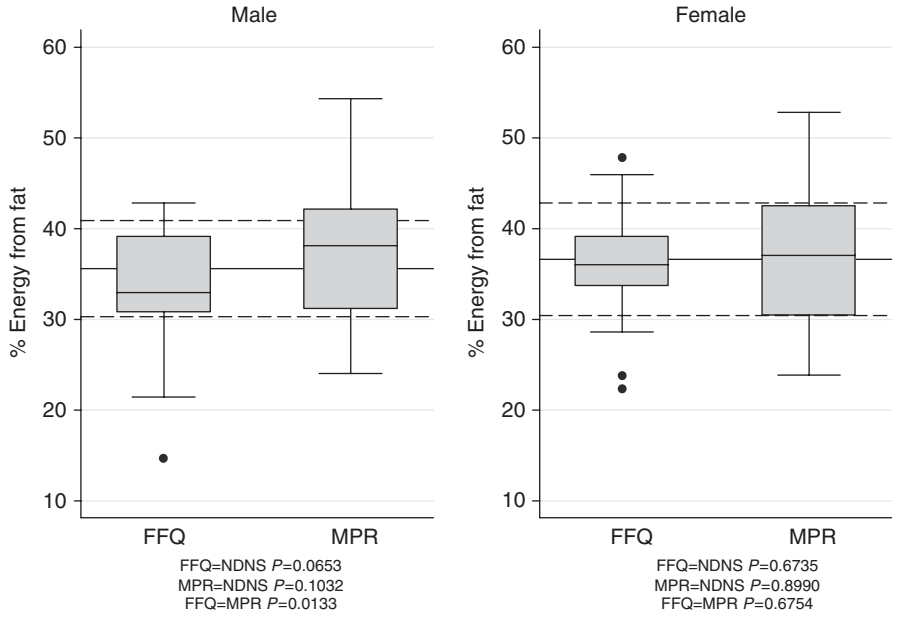

Figure 3 Proportion of total energy derived from fat as measured by food frequency questionnaire (FFQ) and repeated multiple pass recall (MPR) for men and women. Horizontal solid and broken lines indicate NDNS mean and s.d., respectively (Finch *et al.*, 1998).

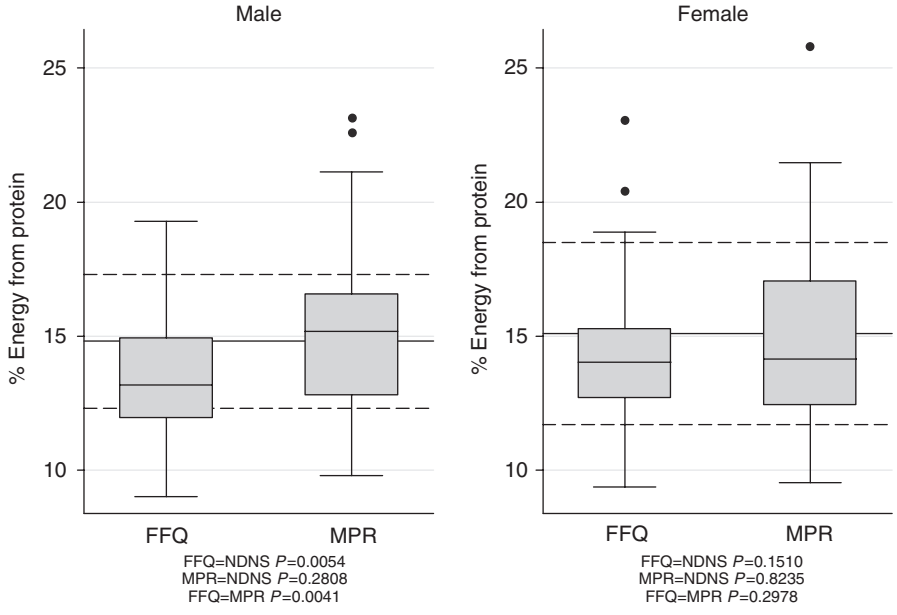

Figure 4 Proportion of energy derived from protein as measured by food frequency questionnaire (FFQ) and repeated multiple pass recall (MPR) for men and women. Horizontal solid and broken lines indicate NDNS mean and s.d., respectively (Finch *et al.*, 1998).

