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Original Study

An Even Distribution of Protein Intake Daily Promotes Protein Adequacy but Does Not Influence Nutritional Status in Institutionalized Elderly

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A B S T R A C T

Objective: Although it has been established that sufficient protein is required to maintain good nutritional status and support healthy aging, it is not clear if the pattern of protein consumption may also influence nutritional status, especially in institutionalized elderly who are at risk of malnutrition. Therefore, we aim to determine the association between protein intake distribution and nutritional status in institutionalized elderly people.
Design: Cross-sectional study among 481 institutionalized older adults.
Methods: Dietary data from 481 ambulant elderly people (68.8% female, mean age 87.5 ± 6.3 years) residing in 52 aged-care facilities in Victoria, Australia, were assessed over 2 days using plate waste analysis. Nutritional status was determined using the Mini-Nutritional Assessment tool and serum (n = 208) analyzed for albumin, hemoglobin, and IGF-1. Protein intake distribution was classified as: spread (even distribution across 3 meals, n = 65), pulse (most protein consumed in one meal, n = 72) or intermediate (n = 344). Regression analysis was used to investigate associations.
Results: Mean protein intakes were higher in the spread (60.5 ± 2.0 g/d) than intermediate group (56.0 ± 0.8 g/d, $P = .037$), and tended to be higher than those in the pulse group (55.9 ± 1.9 g/d, $P = .097$). Residents with an even distribution of protein intake achieved a higher level of the recommended daily intake for protein (96.2 ± 30.0%) than the intermediate (86.3 ± 26.2%, $P = .008$) and pulse (87.4 ± 30.5%, $P = .06$) groups, and also achieved a greater level of their estimated energy requirements (intermediate; $P = .039$, pulse; $P = .001$). Nutritional status (Mini-Nutritional Assessment score) did not differ between groups (pulse; 20.5 ± 4.5, intermediate; 21.0 ± 2.5, spread; 20.5 ± 3.5), nor did any other indices of nutritional status.
Conclusions: Meeting protein requirements is required before protein distribution may influence nutritional status in institutionalized elderly. Achieving adequate protein and energy intakes is more likely when protein is distributed evenly throughout the day. Provision of high protein foods especially at breakfast, and in the evening, may support protein adequacy and healthy aging, especially for institutionalized elderly.

Insufficient protein intake contributes to poor health and sarcopenia or the aged-related loss of muscle mass and strength.[1,2] Institutionalized elderly, in whom protein-energy malnutrition is common, have a high prevalence of sarcopenia.[3] Malnutrition is a risk factor for sarcopenia.[4] Recent evidence suggests that adults >65 years of age have higher protein needs than the current recommended intake levels of 0.8 g protein per kg bodyweight per day (g/kg BW/d), extrapolated from

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adult balance studies, to adequately support muscle and overall health, and to maintain physical function and independence.[5–7] Protein intakes of 1.0–1.2 g/kg BW/d are considered more appropriate for healthy older adults, with levels of between 1.2 and 1.5 g/kg BW/d suggested for those with acute or chronic illnesses.[5] Despite these recommendations, institutionalized elderly commonly have inadequate protein intakes, with levels below 0.8 g/kg/d observed.[8,9]

Additional to total protein intake, the timing of protein consumption may also influence nutritional status and muscle health. While some short-term studies in both younger and older adults indicate enhanced muscle protein synthesis with an even distribution of protein across 3 main meals,[10–12] others have reported that the consumption of the majority of protein in 1 meal stimulates muscle protein synthesis more than an even distribution.[13,14] However, the suitability of a single high protein meal for more frail elderly such as those in institutionalized care, and the long-term feasibility of each dietary strategy to slow muscle loss and reduce malnutrition risk, remains unknown.

As there is limited data describing protein intake distribution in institutionalized elderly people and its relationship with nutritional status, we conducted a cross-sectional study in elderly aged-care residents. We hypothesized that an even distribution of protein across 3 meals would be associated with better nutritional status than if the majority of protein was consumed in 1 meal.

