Nutritional screening of older people in a sub-acute care facility in Australia and its relation to discharge outcomes

Renuka Visvanathan[1,2], Robert Penhall[1], Ian Chapman[2]

[1]Department of Geriatric and Rehabilitation Medicine, Royal Adelaide Hospital, Adelaide, SA, Australia
[2]Department of Medicine, University of Adelaide, Adelaide, SA, Australia

Address correspondence to: R. Visvanathan. Fax: (+61) 8 822 36472. Email: rvisvanathan@ozemail.com.au

Abstract

Objectives: to determine the prevalence of under-nutrition using brief screening methods and to determine the relation between these results and (1) those of a more standard nutritional assessment and (2) discharge outcomes.
Design: prospective study.
Subjects: 65 (21 males) patients older than 65 years.
Setting: sub-acute care facility.
Measurements: the Mini Nutritional Assessment, standard nutritional assessment, 'rapid screen' and discharge outcome.
Results: the prevalence of under-nutrition was high, ranging from 35.4% to 43.1%, depending on the screening method used. Compared to the standard nutritional assessment the 'rapid screen' consisting of (1) body mass index $<22 \, kg/m^2$; and/or (2) reported weight loss of $>7.5\%$ over the previous 3 months and the two-tiered Mini Nutritional Assessment process (at-risk subjects (46% of total) further evaluated using standard nutritional assessment) had sensitivities of 78.6 and 89.5% and specificities of 97.3 and 87.5% respectively in diagnosing under-nutrition. Under-nourished patients as identified by the standard nutritional assessment (50.0% (under-nourished) *versus* 21.6% (nourished); $P = 0.017$), the two-tiered Mini Nutritional Assessment process (50.0% (under-nourished) *versus* 21.6% (nourished); $P = 0.017$) and the rapid screen (56.5% (under-nourished) *versus* 21.4% (nourished); $P = 0.004$) were more likely to be discharged to an acute hospital or an accommodation with increased support (poor discharge outcomes) than nourished patients.
Conclusion: all screening methods identified patients more likely to have a poor discharge outcome. The highly specific but less sensitive 'rapid screen' may be the best method in facilities with limited resources as it can be easily incorporated into nursing/medical admissions and avoids biochemical investigations in all patients. The more sensitive two-tiered Mini Nutritional Assessment is better if resources permit.

Keywords: *sub-acute care, screening, under-nutrition, elderly, poor outcome*

Introduction

Malnutrition is prevalent in the elderly and is associated with impaired muscle function, decreased bone mass, immune dysfunction, anaemia, reduced cognitive functioning, prolonged hospitalisation, delayed post-operative recovery, and increased falls, morbidity and mortality [1, 2].

In two recent Australian studies, 20% of hospitalised patients and 4.8% of community dwelling functionally dependent elderly people were malnourished as assessed by the Mini Nutritional Assessment (MNA) [2, 3]. The prevalence of under-nutrition in sub-acute care facilities in Australia is not readily known. Nutritional status often deteriorates after acute hospitalisation, due to poor recognition and monitoring of nutritional status and inadequate intake of nutrients for days at a time [4–8]. In one study, 40% of patients admitted to an acute hospital in Scotland were under-nourished and 75% of these under-nourished patients when reassessed upon discharge had lost weight whilst in hospital [9]. It is therefore likely that more people are under-nourished at discharge from an acute hospital to a subacute care facility than in the acute hospital or in the community as a whole.

Impaired appetite, inadequate nutrient intake and weight loss may continue for long periods following discharge from

acute hospitals [10]. Therefore, at admission to a subacute care facility, there may be a 'golden opportunity' for health care providers to screen for and correct under-nutrition. However, this is not done routinely in most facilities, because of the time and need for blood tests and nutritionally trained health professionals (e.g. dietitians) to complete more comprehensive nutritional assessments.

