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Nutritional status in elderly female hip fracture patients: comparison with an age-matched home living group attending day centres

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Fractured neck of femur occurs mostly in the older female population and is generally caused by falls. Malnutrition has been postulated as a factor that increases the tendency to suffer falls. Nutritional status of older female hospital patients admitted for emergency surgery for fractured neck of femur recruited (*n* 75), was compared with an age-matched independent-living group of females attending one of three local day centres (*n* 50). Dietary assessment was undertaken using three consecutive 24 h dietary recalls and, in the hip fracture group, completed menu cards were used as memory prompts. Data concerning key lifestyle characteristics were obtained using a face-to-face administered questionnaire. Blood samples were taken to determine levels of plasma albumin, transferrin, C-reactive protein (CRP), cholesterol, vitamin C, Se, Zn and total antioxidant status. Haemolysate samples were analysed for Se-dependent glutathione peroxidase activity. There were no significant differences in age between the two groups, but the hip fracture patients had lower mean values for body weight (59·6 *v.* 67·5 kg; $P = 0{\cdot}005$), mindex (weight/demispan) (83·1 *v.* 94·4 kg/m; $P < 0{\cdot}0001$), calculated BMI (24·1 *v.* 27·5 kg/m^2 $P < 0{\cdot}0001$), mid-upper arm circumference; 27·1 *v.* 31·3 cm, $P = 0{\cdot}001$) and triceps skinfold thickness; 17·0 *v.* 18·9 mm, $P = 0{\cdot}005$) than the home-living group. The hip fracture patients had lower intakes of energy (4·3 *v.* 5·4 MJ, $P = 0{\cdot}001$), fat ($P = 0{\cdot}025$), carbohydrate ($P = 0{\cdot}002$), protein ($P = 0{\cdot}006$), thiamine ($P = 0{\cdot}017$), vitamin B_6 ($P = 0{\cdot}001$), calcium ($P = 0{\cdot}01$), K ($P = 0{\cdot}001$), Mg ($P = 0{\cdot}001$), P ($P = 0{\cdot}001$), Fe ($P = 0{\cdot}007$), Se ($P = 0{\cdot}008$) and NSP ($P = 0{\cdot}001$). Mean intakes of both groups were below the estimated average requirement for energy and below the reference nutrient intakes for folate, Ca, vitamin D, Mg, K, Se and Zn. In a high percentage of the hip fracture group the dietary intake of particular nutrients fell below the lower reference nutrient intake for Se (73 %), Mg (54 %) and Fe (19 %). As expected, the fracture patients had reduced plasma albumin ($P < 0{\cdot}0001$) and increased CRP ($P < 0{\cdot}001$) values. They had higher plasma vitamin C levels ($P < 0{\cdot}001$) and lower cholesterol levels ($P = 0{\cdot}04$) than the day centre attendees. There were no significant differences in plasma levels of Se, Zn, transferrin or haemolysate glutathione peroxidase activity between the two groups. However, there was evidence of under-nutrition in both groups as key anthropometric values were low, plasma nutrient and metabolite levels were below the standard reference ranges and many individuals had low dietary intakes for specified nutrients.

Elderly: Hip fracture: Nutritional status: Dietary intake

Introduction

Fracturing a hip is one of the commonest reasons for an elderly person being admitted to hospital. Incidences of osteoporosis-associated fractures have been estimated to be 200 000 cases per year in the UK (Royal College of Physicians, 1999). The proportion of people over 65 years in the UK is 16 % (1996 data), with a predicted rise to 20 % by the year 2021 (Office of National Statistics, 2000). Increases in the over-85 age group will be particularly high. Studies have shown that approximately 30 % of people over the age of 65 have a fall each year and this increases to

Abbreviations: CRP, c reactive protein; FNF, fractured neck of femur; GSHPx, glutathione peroxidase; MUAC, mid-upper arm circumference; MUAMC, mid-upper arm muscle circumference; NDNS, National Diet and Nutrition Survey; TST, triceps skinfold thickness.