Methods

Study Design and Participants

Data were collected from a convenience sample of 481 ambulant elderly from 52 aged-care facilities in metropolitan Melbourne and regional Victoria, Australia, between December 2014 and September 2015, as part of baseline assessments for a cluster-randomized placebo-controlled trial. Inclusion criteria for the trial were (1) facilities required accreditation by the Australian Aged-Care Quality Agency and (2) they accommodated ambulant residents. The inclusion criteria for this study were being ambulant and older than 70 years of age, as recommendations for protein and energy intake differ for elderly above or below 70 years of age.[15] The overall study was approved by the Human Research Ethics Committee of Austin Health (Project No. 04958) and is registered with the Australian and New Zealand Clinical Trials Registry (ACTRN 12613000228785). Written informed consent was obtained from all participants, or their next of kin.

Dietary Assessment

Food provision in residential aged-care follow 4-week menu cycles, with foods prepared on-site. Meal service typically consisted of a continental-style breakfast (occasional hot breakfast), a mid-day meal providing a hot dish and dessert, an evening meal consisting of soup and choice of a hot or cold dish and dessert, and morning, afternoon and evening snacks. Dairy was consumed at breakfast if cereal/porridge was provided, main meals tended to contain a serving of meat, and dairy if a dairy-based dessert is offered, and snacks tended to consist of plant-based proteins (grain), often consisting of cakes and biscuits.

Trained dietitians determined dietary intake on 2 random days using the validated method of visual estimation of plate waste.[16] All foods and beverages were compared against a weighed, "standard" serving size using a 7-point scale that represents portions of each food remaining; 0 = no food remaining, +M = mouthful remaining, 1/4 = ¼ remaining, 1/2 = ½ remaining, 3/4 = $^3/_4$ remaining, −M = 1 mouthful consumed, 1 = no food eaten. Meals served were rated against the standard meal (medium given the value of 100%); small serving = 75%, large serving = 125%, extra-large serving = 150%. All components of standard serves were weighed on a digital food scale (±1g) (Sohnele Page Profi, Nassau, Germany). Mean dietary intake of protein and energy was calculated per day and per meal using Foodworks v 7 (Xyris Software, Brisbane, Australia). The food composition values used to calculate nutrient intakes were derived from product-specific nutritional information on packaging. When packaging information was not available, nutrient values were obtained from Nutrient Tables for use in Australia 2010 and Food Standards Australia New Zealand 2010.[17]

Proportion of recommended dietary intake (RDI) for protein were based on Australian standards and calculated separately for men and women using the weight of residents (ie, RDI; men >70 years; 1.07 g/kg and women >70 years; 0.94 g/kg). These levels are higher than the internationally recognized RDA of 0.8 g/kg BW.[15] Estimated energy requirements (EER) were based on nutrient reference values equations.[15] Energy intake was calculated as total energy intake per day (kJ/d), and as the percentage of EER achieved (%EER).

Analysis of Protein Intake and Distribution

Total protein intake was calculated for residents in whom accurate data was obtained for all 3 main meals (breakfast, lunch, dinner) and 3 between-meal snacks (including intentionally missed meals/snacks) on at least 1 of the 2 assessment days. Protein intake per meal occasion was calculated as the mean of both meals when both assessment days were available, otherwise the observed meal intake of the single day was used.

Dietary protein intake was expressed as total protein intake (g/d), per kilogram body weight (g/kg/d), and percentage of the RDI for protein. The number of residents reaching the RDI for protein was also calculated. Furthermore, protein intakes (g) per meal occasion (breakfast, lunch, dinner) and snack (morning and afternoon teas and supper) were calculated.

The study population was divided into 3 groups: a spread, intermediate, or pulse group. The spread diet is defined as a diet providing protein in equal amounts over 3 main meals (breakfast, lunch, dinner) with a maximum difference of 10% of protein intake between each meal. The pulse diet is defined as a diet providing 50% or more of the daily protein intake in 1 meal (breakfast, lunch, or dinner). The intermediate group had a protein intake distribution between these 2 criteria.