method required detailed protocols, two training sessions each of 2 h, pilot interviews (~5 h per nurse) plus feedback and quality control. In addition, the MPR method required two interviews with each participant and increased the time required for dietary assessment to 60 min (2×30 min). Once completed, each recall had to be coded manually prior to double data entry. Coding dietary intake is a complex task that requires an in-depth understanding of the nature of

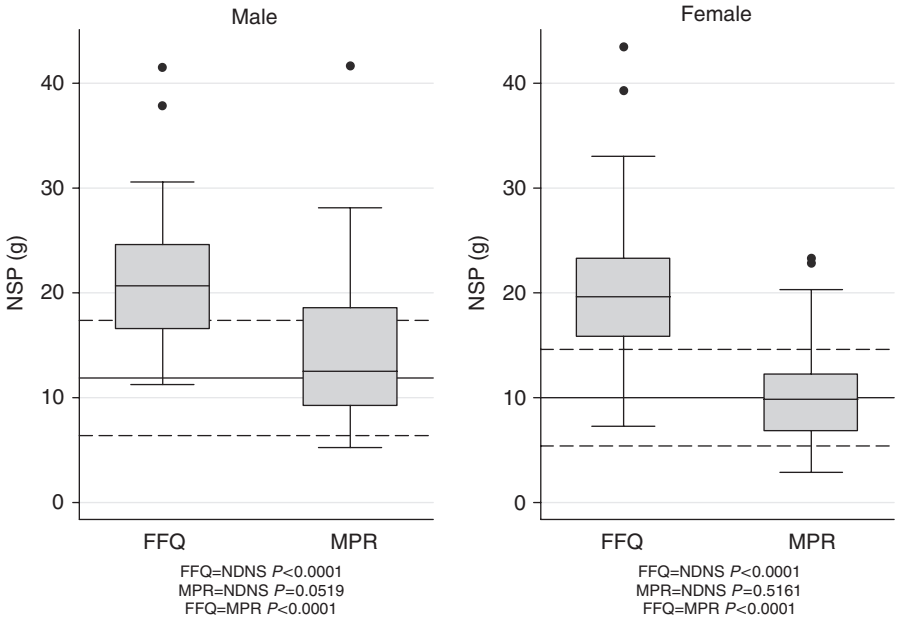

Figure 5 Daily intake of non-starch polysaccharide (g) as measured by food frequency questionnaire (FFQ) and repeated multiple pass recall (MPR) for men and women. Horizontal solid and broken lines indicate NDNS mean and s.d., respectively (Finch *et al.*, 1998).

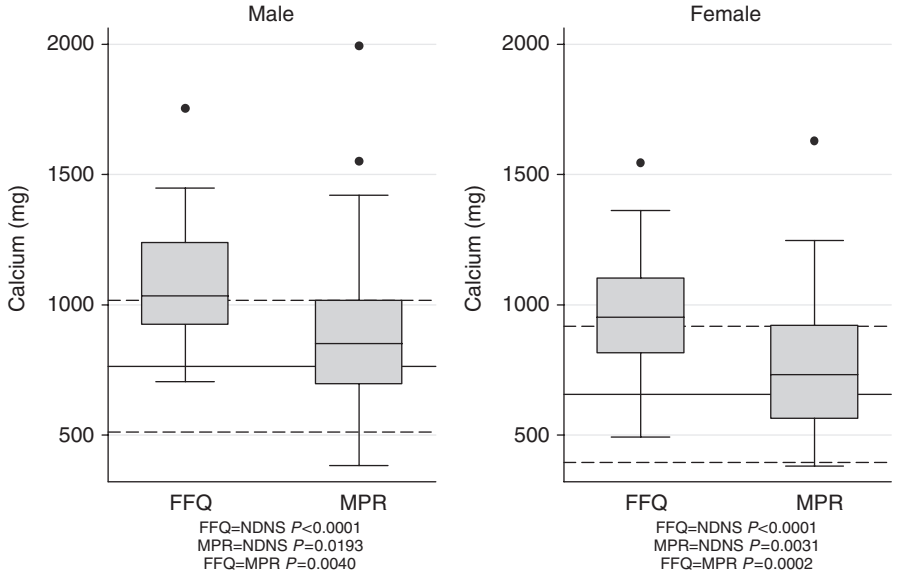

Figure 6 Daily intake of calcium (mg) as measured by FFQ and MPR for men and women. Horizontal solid and broken lines indicate NDNS mean and s.d., respectively (Finch *et al.*, 1998).

food composition databases and nutritional expertise. The additional time requirements and need for skilled staff have resource and cost implications.