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50 % in those over 80 years (Vellas *et al.* 1992). Many fractures are a result of osteoporosis, with costs estimated to reach in excess of £940 million per year in the UK (Hollingsworth *et al.* 1995; Royal College of Physicians, 1999). Not only is hip fracture a common occurrence among this age group, typically it results in a poor outcome (Grimley Evans, 1982). The fracture may mark the end of a person's independent life, with reports that only 50–60 % of patients return to their own home (Parker *et al.* 1996). Recent findings from the National Diet and Nutrition Survey (NDNS) of people aged over 65 years suggest that the prevalence of under-nutrition in older people living at home is relatively low (3 % of men and 6 % of women with a BMI of less than 20). However, the percentage classified as underweight increases to 16 % in those people living in residential and nursing homes (Finch *et al.* 1998). The prevalence of under-nutrition in patients on admission to hospital has been found to be even higher, with particularly high rates found in elderly patient groups (45 %; McWhirter & Pennington, 1994; Cohendy, 1998). Whilst poor nutritional status is known to affect clinical outcome (Bastow *et al.* 1983; Lumbers *et al.* 1996) the extent to which under-nutrition and other lifestyle characteristics contribute to falls among this group, needs more detailed investigation.

The aim of the present study was to examine the dietary intake and nutritional status of a group of recently admitted elderly hip fracture patients with age-matched home living females attending local day-centres. The day centres were located in the same geographical area as the hospital. The dietary, biochemical and anthropometric data obtained from the hip fracture patients in the present study complements the recently published NDNS data (Finch *et al.* 1998) from healthy free-living and institutionalised older people.

Biochemical measurements included plasma albumin, transferrin and C-reactive protein (CRP) levels. Plasma albumin (half life of 20 d) and transferrin (half life of 8–10 d) were measured to give an indication of nutritional intake in the long and medium term, although it is well established that the levels of both hepatic proteins are affected by many factors including dehydration, trauma and sepsis (Gibson, 1990). CRP is an acute-phase protein, which is produced in response to a wide range of stimuli including microbial invasion, tissue injury, immunological reactions and inflammatory responses. However, raised values are not necessarily diagnostic of any particular condition (Pepys, 1987) and in the context of the present study plasma CRP levels were analysed to assess possible non-nutritional causes of low albumin and transferrin levels. Cholesterol levels were examined because an association between low cholesterol levels, depression and increased likelihood of falls has been suggested in studies by Dealberto *et al.* (1993).

Poor antioxidant status has been observed in hospitalised elderly patients (Schmuck *et al.* 1996) and in free-living elderly in a larger Norwich study (Bailey *et al.* 1997). Many researchers have stressed the need to investigate the reasons for poor antioxidant status found among older people (Department of Health, 1992). Thus, measures of plasma vitamin C, Se, Zn and total antioxidant status were recorded in the study groups as well as haemolysate Se-dependent GSH peroxidase (GSHPx) activity.

Methods

Subject recruitment

The study group included seventy-five females recently admitted to one of two orthopaedic wards for emergency surgery for hip fracture and fifty women of similar age and background living in the local community and attending local day centres. The sample size (*n* 75, 50) was calculated to be sufficient to detect a difference in energy intake of 10 % between the hip fracture patients and the non-hospitalised group at the 95 % level of significance. Subjects recruited to the study were those over the age of 60 years and who gave their written consent to participate. Ethical approval for the study was granted by South West Surrey Local Ethics Committee. The patients and day centre attendees were studied from October to March each year for three years (1996–9). Each patient was approached 4 d following surgery and asked if they were prepared to participate.