Any screening tool adopted in a high patient load, sub-acute facility, would ideally be sensitive, specific, cheap, simple and rapid to administer. Several screening tools are available to detect under-nutrition in older people. The MNA, an easily administered, validated (in the elderly) and widely used clinical tool can be performed in 15 minutes without the need for biochemical testing or nutritional training [11, 12]. To the best of our knowledge, the results of MNA assessment have not been compared previously to those of comprehensive nutritional assessment in any Australian setting. A low body mass index (BMI) and weight loss are the two most important contributors to a low (impaired) MNA score and so a simple assessment incorporating these two variables ('rapid screen') could also possibly function as a quick measure of under-nutrition and predictor of subsequent worse outcome [13].

The aim of this study was to determine the prevalence and consequences of under-nutrition among older people in a sub-acute health care facility, using different screening methods (the single and two-tiered MNA processes and the 'rapid screen'), and compare the results to those of a more standard nutritional assessment (SNA).

Method

This study was conducted at the Hampstead Rehabilitation Centre in Adelaide, a sub-acute care facility admitting patients on discharge from surrounding acute hospitals. Consecutive patients admitted to the geriatric, medical and orthopaedic rehabilitation units were recruited and only the patient's first subacute-care admission during the study period was considered. Patients admitted to this facility are assessed for their rehabilitation potential and are selected for admission if (i) they have the potential to be eventually discharged directly to their own homes, (ii) they are medically stable and (iii) they would have been discharged home

from the acute care facility if not for their physical disability and need to recover. A poor discharge outcome for this sub-acute care facility was therefore defined as a transfer to an acute hospital directly from the sub-acute care facility or discharge to accommodation with greater supports than they lived in before admission to the acute hospital (e.g. home to nursing home/hostel). All participating patients were followed up until they left the sub-acute care facility for home, hospital or other accommodation.

All patients ($n = 86$) aged 65 years and over, admitted to the centre between 22 October 2002 and 17 January 2003 (87 days), were invited to participate in this study. For logistical reasons, the following patients were excluded from the study: those who were unable to speak English ($n = 5$), unable to provide informed consent ($n = 4$), with moderate to severe dysphagia ($n = 3$), on nasogastric feeds ($n = 1$) and amputees ($n = 8$). All participating patients ($n = 65$) provided informed consent and the study was approved by the Research Ethics Committee of the Royal Adelaide Hospital.

Nutritional assessment

All participating patients were assessed using the MNA, SNA and the rapid screen within 48 hours of admission by two investigators at separate times, in random order. One investigator always administered the SNA, the other the MNA. The patient and the investigators were initially blinded to the results of the assessments. Once all three assessments were completed, a referral to the dietitian was made based on the results of the SNA (see below).

The SNA (Table 1) was devised for this study based on the usual clinical practices of the trained dietitians at this facility and is similar to that used in previous studies [14, 15]. The SNA was used as the 'gold standard' comparator in this study. Food records were not included due to time and personnel constraints. The parameters and cut-off values were selected based on literature evidence and the clinical experience of the dietitians in this facility. In the Nutritional Screening Initiative, the normal BMI in the elderly was determined to be between 22 and 27 kg/m^2 and therefore a cut-off value of 22 kg/m^2 was chosen for this study to identify under-nourished patients (Table 1) [16]. The other cut-off values selected for the other parameters used in this study (Table 1) were based on a previous detailed nutritional

Table 1. The Standardised Nutritional Assessment (SNA) devised based on the usual clinical practices of the dietitians at this facility was used in this study as comparator (see Tables 3a–c)

Criteria assessed	Normal (N)	Borderline (B)	Under-nourished (U)
Total lymphocyte count ($\times 10^9$/l)	>1.5	1.2–1.5	<1.2
Serum albumin level (g/l)	>35	28–34	<28
Total cholesterol level (mmol/1)	>4.15	–	<4.15
No of risk factors:			
nausea, vomiting, diarrhoea, constipation, difficulty chewing or swallowing, history of gastrointestinal disease	≤1	2	≥3
% unintentional weight loss over 3 months (subjective)	0	1.0–7.5	>7.5
BMI (kg/m^2)	≥22		<22