Nutritional Status

A trained dietitian assessed each participant to determine nutritional status using the Mini-Nutritional Assessment (MNA) tool (Nestlé Nutrition Institute, Vevey, Switzerland). The MNA involves 18 questions, with a maximum total score of 30 points. The MNA categorizes older adults into 3 categories: malnourished (score below 17); at risk of malnutrition (score between 17 and 23.5); or normal nutritional status (score between 24 and 30).

Anthropometric Measurements

Body weight was obtained from facility documentation as it is measured monthly in residents. Ulna length (UL) was used to estimate height using the following equation; males, height (cm) = 4.605UL+1.308age+28.003 (R^2 = 0.96); female, height (cm) = 4.459UL+1.315age+31.485 (R^2 = 0.94).[18,19] UL has been validated for use in elderly populations as it is less affected by aging than standing height.[18,20] Body mass index was calculated; weight (kg)/height^2 (m^2). A BMI score of <18.5 was used as the cut-off for underweight.

Biochemistry

A subsample of 137 female and 71 male persons underwent morning fasting blood tests analyzed for albumin (Roche Sysmex and Cobas 701; Roche Diagnostics, Indianapolis, IN), hemoglobin (Roche Sysmex XN20 analyzer), and IGF-1 (Liason; DiaSorin, Saluggia, Italy); coefficient of variation: 1%–5%. Normal references ranges were; albumin (> 80 years; men and women, 32–43 g/L; 50–79 years; women 33–44 g/L; men 34–45 g/L), hemoglobin (women 120–165 g/L, men 130–185 g/L), and IGF-1 (13–50 nmol/L). Values less than the reference ranges were considered low.

Statistical Analysis

For all statistical analyses SPSS v 22.0 (IBM, Armonk, NY) software was used. Differences in baseline characteristics and in protein and energy intake between the 3 groups were tested with 1-way analysis of variance with Turkey honestly significant difference procedure for post hoc pairwise comparisons) or the Kruskal-Wallis test for continuous variables. Pearson χ^2 test was used to test differences between groups for categorical variables. To study the association between MNA score and protein intake distribution, ordinal regression was used with MNA categories as the outcome variable and the 3 diet groups (pulse, spread, and intermediate) as exposure. The intermediate group served as the reference category. MNA was divided in 3 categories: normal nutritional status, at risk of malnutrition, and malnourished. The crude model and a model adjusted for sex were used in the regression analysis. A P value of <.05 was considered statistically significant (2-tailed).

Results

Characteristics of the Participants

Of 550 residents screened, 481 met the inclusion criteria. Residents were excluded due to being <70 years of age (n = 15), not being ambulant (n = 17), incomplete dietary assessment (n = 12), and missing anthropometric data (n = 25). The study population consisted of 150 male (31.2%) and 331 female participants (68.8%), mean age 87.5 ± 6.3 years and mean BMI 25.9 ± 5.3 kg/m^2 (Table 1). Male participants were on average younger (85.9 ± 7.0 vs 88.3 ± 5.7 years; P = .004), taller, and heavier than female participants, but they did not differ in BMI. Sixty-five residents met the criteria for a spread diet, and 72 met the criteria for a pulse diet. The remaining residents (n = 344; 71.5%) were classified as intermediate.

Based on MNA score, the majority of residents (65.9%) were at risk of malnutrition, 12.9% were malnourished, with the remaining 21.2% considered to be of normal nutritional status. No significant differences in MNA categories or mean MNA scores were observed between the protein distribution groups (Tables 1 and 2). No significant differences were observed between groups for any of the serum markers of nutritional status or BMI (Table 3). However, following adjustment for age and sex, hemoglobin tended to be higher in the intermediate compared to spread diet group (P = .065). No differences were observed between the protein intake distribution groups for the proportion of participants with low levels of albumin (>80 years; men and women <32g/L; 50–79 years; women < 33 g/L; men <34 g/L), hemoglobin (women <120 g/L, men <130 g/L) or IGF-1 (<13 nmol/L), nor low BMI (<18.5), or a composite score (0–5) comprising the number of malnutrition risk factors per resident (data not shown).