Inclusion and exclusion criteria

Only subjects aged 60 years or over were eligible to be recruited to the study. In order to ensure that subjects could give their informed consent and would be able to participate, individuals were screened using the abbreviated mental function test (Royal College of Physicians, 1992). Patients who scored 7 or above were judged as being eligible to enter the study and were invited to participate. Although a score of 7 indicates mild cognitive impairment the inclusion of such individuals was justified on the basis that they were more likely to be at nutritional risk and therefore worthy of inclusion. Safeguards were built into dietary reporting methods to ensure the accuracy of recall of patients at the lower end of scores for cognitive function.

Demographic variables

Demographic variables such as age, marital status and type of residence were obtained. A detailed history of social and medical factors was obtained by interview using a structured questionnaire. The respondent was asked to provide information on a variety of factors including mobility, history of falls, use of walking aids, activities of daily living, ability to do their own shopping and cooking, psychological well-being, recent bereavement, physical health, smoking habits, alcohol consumption and menstruation history.

Anthropometric assessment

Measurements of triceps skinfold thickness (TST) and mid upper arm muscle circumference (MUAMC) provide an indirect measure of body muscle and fat. TST was measured using Holtain callipers (Holtain, Dyfed, UK) and the mid-upper arm circumference (MUAC) measurements were taken at the same mid point as the TST with a non-elastic tape according to standard techniques. The MUAMC was calculated according to standard formulae (Gurney & Jelliffe, 1973).

Body weight was measured in both hospital and home-living group using calibrated portable scales. Demispan was measured according to standard techniques (Bassey, 1986; Kwok & Whitelaw, 1991) and an estimate of height based upon demispan was calculated using the formula for women aged over 60 years: Height (cm) = 1·35 × Demispan (cm) + 60·1. Values for mindex (weight/demispan; kg/m) were calculated according to Lehmann *et al.* 1991.

Dietary assessment

Food consumption data were collected on three consecutive days using 24 h dietary recalls and for hip fracture patients the individually completed menu cards were used as memory prompts and as a means of checking the information given by each hospital subject. Nursing staff assisted in ensuring that all completed menu cards were retained by each subject for the purpose of the study. Two trained investigators carried out the dietary assessment. Recorded data included the proportion of the meal eaten and the consumption of additional snacks, drinks and supplements. The portion sizes used in the hospital meals were obtained from the catering service. For the day centre attendees, food intake was estimated using household measures and quantities assessed using standard portion sizes (MAFF, 1988). Dietary intake data were coded and analysed by one trained technician using Diet5 for Windows (The Robert Gordon Institute, Aberdeen, UK).

Analytical procedures

Non-fasting blood samples were obtained from forty-two hip fracture patients and twenty-two of the day-centre attendees. Blood was taken 4 d post-operatively from the fractured neck of femur (FNF) patients. Plasma and haemolysate were separated and stored at −20°C until analysis. Levels of vitamin C, albumin, transferrin, CRP, cholesterol, Se, Zn and total antioxidant status were measured in plasma, and GSHPx activity was measured in the haemolysate fraction. Plasma for the determination of vitamin C was treated with 10 % TCA solution and frozen at −70°C until further analysis. Plasma vitamin C levels were analysed spectrophotometrically using 2,4-dinitrophenylhydrazine according to Omaye *et al.* (1979). Plasma albumin (bromocresol green), transferrin and cholesterol levels and CRP analyses were assayed spectrophotometrically using the Cobas Mira Plus analyser (Roche Products Ltd., Welwyn Garden City, UK) and appropriate kits for albumin, cholesterol and transferrin supplied by Roche Products Ltd. Plasma CRP levels were analysed using a kit supplied by Sigma (Poole, UK) based upon the reaction whereby increased immunoturbidity occurs when CRP binds with the anti-human CRP antibody. The inter-assay coefficient of variation was 2·7 % at 4·87 g/dl for albumin, 0·67 % at 1·97 g/l for transferrin, 1·2 % at 7·8 mmol/l for cholesterol and 4·94 % at 4·92 g/l for CRP. Se and Zn analyses were carried out by atomic absorption spectroscopy and haemolysate GSHPx activity measured according to St Clair & Chow (1996). Plasma total antioxidant status was assessed using the method described by Miller *et al.* (1993) and adapted for the Cobas Bio Centrifugal Analyser (Roche Products Ltd., under Dr J. Chakraborty, University of Surrey). This was expressed as Trolox equivalent antioxidant capacity (units) which is defined as the equivalent antioxidant status of a mM concentration of a water soluble vitamin E analogue (Trolox) solution.