Under nourished (Mild) = 1U + 2B or 2U + 1B; Under nourished (Moderate-Severe) = 3U and greater.

assessment grid used by Azad *et al.* as the 'gold standard' comparator to assess three different nutritional screening tools [15]. All these parameters are important markers of poor nutritional status. More than 10% weight loss from the usual weight in 6 months, or more than 5% in the month, before evaluation is said to be clinically significant [17]. Serum albumin levels ≤30 g/l are associated with increased mortality [18]. A 4-fold increase in mortality has been reported with a total lymphocyte count of less than 1500/mm^3 [19]. A decrease in cholesterol levels after admission to hospital has been associated with more complications and increased length of stay [20]. The presence of symptoms such as nausea, vomiting, diarrhoea, difficulty chewing and swallowing place a patient at risk of decreased nutritional intake and have been utilised in other published studies [15, 16]. In this study, patients were classified as moderately to severely under-nourished if they met the cut-off values for at least three criteria in the under-nourished column (U) as shown in Table 1. Patients with a combination of two values in the borderline (B) and one in the U columns or two in the U and one in the B columns were classified as mildly under-nourished. Patients classified by the SNA as having any degree of under-nutrition (mild, moderate-severe) were referred to the dietitian for further assessment and for treatment as deemed appropriate. Those with mild under-nutrition were monitored whilst those with moderate-severe under-nutrition received nutritional supplements whilst in this sub-acute care facility.

The MNA consists of four main components: (i) anthropometric measurements (weight, height and weight loss); (ii) global assessment (six questions related to lifestyle, medication and mobility); (iii) dietary assessment (eight questions related to number of meals, food and fluid intake, and autonomy of feeding); and (iv) subjective assessment (self-perception of health and nutrition) [11]. Patients were classified as well nourished (N) (MNA ≥ 24), at risk of malnutrition (AR) (MNA = 17–23.5) or malnourished (M) (MNA < 17) according to the MNA score (maximum = 30). The single and two-tiered MNA results are derived from the MNA scores. In the *single-tiered MNA process*, subjects scoring < 24 were classified as under-nourished. In accordance with a previous validation study of the MNA [11], in which the authors recommended a more in-depth assessment of the subjects at risk of malnutrition (MNA = 17–23.5) in the *two-tiered MNA process*, patients scoring between 17 and 23.5

were investigated by the SNA. This resulted in all 65 subjects being classified as under-nourished or nourished as opposed to three categories when the MNA is used alone (M, AR, N; see above).

Patients screened positive on the '*rapid screen*', which was devised for use in this study, if they fulfilled one or both of the following: (1) BMI < 22 kg/m^2; (2) reported weight loss of > 7.5% in the preceding 3 months. As previously stated, a low BMI and weight loss are known to contribute greatly towards mortality and morbidity in older people. These cut-off values were chosen for the reasons previously described (see above, SNA).

Statistical analysis

The sensitivity and specificity of the single and two-tiered MNA process and the 'rapid screen' when compared to the SNA were calculated. Sensitivity was defined as the proportion of patients found to be under-nourished by the various screening tools compared to the proportion of patients classified as under-nourished by the SNA. The specificity was defined as the proportion of patients found to be nourished by the screening tool compared to the proportion of patients identified as nourished by the SNA. Chi-square analysis was used to evaluate the differences in the rate of occurrence of poor discharge outcomes between groups of subjects with different nutritional status. *P* values < 0.05 were considered to be statistically significant.