Protein Intake

Unadjusted values for total dietary protein intake (g/d) did not differ significantly between the spread (60.1 ± 17.7g/d), pulse (55.9 ± 22.3g/d), or intermediate diet group (56.0 ± 15.0g/d) (P = .183). However, after adjusting for sex, the difference between the spread and intermediate groups reached significance (P = .037), and the difference between the spread and pulse groups trended toward significance (P = .097) (Table 2). Relative protein intake was higher in the spread (0.93 ± 0.28 g/kg BW/d) compared with intermediate group (0.84 ± 0.25g/kg BW/d, P = .012 after adjustment for sex), and tended to be higher than the pulse group (0.85 ± 0.30 g/kg BW/d, P = .078 after adjustment for sex), but no differences were observed between the pulse and intermediate groups. Residents achieved a higher level of the recommended protein intake in the spread (96.2 ± 30.0%) compared with intermediate (86.3 ± 26.2%, P = .012 after adjustment for sex) and pulse (87.4 ± 30.5%, P = .072 after adjustment for sex) groups.

Table 1
Baseline Characteristics of Elderly Australian Aged-Care Residents, Divided into 3 Protein Intake Distribution Groups; Pulse (>50% of Protein Consumed in 1 Meal), Spread (Even Protein Consumption between 3 Meals), and Intermediate (Protein Intake Distribution between Pulse and Spread

	Pulse (n = 72)	Intermediate (n = 344)	Spread (n = 65)
Sex, n (%)			
Male	22 (30.6%)	111 (32.3%)	17 (26.2%)
Female	50 (69.4%)	233 (67.7%)	48 (73.8%)
Age (y)			
Total	87.1 ± 6.6	87.6 ± 6.3	87.7 ± 6.0
Men	85.7 ± 6.8	86.2 ± 7.1	84.0 ± 7.1
Women	87.7 ± 6.5	88.3 ± 5.7	89.0 ± 5.0
Weight (kg)			
Total	67.0 ± 18.6	68.7 ± 15.3	65.9 ± 12.7
Men	76.3 ± 21.7	75.6 ± 14.3	76.1 ± 11.0
Women	63.0 ± 15.7	65.4 ± 14.6	62.3 ± 11.3
Height (m)			
Total	1.62 ± 0.07	1.62 ± 0.08	1.61 ± 0.08
Men	1.69 ± 0.07	1.70 ± 0.06	1.71 ± 0.05
Women	1.59 ± 0.05	1.58 ± 0.05	1.57 ± 0.05
BMI, (kg/m^2)			
Total	25.7 ± 5.9	26.0 ± 5.3	25.4 ± 4.2
Men	26.5 ± 6.1	26.0 ± 4.6	25.9 ± 3.4
Women	25.3 ± 5.8	26.1 ± 5.7	25.2 ± 4.5
Medication use >3/d, n (%)			
Total	9 (12.5)	37 (10.8)	9 (13.8)
Men	5 (22.7)	8 (7.2)	2 (11.8)
Women	4 (8.0)	29 (12.4)	7 (14.6)
MNA category, n (%)			
Well-nourished	14 (19.4)	76 (22.1)	12 (18.5)
At risk	46 (63.9)	228 (66.3)	43 (66.2)
Malnourished	12 (16.7)	40 (11.6)	10 (15.4)
MNA score			
Total	20.5 ± 5.0	21.0 ± 3.5	21.0 ± 3.5

Data expressed as mean ± standard deviation unless otherwise stated.