Statistical analysis

Mean values (±SD and SEM) for each measurement were calculated. Differences between the two groups were determined using Mann–Whitney and *t* tests as appropriate, using SPSS for Windows Version 9 (SPSS Inc. Woking, Surrey, UK). Values of $P < 0·05$ were taken as significant.

Results

Age and anthropometry

There were no significant differences in the mean age of the two study groups. The mean (SD) age of the hip fracture patients was 80·5 years (11·9, range 61–103). Seven percent were aged 60–69 years; 39 % 70–79 years; 40 % were aged 80–89 years; 12 % were aged 90–99 years; 1 % was over 100 years (one individual). The mean (SD) age of the day centre attendees was 79·8 years (7·5, range 63–95 years). Twelve percent of those living at home were aged 60–69 years; 30 % 70–79 years; 54 % were aged 80–89 years and 4 % were aged 90–99 years.

In the hip fracture group the mean weight of patients was 59·6 kg and that of the home-living group was 67·5 kg ($P = 0·002$). The hip fracture patients had higher mean values for demispan ($P = 0·04$) and thus lower mean values for mindex (83·1 *v.* 94·4 kg/m; $P < 0·001$) and calculated BMI (24·1 *v.* 27·5 kg/m^2; $P = 0·005$) compared with the day centre attendees. Similarly, the mean values for MUAC ($P < 0·001$), TST ($P = 0·005$), and thus MUAMC ($P = 0·01$) were all lower in the hip fracture patients compared with the home group (Table 1). Reference ranges of values for mindex established in groups of elderly people are said to be useful to identify those at the extremes of the distribution (Department of Health, 1992). In the present study, 46 % of hip fracture patients compared with 29 % of the day centre attendees were found to fall below the 50th percentile (81·7 kg/m for 75+ age group or 84·8 kg/m for 64–75 year olds) based on published reference data (Lehmann *et al.* 1991). Of greater concern, 13 % of hip fracture patients and 2 % of the day centre attendees were below the 10th percentile value for mindex. Reference ranges for MUAMC indicated that 65 % of hip fracture patients and 39 % of day centre attendees had values below the 50th percentile and 46 % and 21 % of subjects' values were below the 10th percentile respectively (Bishop *et al.* 1981).

Taking the whole group together there were significant negative correlations between age and albumin (r −0·32, $P = 0·01$), age and transferrin (r −0·33, $P = 0·02$) and between albumin and CRP levels (r−0·45, $P < 0·001$).

Table 1. Comparison of age, anthropometric and biochemical variables in the hip fracture patients *v.* day centre attendees with the National Diet and Nutrition Survey (NDNS) findings (Finch *et al.* 1998)

(Data are means and their standard deviations for 75 hospital patients and 50 day centre attendees)