Results

The baseline characteristics of the study population are outlined in Table 2. Using the two-tiered MNA process, with further evaluation of the AR group using the SNA, 28 (43.1%) patients were under-nourished and 37 (56.9%) were nourished [Table 3a]. The single-tiered MNA process classified 75.4% of patients as under-nourished and 24.6% as nourished [Table 3b]. The 'rapid screen' classified 23 (35.4%) patients as under-nourished and 42 (64.6%) were nourished [Table 3c]. Eight (34.8%) subjects screened positive as they had a BMI < 22 kg/m^2, nine (39.1%) patients had weight loss > 7.5% of their weight in the 3 months before evaluation and six (26.1%) fulfilled both criteria. The SNA classified 28 (43.1%) of the patients as under-nourished and 37 (56.9%) as nourished. Twenty were mildly under-nourished and eight were moderately-severely under-nourished.

Table 2. Baseline characteristics of the patients admitted to the Hampstead Rehabilitation Centre, South Australia between October 2002 and January 2003 who participated in this study

Rehabilitation units surveyed	Medical	Orthopaedic	Geriatric
No of patients studied (*n* = 65)	14 (21.54%)	25 (38.5%)	26 (40.0%)
Mean age ± SD (years)	76.5 ± 5.3	79.5 ± 5.6	79.8 ± 7.7
Total no. male	6 (42.9%)	10 (40.0%)	5 (19.2%)
BMI (kg/m^2) ± SD	26.3 ± 4.8	25.9 ± 5.7	24.9 ± 5.8
Main reason for rehabilitation	CVA, critical care neuropathy	Fracture, joint replacement surgery	Pneumonia, post-abdominal surgery, minor CVA etc.

CVA = Cerebrovascular accident.

Table 3a. Comparison of the two-tiered Mini Nutritional Assessment Process against the Standard Nutritional Assessment

	SNA Under-nourished	SNA Nourished	
MNA Malnourished (Score < 17)	17	2	19 (29.2%)
MNA Nourished (Score > 24)	2	14	16 (24.6%)
MNA At-risk (Score 17–23.5)	9	21	30 (46.1%)
Total	28 (43.1%)	37 (56.9%)	65
[a]	Sensitivity (%) (and 95% CI) 89.5 (68.6–97.1)	Specificity (%) (and 95% CI) 87.5 (64.0–96.5)	

[a]This analysis excludes patients classified as at-risk and they are further evaluated using the SNA.

Table 3b. Comparison of the Single-tiered Mini Nutritional Assessment Process against the Standard Nutritional Assessment

	SNA Under-nourished	SNA Nourished	
Single-tiered MNA process Under-nourished	26	23	49 (75.4%)
Single-tiered MNA process Nourished	2	14	16 (24.6%)
	28 (43.1%)	37 (56.9%)	65
	Sensitivity (%) (and 95% CI) 92.5 (77.4–98.0)	Specificity (%) (and 95% CI) 37.8 (24.1–53.9)	

Table 3c. Comparison of the Rapid Screen against the Standard Nutritional Assessment

	SNA Under-nourished	SNA Nourished	
Single-tiered MNA process Under- nourished	22	1	23 (35.4%)
Single-tiered MNA process Nourished	6	36	42 (64.6%)
	28 (43.1%)	37 (56.9%)	65
	Sensitivity (%) (and 95% CI) 92.5 (77.4–98.0)	Specificity (%) (and 95% CI) 37.8 (24.1–53.9)	

When compared to the SNA (Tables 3a and c), the two-tiered MNA process had a higher sensitivity than the rapid screen (89.5% *vs* 78.6%) but a lower specificity (87.5% *vs* 97.3%). The single-tiered MNA process had a high sensitivity of 92.5% but a low specificity of 37.8% (Table 3b).

Under-nourished (U) patients as identified by the SNA (50.0% (U) *vs* 21.6% (N); $P = 0.017$), the two-tiered MNA process (50.0% (U) *vs* 21.6% (N); $P = 0.017$) and the rapid screen (56.5% (U) *vs* 21.4% (N); $P = 0.004$) were more likely to experience a poor discharge outcome than nourished (N) patients (Table 4).