Energy Intake

Energy intake expressed as kJ/d and as a percentage of the estimate energy requirement (%EER), differed between groups. Both the spread (6826 ± 1564 kJ/d, P < .001) and intermediate diet groups (6495 ± 1527 kJ/d, P < .01) had significantly higher energy intakes than the pulse group (5774 ± 1765 kJ/d), and there was a trend toward greater energy intake in the spread compared to intermediate group after adjusting for sex (P = .056). Energy intake as a % of requirement was greater for the spread group (93.7 ± 19.7%) compared with both the intermediate (87.6 ± 19.3%, P = .039) and pulse (78.6 ± 21.8%, P < .001) groups after adjusting for sex. %EER was also greater for the intermediate compared to pulse group (P < .001). A trend toward group differences in the proportion of residents that achieved their EER was observed (P = .101), which may have been driven by the

Table 2
Nutritional Status and Dietary Protein and Energy Intakes of Elderly Australian Aged-Care Resident Based on Their Protein Intake Distribution; Pulse (>50% of Protein Consumed in 1 Meal), Spread (Even Protein Consumption between 3 Meals), and Intermediate (Protein Intake Distribution between Pulse and Spread)

	Groups			*P* Values		
	Pulse (n = 72; 22 male)	Intermediate (I) (n = 344; 111 male)	Spread (S) (n = 65; 17 male)	Pulse vs I	Pulse vs S	I vs S
MNA Score						
Women	20.0 ± 5.0	21.0 ± 3.5	20.5 ± 4.0	.295	.787	.805
Men	21.5 ± 4.5	21.0 ± 3.5	21.5 ± 2.0	.837	.998	.900
Total group (crude)	20.5 ± 4.5	21.0 ± 3.5	20.5 ± 3.5	.586	.888	.932
Protein (g/d)						
Women	50.4 ± 16.3	53.8 ± 13.9	58.5 ± 17.0	.303	.020	.117
Men	68.3 ± 28.7	60.7 ± 16.2	64.7 ± 19.3	.202	.831	.691
Total group (crude)	55.9 ± 22.3	56.0 ± 15.0	60.1 ± 17.7	.996	.297	.169
Total group (Adj)*	55.9 ± 1.9	56.0 ± 0.8	60.5 ± 2.0	.988	.097	.037
Protein (g/kg/d)						
Women	0.82 ± 0.28	0.85 ± 0.25	0.95 ± 0.29	.796	.040	.036
Men	0.91 ± 0.34	0.82 ± 0.23	0.86 ± 0.26	.251	.818	.776
Total group (crude)	0.85 ± 0.30	0.84 ± 0.25	0.93 ± 0.28	.946	.175	.028
Total group (Adj)*	0.85 ± 0.03	0.84 ± 0.03	0.93 ± 0.03	.760	.078	.012
Protein (% RDI)						
Women	87.7 ± 30.0	90.5 ± 27.1	101.6 ± 30.4	.796	.040	.036
Men	86.6 ± 32.3	77.3 ± 21.8	81.1 ± 23.7	.216	.752	.813
Total group (crude)	87.4 ± 30.5	86.3 ± 26.2	96.2 ± 30.0	.947	.145	.021
Total group (Adj)*	87.3 ± 3.2	86.4 ± 1.4	95.6 ± 3.3	.794	.072	.012
Protein (n and % above the RDI)						
Women	16/50 (32.0)	78/233 (33.5)	23/48 (47.9)	.979	.226	.138
Men	6/22 (27.2)	17/111 (15.3)	3/17 (17.6)	.371	.713	.970
Total group	22/72 (30.5)	95/344 (27.6)	26/65 (40.0)	.873	.448	.112
Energy (kJ/d)						
Women	5424 ± 1603	6199 ± 1354	6512 ± 1345	.001	.000	.333
Men	6570 ± 1985	7115 ± 1680	7711 ± 1827	.375	.110	.391
Total group (crude)	5774 ± 1795	6495 ± 1527	6826 ± 1564	.001	.000	.267
Total group (Adj)*	5780 ± 178	6484 ± 81	6875 ± 187	.000	.000	.056
Energy (% EER)						
Women	79.5 ± 22.7	89.9 ± 19.3	96.0 ± 19.7	.003	.000	.131
Men	76.3 ± 20.2	82.9 ± 18.4	86.5 ± 18.5	.297	.224	.743
Total group (crude)	78.6 ± 21.8	87.6 ± 19.3	93.7 ± 19.7	.001	.000	.066
Total group (Adj)*	78.5 ± 2.3	87.7 ± 1.1	93.2 ± 2.4	.000	.000	.039
Energy (n and % above the EER)						
Women	10/50 (20.0)	68/233 (29.2)	19/48 (39.6)	.397	.085	.319
Men	3/22 (13.6)	17/111 (15.3)	3/17 (17.6)	.979	.938	.967
Total group	13/72 (18.1)	85/344 (24.7)	22/65 (33.8)	.461	.084	.262