	Hip fracture patients		Day centre attendees			
Variable	Mean	SD	Mean	SD	NDNS Free-living	NDNS Institutions
Age (years)	80·5	8·2	79·8	7·5		
Weight (kg)	59·6***	11·9	67·5	13·1	64·9 (12·2)	56·5 (10·9)
Demispan (mm)	727·2*	38·7	711·2	35·7	727 (3·7)	711 (3·8)
Mindex (kg/m)	83·1***	16·1	94·4	17·2	897 (157)	806 (15·9)
Calculated BMI (kg/m^2)	24·1***	4·7	27·5	4·9	26·8 (4·7)	24·9 (4·6)
MUAC (cm)	27·1***	4·3	31·3	4·7	29·7 (3·9)	27·0 (4·2)
TST (mm)	17·0***	2·7	18·9	2·8		
MUAMC (cm)	21·4***	3·4	23·3	3·8		
Plasma albumin (g/l)	36·5***	4·7	42·5	3·3		
Plasma cholesterol (mmol/l)	4·5*	1·4	8·7	10·9	6·23 (1·52)	5·49 (1·25)
Plasma vitamin C (μmol/l)	42·7***	21·4	20·8	14·2	48·6 (26·2)	25·7 (21·6)
Plasma Se (μmol/l)	0·67	0·23	0·76	0·32		
Plasma Zn (μmol/l)	14·4	3·0	13·3	1·8		
Plasma total antioxidant status (TEAC)	1·81	0·11	1·73	0·06		
Haemolysate GSHPx (U/g Hb)†	24·2	8·8	29·8	14·7		
Plasma transferrin (g/l)	2·11	0·80	2·22	0·73		
Plasma C-reactive protein (mg/l)	53·2***	41·7	5·4	4·5		

GSHPx, glutathione peroxidase; MUAC, mid-upper arm circumference; MUAMC mid-upper arm muscle circumference; TEAC, Trolox equivalent antioxidant capacity; TST, triceps skinfold thickness.
Mean values were significantly different from the day centre attendees **P* < 0·05, ***P* < 0·01, ****P* < 0·005.
† GSHPx (μmol GSH reduced/min at 37°C).

There was also a significant correlation between albumin and TST (r 0·29, $P < 0·006$).

Lifestyle

A greater proportion of the day centre attendees lived alone compared with the fracture patients (76 % *v.* 54 %; $P <$ 0·05). However, the hip fracture patients were more likely to report that they were still married compared with the day centre attendees (21 % *v.* 2 %; $P = 0·001$) and a greater proportion of the hip fracture patients had been living in their own home prior to admission (64 % *v.* 40 % $P <$ 0·01). However, fewer hip fracture patients were still able to shop for themselves (58 % *v.* 89 %; P < 0·001) and a greater proportion reported having milk delivered compared with the day centre attendees. There were no significant differences in the reporting of recent illness, smoking habits or alcohol consumption, menstruation history, between the two groups although the hip fracture patients had had fewer children ($P = 0·05$), (Table 2).

Table 2. Lifestyle characteristics of the hip fracture patients *v.* day centre attendees

(Values are means and their standard deviations for 75 hospital patients and 50 day centre attendees)

	Hip fracture patients		Day centre attendees	
Variable	Mean	SD	Mean	SD
Number of children	1·7*	1·4	2·2	1·3
Age of menarche	13·8	2·4	14·1	1·8
Age of menopause	46·5	7·7	46·7	8·2
Number of cigarettes per day (prior to admission)	0·9	3·5	0·6	2·5
Alcohol consumption (units per day)	0·4	0·7	0·3	0·6
Married now (%)	21***		2	
Living alone (%)	54*		76	
Living in own home (%)	64**		40	
Having milk delivered (%)	55*		36	
Shop for themselves (%)	58***		89	
Cook for themselves (%)	77		91	
Report having eating problems (%)	19		20	
Have a walking aid (%)	53		44	
Walk outside everyday (%)	61		75	
Report being ill recently (%)	36		42	

Mean values were significantly different from the control group **P* < 0·05, ***P* = 0·01, ****P* < 0·001.