Discussion

The prevalence of under-nutrition in the patients in this sub-acute care facility varied according to the nutritional screening method. The SNA and the two-tiered MNA process classified 43.1% of patients as having some degree of under-nutrition

Table 4. The ability of various screening tools to predict the occurrence of poor discharge outcomes

	Total patients (n = 65)	Re-admitted to AC	Admitted to LTC facility	Total with poor discharge outcome (AC+LTC)	P (chi-square analysis)
Rapid Screen					
Positive (under-nourished)	23 (35.4%)	8	5	13 (56.5%)	0.004
Negative (nourished)	42 (64.6%)	6	3	9 (21.4%)	
SNA					
Under-nourished	28 (43.1%)	9	5	14 (50.0%)	0.017
Nourished	37 (56.9%)	5	3	8 (21.6%)	
Two-tiered MNA process					
Under-nourished	28 (43.1%)	9	5	14 (50.0%)	0.017
Nourished	37 (56.9%)	5	3	8 (21.6%)	
MNA single-tiered process					
Under-nourished (< 24)	49 (75.4%)	12	6	18 (66.7%)	[a]
Nourished (≥ 24)	16 (24.6%)	2	2	4 (10.5%)	

[a]Chi square analysis not performed as event rate was too low amongst nourished patients.
AC = Acute care; LTC = Long term care.

requiring review and/or intervention by the dietitian, whilst the rapid screen identified 35.4% of the patients as under-nourished. These results show that there is a high prevalence of under-nutrition in this sub-acute care facility, a much higher prevalence than that seen in the community as a whole (4.8% malnourished [2]). The results of this study are similar to previous studies in other countries, which have found that 29–33% of patients admitted to sub-acute care facilities are malnourished (score <17) when assessed by the MNA [4, 21].

The BMI has been widely utilised as a surrogate marker of under-nutrition but controversy remains as to the best lower cut-off values, especially in older people. The 1990 United States guidelines for weight found that the healthy BMI was between 21 and 27 for people aged 35 years and older but these values were biased by reverse causation and inadequate control for smoking [22, 23]. In a recently published large prospective study of 1 million adults, the lowest rates of death from all causes were found at BMIs between 23.5 and 24.9 in men and 22.0 and 23.4 in women; relative risks were not significantly increased for the range of BMIs between 22.0 and 26.4 in men and 20.5 and 24.9 in women [24]. In this study, we arbitrarily selected a lower cut-off value of 22 kg/m^2 and this may need to be re-evaluated in the future when evidence based cut-off values are agreed upon.

In this study, under-nourished patients were more likely than well-nourished patients to transfer to an acute hospital directly from the sub-acute care facility or to require discharge to accommodation with increased supports. This too is consistent with the results of a larger study which found that malnourished patients scoring less than 17 on the MNA in a tertiary geriatric hospital had a 3-fold increased risk of mortality and rate of discharge to a nursing home in comparison to those who were nourished (score ≥24) [25].

We cannot be sure that under-nutrition *per se* is the cause of the worse discharge outcomes experienced by the 'under-nourished' patients in this study. There is likely to be some contribution, at least, from frailty and co-existing medical and other conditions that do not respond to nutritional intervention. Nevertheless, nutritional intervention has been shown to decrease mortality, hospitalisations and morbidity in under-nourished people in various clinical settings [26–29]. We believe the results support the need for nutritional screening of patients in sub-acute facilities and nutritional intervention in those identified as under-nourished.

It is not possible to determine with certainty from this study the best screening tool for under-nutrition. As in previous studies, when the MNA was used with a cut-off value of 24 (single tiered MNA process; [13]), a high proportion of patients (75.4%) were designated as malnourished and, while this categorisation had a high sensitivity, it had a specificity of 37.8% in relation to the results of the SNA (Table 3b). Such a low specificity is unacceptable in our sub-acute facility, as it would result in many patients being unnecessarily referred to an over-worked part-time dietitian and maybe receiving unnecessary treatment. However, the use of the MNA in this way may be acceptable when screening for the use of interventions that are safe and cost-effective.