Discussion

We are not aware of any earlier study that has investigated the relative validity and utility of retrospective dietary assessment methods in those aged 85 years and above in comparable detail. Our findings indicate that the MPR (repeated on two occasions) resulted in reported dietary intakes, that are closer to those expected (using the NDNS data as the 'gold standard') than those obtained using the FFQ. However, this study has a number of limitations. Dietary intakes as reported by free-living older participants in the NDNS (Finch *et al.*, 1998) were used as the only reference population available against which to compare

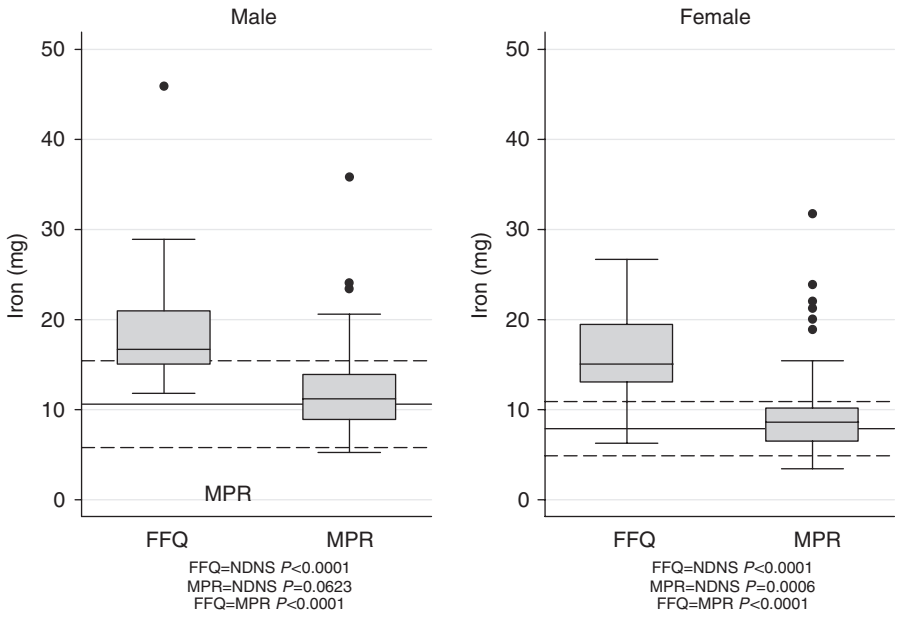

Figure 7 Daily iron intake (mg) as measured by food frequency questionnaire (FFQ) and repeated multiple pass recall (MPR) for men and women. Horizontal solid and broken lines indicate NDNS mean and s.d., respectively (Finch *et al*., 1998).