Data expressed as mean ± standard deviation unless otherwise stated.
P values were derived from *post-hoc* Turkey honestly significant difference (HSD) procedure for observed means.
*Mean ± standard error of the mean adjusted for sex.

Table 3
Biomarkers of Nutritional Status for Elderly Australian Aged-Care Resident Based on Their Protein Intake Distribution; Pulse (>50% of Protein Consumed in 1 Meal), Spread (Even Protein Consumption between 3 Meals), and Intermediate (Protein Intake Distribution between Pulse and Spread)

	Groups			*P* Values		
	Pulse (n = 22; 7 male)	Intermediate (I) (n = 159; 58 male)	Spread (S) (n = 27; 6 male)	Pulse vs I	Pulse vs S	I vs S
Hemoglobin (g/L)						
Women	128.3 ± 10.4	126.7 ± 14.1	118.8 ± 19.5	.918	.137	.066
Men	126.6 ± 16.4	133.0 ± 15.5	134.8 ± 17.7	.565	.617	.962
Total (crude)	127.8 ± 12.3	129.0 ± 14.9	122.4 ± 19.9	.931	.441	.096
Total (sex)*	127.9 ± 3.2	128.9 ± 1.2	123.1 ± 2.9	.781	.272	.071
Total (sex, age)*	127.6 ± 3.2	128.9 ± 1.2	123.1 ± 2.9	.704	.297	.065
IGF-1 (nmol/L)						
Women	17.0 ± 6.4	15.4 ± 6.1	14.1 ± 5.3	.550	.301	.656
Men	17.9 ± 3.6	15.7 ± 6.2	18.7 ± 8.5	.674	.970	.520
Total (crude)	17.3 ± 5.6	15.5 ± 6.1	15.1 ± 6.3	.387	.422	.950
Total (sex)*	17.3 ± 1.2	15.5 ± 0.5	15.2 ± 1.2	.174	.224	.836
Total (sex, age)*	17.2 ± 1.2	15.5 ± 0.5	15.2 ± 1.2	.205	.242	.812
Albumin (g/L)						
Women	34.9 ± 2.9	36.0 ± 3.9	35.7 ± 4.0	.518	.769	.960
Men	35.6 ± 1.8	37.0 ± 3.1	38.9 ± 2.4	.440	.099	.268
Total (crude)	35.1 ± 2.6	36.4 ± 3.6	36.5 ± 3.9	.236	.331	.982
Total (sex)*	35.1 ± 0.7	36.3 ± 0.3	36.6 ± 0.7	.129	.134	.691
Total (sex, age)*	35.1 ± 0.7	36.3 ± 0.3	36.6 ± 0.7	.100	.116	.715

Data expressed as mean ± standard deviation unless otherwise stated.
P values derived from post-hoc Turkey honestly significant difference (HSD) procedure for observed means.
*Mean ± SEM, adjusted for sex.