Both the two-tiered MNA process and rapid screen had a high rate of agreement with the results of the SNA (Tables 3a and c). The two-tiered MNA process avoided the need to do the SNA (and hence blood sampling) in the 54% of patients who were initially classified as mal- (<17) or well-nourished (≥24) by MNA. The rapid screen test had a higher specificity but lower sensitivity than the two-tiered method. However, the use of the rapid screen avoided the need for biochemical investigations in all patients. It appears from the results of this study that it might be best to use the rapid screen (which can readily be included into nursing and/or medical admission procedures) if budgetary and staffing resources are limited and there is a need to minimise unnecessary referrals for detailed nutritional assessment and interventions as in this facility. If more resources are available, the two-tiered approach, with its higher sensitivity, would appear to be the better approach as the content of the MNA can prompt and guide clinical intervention (e.g. medication review if taking more than three medications or screening for depression/cognitive impairment).

In conclusion, there is a need to systematically screen for under-nutrition in sub-acute care facilities and intervene, as the prevalence of under-nutrition is high. The choice of screening tool would be highly dependent on the staffing resources available at individual institutions. Studies attempting to confirm the independent predictors of poor discharge outcomes (i.e. prolonged length of stay or mortality) are required, as addressing these risk factors very early on during an admission is likely to translate into improved health and functional outcomes. Studies demonstrating effective intervention strategies that result in beneficial health outcomes in facilities such as this should also be encouraged.

Key points

- Prevalence of under-nutrition in this sub-acute facility was high.
- Patients identified as being under-nourished by the SNA, two-tiered MNA process and rapid screen were more likely to be discharged to accommodation with increased support or be readmitted to an acute hospital.
- The rapid screen had a higher specificity but a slightly lower sensitivity than the two-tiered MNA process when compared to the SNA.
- In a facility with limited resources such as this, the 'rapid screen' was found to be more useful as it was easily incorporated into nursing or medical admissions and avoided biochemical testing in all patients.
- Where resources permit, then the more sensitive two-tiered MNA process may be better as the content of the MNA may prompt and guide clinical management.

Acknowledgements

Ms Louise Graham (dietitian), the medical interns and nursing staff at the Hampstead Rehabilitation Centre.