Table 3. Dietary energy and nutrient intakes of the hip fracture patients *v.* day centre attendees compared with dietary reference values (Department of Health, 1991) and Nutrition Diet and Nutrition Survey (NDNS) data (Finch *et al.* 1998)

(Values are means and their standard deviations for 75 hospital patients and 50 day centre attendees)

Variables	Hip fracture patients		Day centre attendees		Comparisons	
Intake per day	Mean	SD	Mean	SD	EAR/RNI	NDNS study
Energy (MJ)	4·29***	1·25	5·40	1·88	7·96 (60–74) 7·61 (75+)	5·98
Fat (g)	41*	14	50	21	110	58
Carbohydrate (g)	129**	41	164	63	172	175
Protein (g)	43***	13	54	21	47	56
Thiamine (mg)	0·84*	0·25	1·39	1·44	0·76	1·73
Riboflavin (mg)	1·19	0·52	1·54	1·36	1·1	1·76
Niacin (mg)	16·5	7·2	20·1	13·4	12·0	26·1
Pyridoxine (mg)	1·0***	0·4	1·4	0·6	1·2	2·00
Folate (μg)	145	62	196	165	200	220
Vitamin C (mg)	60·7	33·2	55·2	38·8	40·0	68·1
Vitamin A (μg)	810	202	613	361	700	1073
Vitamin D (μg)	1·7	1·1	2·2	1·6	10·0	3·4
Ca (mg)	533**	160	654	265	700	491
P (mg)	744***	192	930	263	550	707
Mg (mg)	153***	52	191	61	270	141
Na (mg)	1772	625	2035	1032	1600	1471
K (mg)	1613***	459	2052	675	3500	1588
Fe (mg)	6·2**	2·3	7·8	3·1	8·7	6·2
Se (μg)	30·3***	14·2	39·2	17·7	60	–
Zn (mg)	5·3	1·7	6·0	1·9	7·0	4·9
NSP (g)	7·7***	3·2	12·5	5·2	12–18	11

EAR/RNI, estimated average requirement/reference nutrient intake.
Mean values were significantly different from the control group (* $P < 0·05$, ** $P = 0·01$, *** $P < 0·001$).

Dietary analysis

There were a number of significant differences in the dietary intakes between the two groups (Table 3). The fracture patients had lower intakes of energy (4·3 *v.* 5·4 MJ; $P = 0·001$), fat ($P = 0·025$), carbohydrate ($P = 0·002$), protein ($P = 0·006$), thiamine ($P = 0·017$), vitamin B_6 ($P = 0·001$), Ca ($P = 0·01$), K ($P = 0·001$), Mg ($P = 0·001$), P ($P = 0·001$), Fe ($P = 0·007$), Se ($P = 0·008$) and NSP ($P = 0·001$) compared with the day centre attendees. The mean energy intakes of both groups were below the estimated average requirement (Department of Health, 1992) and intakes were also lower than those found in the recent survey of free-living individuals (Finch *et al.* 1998) reflecting the low mean intakes of fat, protein and carbohydrate. In fact, 100 % of hip fracture patients and 75 % of the home group were consuming less than the EAR for energy. Mean intakes below the reference nutrient intake were noted for folate, Ca, Mg, Se and Zn. In addition, mean intakes of the hip fracture patients were below the reference nutrient intake for pyridoxine and NSP. The high proportion of hip fracture patients consuming intakes below the lower reference nutrient intake (compared with the home-living group) was particularly marked in the case of Se (73 % *v.* 55 %), Mg (54 % *v.* 22 %), Fe (19 % *v.* 10 %), folate (18 % *v.* 7 %), Ca (18 % *v.* 12 %) and Zn (18 % *v.* 12 %).

Biochemical analysis

Plasma albumin levels were significantly lower in the fracture group compared with the home group ($P < 0·001$). Sixty-eight percent of patients and 14 % of the home group had albumin levels below the normal reference range of 3·83 g/dl. As expected, CRP levels were significantly higher in the hip fracture group compared with the day centre attendees ($P < 0·0001$). Cholesterol levels in the patients were significantly less than the community group ($P = 0·04$). No significant differences were found between the groups for transferrin levels although 53 % and 36 % of the patients and home groups respectively would have been classified as having mild to moderate protein deficiency according to guidelines laid down by Grant *et al.* (1981).