Table 4
Protein Intake (g) per Meal and Snack in Elderly Australian Aged-Care Resident Based on Their Protein Intake Distribution; Pulse (>50% of Protein Consumed in 1 Meal), Spread (Even Protein Consumption between 3 Meals) and Intermediate (Protein Intake Distribution between Pulse and Spread)

	Pulse	Intermediate	Spread
Breakfast	9.7 ± 4.5*	12.4 ± 5.4*,†	16.2 ± 5.3†
Morning snack	1.2 ± 1.2*	1.9 ± 2.0†	2.4 ± 2.2†
Lunch	24.3 ± 12.1*	19.6 ± 7.3†	17.5 ± 6.2†
Afternoon snack	1.7 ± 1.9*	2.8 ± 3.6†	3.4 ± 4.5†
Dinner	18.6 ± 15.7	16.7 ± 7.0	17.1 ± 5.5
Evening snack	1.3 ± 1.9*	2.3 ± 2.8†	3.1 ± 3.7†

Data are presented as mean ± standard deviation.
*Significantly different from spread diet (post-hoc Turkey honestly significant difference (HSD) procedure for pairwise comparison, $P < .05$).
†Significantly different from pulse diet (post-hoc Turkey honestly significant difference (HSD) procedure for pairwise comparison, $P < .05$).

difference observed between the spread and pulse groups (33.8% vs 18.1%, $P = .084$).

Protein Distribution and Intake at Meals

Protein intake differed between groups for most meal occasions, except dinner (Table 4). The pulse group consumed significantly more protein during lunch (24.3 ± 12.1g) than the intermediate (19.6 ± 7.3 g, $P < .001$) or spread group (17.5 ± 6.2 g, $P < .001$), but both groups consumed more protein at morning and evening snacks than the pulse group. The protein content at breakfast was higher for the spread group (16.2 ± 5.3g, both $P < .001$) compared with the intermediate (12.4 ± 5.4g) and pulse groups (9.7 ± 4.5g).

Discussion

In this cohort of institutionalized elderly, after adjusting for sex, both absolute and relative protein intakes were higher in the spread than pulse or intermediate protein distribution groups. Furthermore, absolute energy intake and percentage of energy requirements (%EER) achieved were higher, or tended to be higher in the spread compared with the intermediate and pulse groups. No group differences in nutritional status were observed between the 3 protein intake distribution groups.

Protein Distribution and Protein Intake

Protein adequacy was more likely with a spread than pulse distribution. However, relative protein still remained below the suggested 1.0–1.2 g/kg BW, so by recommended standards, protein intake was still inadequate.[21]

Kim et al[22] observed that in healthy older adults (mean age ~65 years), the provision of protein at ~1.5g/kg BW stimulated muscle protein synthesis more than an intake equivalent to ~0.8 g/kg BW, irrespective of distribution being pulse or spread. Furthermore, prior comparisons of muscle protein synthesis between spread and pulse protein distribution in adults and the elderly have yielded inconsistent results, however, all have utilized protein intakes >1 g/kg BW, which reinforces the notion that protein adequacy is likely required for the efficacy of changes in distribution on muscle protein synthesis to be apparent.[11,13,14,23,24]

Our results indicate that protein adequacy was more achievable in the spread than pulse distribution of protein. Therefore, in institutionalized elderly this may be a preferred means of enhancing protein intake, so options to provide sufficient protein at each meal need to be explored, in particular at breakfast and in the evening. Providing high protein foods (eg, dairy foods at meals is a relatively simple method).[25]

Mila et al[26] observed that with the provision (and consumption) of sufficient servings of meat and dairy foods, nursing home residents achieved recommended intakes for protein, with a median intake of 1g/kg BW. The distribution of the protein was not specified, however, the most consumed protein-rich food was milk, which was consumed mostly at breakfast. Others have also reported that breakfast is the lowest protein-containing meal, so strategies to augment protein intake at breakfast may be beneficial.[8]

Another method of enhancing protein intake is food fortification.[27] In a single blind randomized trial in 34 older rehabilitation patients, van Til et al[28] used protein-fortified bread and yogurt to enhance protein intake compared to non-fortified equivalent foods. Protein intake was significantly greater (~43 g) ($P < .001$) in the intervention group compared to controls. Product consumption was ad lib resulting in; protein intake during breakfast and lunch being augmented, a more spread distribution of protein, and patients achieving at least 25g of protein intake per meal. Expanding the choices of protein-fortified foods may facilitate protein intake at all three meals, and may provide for high-protein snacks between meals.