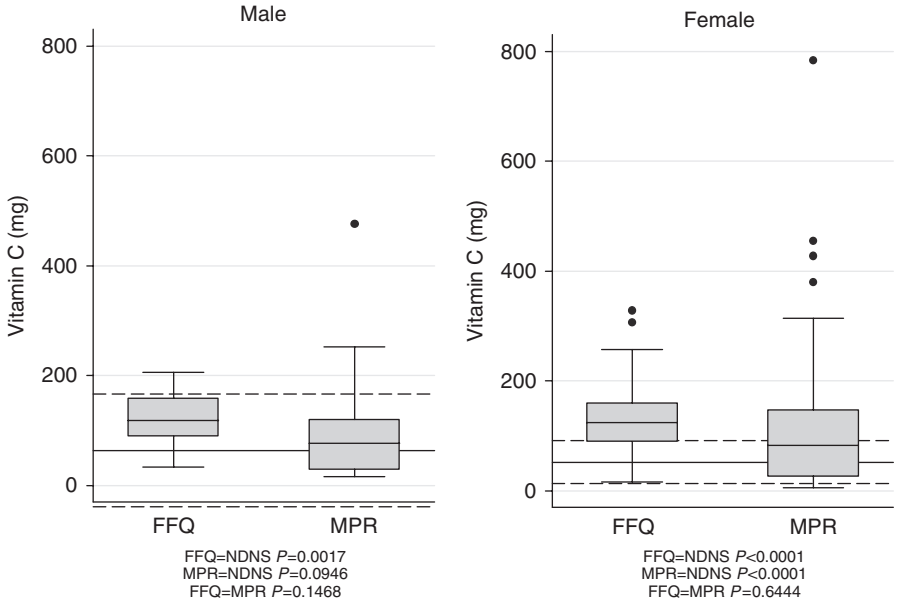

Figure 8 Daily intake of vitamin C (mg) as measured by food frequency questionnaire (FFQ) and repeated multiple pass recall (MPR) for men and women. Horizontal solid and broken lines indicate NDNS mean and s.d., respectively (Finch *et al*., 1998).

estimates of intakes obtained by each of the two test methods; the use of both methods reported intakes higher than this reference. The free-living sample of the NDNS (Finch *et al*., 1998) was chosen as the reference, as the majority of the Newcastle 85+ study populations (FFQ group 96.3% and MPR group 91.2%) were not living in institutions. The reference NDNS sample included participants 85 years and above, and although the upper age range of these 96 men and 170 women is not known, the NDNS will have included participants older than those

included in this study. Given the likelihood of a decline in health with age in those aged above 85 years and assuming that this would be associated with a lower nutrient intake, one would anticipate that the mean intake in the NDNS sample would be lower than that of the participants in the Newcastle 85+ study (who were all aged ~85 years). This assumption is supported by higher body weights in the Newcastle 85+ study sample compared with the NDNS reference (Table 3). The EI:BMR ratios calculated from the EI reported by MPR for both men and women supports the view that the MPR method may give reliable estimates of EI.

A further limitation of this study is that the data of Finch *et al*. (1998) were collected more than 10 years before the Newcastle 85+study and so the differences between the study outcomes may reflect secular changes in food habits rather than differences between the methods.

Neither the adapted EPIC FFQ nor the MPR method has been validated specifically for use in an older population, although an almost identical FFQ has been extensively validated in middle-aged adults (Bingham *et al*., 2001). Recall of intake and estimating the frequency of consumption foods over the past 12 months is a complex cognitive task that was challenging for some of the Newcastle 85+ pilot study participants. Further, the FFQ had not been validated as an interviewer-administered tool. Although it might be expected that this would improve the quality of the data collected, the intervention by an interviewer may affect the quantity and quality of the food intake reports.

The finding that estimates of % energy derived from fat and protein were similar by both methods suggests that, in general, the FFQ resulted in over-reporting across the diet rather than selective over-reporting. This hypothesis is

Table 4 Summary of advantages and disadvantages of the FFQ and MPR dietary assessment methods

	FFQ		*MPR*	
	Advantages	*Disadvantages*	*Advantages*	*Disadvantages*
Training and skill of data collectors	Requires minimal training			Requires nutritional expertise in conducting interview or considerable training of non-nutritionists required
Collection time and quality of interaction	Administered in one visit	Process is long and repetitive with long list foods and standard responses so subject may tire or become bored	Active interchange with participant helps to engage and maintain respondent interest. Asks for recall in a more familiar way 'what did you have for breakfast'	Each assessment takes approximately same time as FFQ but requires multiple visits therefore increased time overall
Complexity of task		Challenging conceptually—attempts to assess usual intake over past 12 months. Complex task of estimation and calculation of frequency of intake	Less complex task. Less challenging conceptually—attempts to assess yesterday's intake	
Memory and recall		Very heavy reliance on long-term memory	Less reliance on longer term memory	
Portion size assessment		Designing FFQ requires good information on food patterns and portion sizes consumed by this age group which are not readily available	Uses individually assessed food intake and portion size	No validation of food photographs for portion size assessment in this subject group
Data preparation	Pre-coded therefore data preparation requires no nutritional expertise and is efficient so relatively low cost			Data preparation is time consuming and requires nutritional expertise–each food record must be coded individually. Data entry also more time consuming–greater variation in food items
Validity and quality of data		Findings suggest this is unlikely to be a suitable method for older adults. Although estimates of portion size could be improved and may yield more realistic results	Findings suggest method suitable for use with older adults. Data can be used to investigate nutrient intakes and also food consumption behaviour patterns, for example, time and composition meals eaten	