Plasma vitamin C levels were significantly higher in the FNF patients than the home group ($P < 0·001$), but there were no significant differences in the total antioxidant status between the two groups. There was also a significant correlation between vitamin C and total antioxidant levels (r 0·41, $P = 0·003$). There were no significant differences in the plasma Se and Zn levels, nor in the haemolysate GSHPx activity, but levels in both groups were low compared to reference levels. There was a significant negative relationship between age and Zn levels (r −0·12, $P = 0·007$). Suggested reference ranges for Se for the study age group have been proposed as 0·72–1·2 μmol/l based on a study in the Netherlands (Oster & Prellwitz, 1982) and 0·9 ± 0·19 μmol/l from an Italian Study (Olivieri *et al.* 1994). Mean Se concentrations in both groups in the present study compare with the lower end of both suggested ranges. Although there was no association between age and Se status in the group as a whole, when the three patients aged under 65 years were removed there was a significant negative relationship in the remaining subjects (r^2 −0·32, $P = 0·02$).

Discussion

The present study investigated the nutritional status of a recently admitted group of hip fracture patients using women recruited from local day centres of similar age and background as a comparison. The anthropometry of the two groups was significantly different with the hip fracture patients being more likely to be underweight than the day centre attendees. One in six hip fracture patients (15 %) were suffering from undernutrition (defined as a BMI of 20 or less) compared with 2 % of the home-living group. These findings are similar to the prevalence of undernutrition in the recent NDNS survey of older people (15 % of women living in institutions *v.* 6 % among free-living women; Finch *et al.* 1998). Forty-six percent of patients had values for MUAMC which fell below the 10th percentile suggesting low muscle stores. These findings indicate that the hip fracture patients were likely to have been suffering from malnutrition prior to their admission particularly as anthropometric measurements were taken only 4 d after their admission to hospital. The mean values for BMI and MUAC in the hip fracture patients were very close to those described for older people living in institutions in the NDNS survey, whereas those for day centre attendees more closely matched the mean values found among free-living elderly (Finch *et al.* 1998). As these recently published reference data were drawn from a nationally representative sample of older people living in the community in the UK, they provide a useful and meaningful comparison with those found in the present study. However, comparison with anthropometric reference data (Finch *et al.* 1998) may be complicated by geographical and ethnic variations due to age, genetic potential, skeletal size as well social and health status, (Launer & Harris, 1996; Bannerman *et al.* 1997). These differences illustrate the need for caution in using anthropometric data to predict the nutritional status and health outcomes of older people. Furthermore, it was not possible to obtain a random sample of patients. The use of a selected cut-off for the abbreviated mental function test meant that only those patients with satisfactory cognitive function were recruited to the study. Thus those patients who were confused and therefore more vulnerable to nutritional risk were excluded.

The dietary data revealed particularly low intakes in the hip fracture group with none of the subjects consuming the estimated average requirement for energy which in turn compromised the intake of most other nutrients and leading to a further deterioration in status. The mean energy intake in the hip fracture patients and day centre attendees at 4·27 *v* 5·4 MJ/d respectively was lower than the reported intakes of subjects in the NDNS study (5·98 MJ/d in the free living and 6·94 MJ/d in the institutionalised individuals; Finch *et al.* 1998). The relatively high proportion of hip fracture patients consuming nutrient intakes below the lower reference nutrient intake was also of concern especially as requirements are known to increase following surgery. Low dietary intakes of Ca and vitamin D highlighted in the NDNS findings (Finch *et al.* 1998) were also found in the present study. Whilst every precaution was taken to ensure the accuracy of the dietary data, including the use of menu cards as prompts, the collection of dietary data in a hospital setting is difficult. However, it should be noted that similarly low energy intakes have been found in previous studies and this was not the result of under-reporting. Both groups in the present study were existing on institutionalised catering to some extent, either hospital catering or lunch provided at the day centres. Not only should diets be improved during hospitalisation but measures should be developed to ensure an adequate delivery of nutrients to vulnerable groups residing in the community, through high quality provision of food and catering. It has been demonstrated many times that reduced nutritional status in elderly populations probably occurs before disease as well as contributing to its progression and ultimately affecting clinical outcome (Delmi *et al.* 1990, Mowe *et al.* 1994; Lumbers *et al.* 1996). Allison (1999) has suggested that a major reason for the deterioration of nutritional status during admission and stay in hospital may be due to feeding practices being modelled on catering for the healthy rather than for the sick. He emphasises that the provision of food should be seen as part of treatment and not just a hotel function.