References

1. MacIntosh C, Morley JE, Chapman IM. The anorexia of aging. Nutrition 2000; 16: 983–95.
2. Visvanathan R, MacIntosh M, Callary M *et al*. The nutritional status of 250 older Australian recipients of domiciliary care services, and its association with outcomes at 12 months. J Am Geriatr Soc 2003; 51: 1007–11.
3. Barone L, Milosavljevic M, Gazibarich B. Assessing the older person: is the MNA a more appropriate nutritional assessment tool than the SGA? J Nutr Health Aging 2003; 7: 13–17.
4. Thomas DR, Zdrowski CD, Wilson MM *et al*. Malnutrition in subacute care. Am J Clin Nutr 2002; 75: 308–13.
5. Sullivan DH, Moriarty MS, Chernoff R *et al*. Patterns of care: an analysis of the quality of nutritional care routinely provided to elderly hospitalised veterans. J Parenter Enteral Nutr 1989; 13: 249–54.
6. Kamath SK, Lawler M, Smith AE *et al*. Hospital malnutrition: a 33-hospital screening study. J Am Diet Assoc 1986; 86: 203–6.
7. Riffer J. Malnourished patients feed rising costs. Hospitals 1986; 60: 86.
8. Sullivan DH, Sun S, Walls RC. Protein-energy undernutrition among elderly hospitalised patients: a prospective study. JAMA 1999; 281: 2013–19.
9. McWhirter JP, Pennington CR. Incidence and recognition of malnutrition in hospital. Br Med J 1994; 308: 945–8.
10. Williams CM, Driver LT, Lumbers M. Nutrition in the older hospital patient. J R Soc Health 1990; 110: 41–42 & 44.
11. Guigoz Y, Vellas B, Gary PJ. Mini-Nutritional Assessment: a practical assessment tool for grading the nutritional state of elderly patients. Facts Res Gerontol 1994; 2S: 15–59.
12. Guigoz Y, Vellas B, Garry PJ. Assessing the nutritional status of the elderly: The Mini-Nutritional Assessment as part of the geriatric evaluation. Nutr Rev 1996; 54: S59–65.
13. Murphy MC, Brooks CN, New SA *et al*. The use of the Mini-Nutritional Assessment (MNA) tool in elderly orthopaedic patients. Eur J Clin Nutr 2000; 54: 555–62.
14. Azad N, Murphy J, Amos SS *et al*. Nutrition survey in an elderly population following admission to a tertiary care hospital. CMAJ 1999; 161: 511–15.
15. Laporte M, Villalon L, Payette H. Simple nutrition screening tools for health care facilities: development and validity assessment. Can J Diet Prac Res 2001; 62: 26–34.
16. Omran ML, Morley JE. Assessment of protein energy malnutrition in older persons, part I: History, examination, body composition, and screening tools. Nutrition 2000; 16: 50–63.
17. Blackburn GL, Bistrian BR, Maini BS *et al*. Nutritional and metabolic assessment of the hospitalized patient. J Parent Enteral Nutr 1977; 1: 11–22.
18. Liu L, Bopp MM, Roberson PK *et al*. Undernutrition and risk of mortality in elderly patients within 1 year of hospital discharge. J Gerontol A Biol Sci Med Sci 2002; 57: M741–6.
19. Seltzer MH, Bastidas JA, Cooper DM *et al*. Instant nutritional assessment. J Parenter Enteral Nutr 1979; 3: 157–9.
20. Noel MA, Smith TK, Ettinger WH. Characteristics and outcomes of hospitalized older patients who develop hypocholesterolemia. J Am Geriatr Soc 1991; 39: 455–61.
21. Salva A, Bleda JM, Bolibar I. The Mini Nutritional Aseessment in clinical practice. Nestle Nutr Workshop Ser Clin Perform Prog 1999; 1: 1123–9.
22. Willett WC, Dietz WH, Colditz GA. Guidelines for healthy weight. N Engl J Med 1999; 341: 427–34.
23. Department of Agriculture, Department of Health and Human Services. Nutrition and Your Health: Dietary Guideline for Americans, 3rd ed. Home and Garden Bulletin No. 232. Washington, DC: Government Printing Office, 1990.
24. Calle EE, Thun MJ, Petrelli JM *et al*. Body-mass index and mortality in a prospective cohort of U.S. adults. N Engl J Med 1999; 341: 1097–105.
25. Van Nes MC, Herrmann FR, Gold G *et al*. Does the Mini Nutritional Assessment predict hospitalization outcomes in older people? Age Ageing 2001; 30: 221–6.
26. Milne AC, Potter J, Avenell A. Protein and energy supplementation in elderly people at risk from malnutrition. Cochrane Database Syst Rev 2002; (3): CD003288.
27. Tkatch L, Rapin C, Rizzoli R *et al*. Benefits of oral protein supplementation in elderly patients with fracture of the proximal femur. J Am Coll Nutr 1992; 11: 519–25.
28. Delmi M, Rapin CH, Bengoa JM *et al*. Dietary supplementation in elderly patients with fractured neck of the femur. Lancet 1990; 335: 1013–16.
29. Schurch MA, Rizzoli R, Slosman D *et al*. Protein supplements increase serum insulin-like growth factor-1 levels and attenuate proximal femur bone loss in patients with recent hip fracture. A randomised, double-blind, placebo-controlled trial. Ann Intern Med 1998; 128: 801–9.