Abbreviations: FFQ, food frequency questionnaire; MPR, multiple pass 24 h recalls.

supported by the finding that the most commonly consumed foods as reported by FFQ were similar to those reported by the NDNS (Finch *et al*., 1998). Over a 7-day period, 95% of the NDNS participants aged 85 years and above reported consumption of tea, 87% boiled potatoes, 74% white bread and 71% cakes and biscuits; this can be compared with 97% of FFQ respondents consuming tea at least four times a day, 97% boiled potatoes four times a week, 61% white bread and 76% cakes and biscuits on a daily basis. There was some indication that consumption of fruit and vegetables was over-reported; 83% of FFQ respondents reported consuming bananas at least three times per week compared with <50% of NDNS respondents consuming bananas over the 7-day recording period.

In the absence of appropriate food intake data for adults aged 85 years, quantitative analysis of the FFQ used food intake data (type of food and portion size) derived from 367 adults aged 16–62 years and living in Newcastle during 1998–2000. It is likely that these younger adults had different food preferences and may have consumed larger portion sizes than those consumed by the 85-year-olds. As a consequence, estimates of intakes reported by the FFQ might be improved by revising the types of food and portion sizes to reflect more specifically intakes by older adults (those aged 85 years). Weighed food intakes collected in the NDNS (Finch *et al*., 1998) could be used to derive these data and perhaps improve the performance of the FFQ but the NDNS sample size of those aged 85 and above is relatively small, covers an age range in which portion sizes may vary widely and the number of observations for each food may be low resulting in low precision of portion-size estimates.

Table 4 summarizes the advantages and disadvantages of each method in terms of both validity and utility. The MPR method performed better than did the FFQ in this population. This was in respect of ease of administration of the method (for both research nurses and participants) and the results obtained, but repeated MPR is not without problems. The need for training of non-nutritionists, the increase in time taken for data collection (which would be further increased if, as would be ideal, the number of repeats were to be increased to a minimum of four repeat recalls) and the increased demands for data preparation all mean that the cost of MPR is considerably more than that of FFQ. However, the FFQ as used in this study is unlikely to yield meaningful results on the dietary intake of the oldest old, except in respect of macronutrient contribution to EI.

Conclusion

There is a need for accurate dietary assessment methods appropriate for use in large populations of older adults, particularly the oldest of the old. This need is particularly acute, given the secular increase in the numbers of older people, especially those aged 85 years and above and the interest in the role of nutrition in maintaining health and ameliorating age-related decline. Our experience in the Newcastle 85+ study showed that the FFQ overestimated energy and nutrient intakes considerably. It may be possible to improve the estimates obtained by this approach (by adjusting for portion size), but it is unlikely that suitable data to make the necessary improvements for those aged 85 years are available at present. The MPR performed well, giving more realistic estimates of energy and nutrient intakes and was found to be acceptable for use in this population group. However, the use of this tool required greater investment of investigator (nurse) time and resources for training and quality assurance together with considerably more time for data coding and data entry.

This study has taken a pragmatic approach to assess the likely validity of two methods that were originally devised to measure different things, for example, MPR measures 'yesterday's intake', whereas the FFQ measures 'last year's intake'. In the absence of independent measures, such as those that might be obtained by the use of biomarkers, a true validation of these dietary assessment methods is unlikely to be possible. Retrospective FFQ or MPR methods could be 'validated' against a prospective method such as a weighed inventory, but even if such a method could be implemented in those aged 85 and above, one would be left with the uncertainty as to the extent to which imposition of the weighed inventory tool distorted habitual intake. There is a clear need for non-subjective methods for assessing dietary intake, that is, biomarker approaches, which can give a comprehensive and objective assessment of dietary exposure among the oldest old.

Ethics statement

Ethical approval for the Newcastle 85+ study was obtained from the Newcastle & North Tyneside Local Research Ethics Committee.

Disclosure

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