The findings of the present study therefore suggest that older emergency hip fracture patients are poorly nourished compared with those studied in the NDNS survey (Finch *et al.* 1998) who may have been living at home but were able to provide for themselves or fully established in residential care. It would be interesting to identify whether poor dietary intakes persist into the recovery stage and the potential affect on clinical outcome.

This study confirms others showing low albumin levels in elderly FNF patients (Huang *et al.* 1996); this is as expected due to the trauma associated with the hip fracture and is related to the raised CRP levels, as would be predicted from the literature (Gersovitz *et al.* 1980, Pepys, 1987). The use of albumin levels as a marker of nutritional status is controversial but widely used, Mitchell & Lipshitz (1982) found albumin to be the best predictor of malnutrition in any age group, whilst Friedman *et al.* (1985), disputed its use as a marker of nutritional status. Many authors have identified undernutrition as a risk factor for hip fracture (Bastow *et al.* 1983; Delmi *et al.* 1990). The difficulty of identification of undernourished individuals where CRP levels are raised, and thus albumin and transferrin production are compromised, highlights the need for more suitable biochemical indicators of undernutrition in elderly patients. There were clear correlations between many of biochemical measurements with age especially plasma albumin, transferrin and Zn in the whole group, but there was no relationship between age and CRP levels. This suggests that increasing age was related to deterioration in plasma levels independent of illness. It was also interesting to find significant correlations between albumin and an anthropometric measurement of nutritional status such as TST. The correlation between albumin and Zn reflects albumin as the major transport protein, which is well documented in the literature (Groff *et al.* 1995)

The high plasma vitamin C levels in the FNF group were thought to be due to the orange juice on the hospital breakfast menu and highlight the fact that plasma vitamin C levels reflect very recent intake. Fasting blood samples would have been preferable but, in the very sick elderly, are difficult to obtain. The relatively new method for the measurement of total antioxidant status published by Rice-Evans & Miller (1994) did not alleviate the problems of only non-fasting blood samples being available and in fact there a was a significant relationship ($P = 0{\cdot}003$) between plasma vitamin C levels and total antioxidant status.

In the present study there was no significant difference ($P = 0{\cdot}02$) in Se levels in the hospital patients compared to day centre attendees, this may be due to the low levels found in both groups. There are no universally accepted reference ranges for plasma Se levels, and Se bioavailability is generally very low in Europe compared to Northern America (Rayman, 1997). The age-related decreases in Se concentrations in the over-65-year-olds are in agreement with other studies (Miller *et al.* 1983; Verlinden *et al.* 1983; Campbell *et al.* 1989). These data provide limited evidence that the status of certain antioxidant nutrients are reduced with age, especially after 65 years, and more research is required to ascertain if this is due to either poor intake, increased utilisation, or some other factors.

This paper describes poor nutritional intake and some indicators of poor nutritional status in a group of frail elderly in a hospital situation and a similar pattern in a group of free-living elderly who attend a day centre for their meals. It is well documented that poor nutritional intake and status result in poorer clinical outcome, increased time under hospital care and complication rate. These data, along with the increasing concern expressed in the media of undernutrition in our hospitalised elderly, should be used to encourage an increase in hospital budgets for food and nutritional support.

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