On-site food fortification by food service staff is potentially feasible, but it has been observed that without adequate training of food service staff the benefits are limited.[29,30] Moreover, Morilla-Herrera et al[31] noted that, although on-site fortification may be considered a cheaper option than pre-fortified products, labor costs to prepare the foods also need to be considered.

Current recommendations suggest that to optimize muscle protein synthesis, each meal should contain at least 25 g of protein.[21] In our cohort of aged-care residents, regardless of distribution, mean protein intake at meals were below this recommended level, with only those consuming a pulse type distribution nearing this level of protein intake at lunchtime. Even so, as the suggested level of protein intake was not achieved, the ability to maximize an anabolic response was likely limited. As the spread protein distribution was more favorable to achieve protein adequacy, the provision of protein containing foods to provide at least 25 g of protein at each meal is recommended.

Protein Distribution and Energy Intake

Absolute energy intake and % of energy requirement achieved was higher in the spread compared with the intermediate and pulse groups. This further supports the notion that a spread distribution can potentially facilitate a greater protein intake if foods provided contain sufficient protein, so menus should be planned accordingly. In contrast to Mila et al[26] who observed that the provision of sufficient meat and dairy foods enabled nursing home residents to achieve protein adequacy, Iuliano et al[9,32] observed that if the recommended number of servings of meat and/or dairy foods were not provided, residents consumed insufficient protein (<1 g/kg BW). Concomitantly, the consumption of discretionary foods was in excess of recommended levels, so substitution of these foods with high-protein alternatives would likely promote protein adequacy.

Protein Distribution and Nutritional Status

Overall protein and energy intakes were below recommended levels, so it could be postulated that any potential differences in nutritional status as a result of protein distribution may have been masked by the inadequate intakes of both protein and energy.

Few studies have reported on protein distribution and nutritional status. Bollwein et al[33] observed in community dwelling elderly ≥75 years of age, that frail elderly consumed less protein at breakfast, and more at lunchtime (pulse distribution) compared to pre-frail and non-frail elderly people. However, the frail elderly were; older, more were female and lived alone, were prescribed more medications, and had greater difficulties eating than the less frail elderly people. Also, irrespective of frailty status, absolute and relative protein intakes did not differ by group, and mean protein intake was >1 g/kg BW. Farsijani et al[10] observed in a sample of over 700 elders aged 67–84 years with mean protein intakes >1g/kg BW, that protein intake was lower at breakfast compared to lunch and dinner (pulse distribution) in both sexes, but a more even distribution was associated with higher lean mass. In an 8-week randomized-controlled trial Kim et al[34] observed no differences in changes to lean mass, muscle strength or function in a sample of 14 older adults (51–69 years old) prescribed a pulse (proportion of protein per meal: 15%, 20%, 65%) or even (33%, 33%, 33%) protein diet.[34] However, the sample size was small and mean daily protein intake was 1.1 g/kg BW. These outcomes suggest that the initial focus in the aged-care setting to prevent malnutrition is to foster protein adequacy before the efficacy of protein distribution may be apparent.

We used the MNA tool as the main measure of nutritional status, but it may have been insensitive to differences in protein distribution. Only 1 question on the MNA tool relates to protein intake, so the ability to make substantial changes to scores may relate more to long term protein intake influencing body composition (eg, weight loss, BMI, calf and upper arm circumferences). Therefore, serial measures of body composition, more than just weight alone, may be required to assist in the clinical and nutritional management of residents in relation to protein intake, protein distribution, and a normal nutritional status, that would foster the maintenance of lean mass.

The reliability of a single measure of malnutrition has been questioned, so in isolation each of the additional measures of malnutrition reported may not accurately capture nutritional status of participants.[35] Shakersain et al[36] observed that in adults >60 years of age, malnutrition (MNA-Short form) was associated with higher mortality risk [HR (95%CI); 2.40 (1.56–3.67)], and with the addition of an abnormal biomarkers (eg, low albumin or hemoglobin levels) life expectancy was shortened by a further ~1 year. We were unable to differentiate nutritional status between the protein distribution groups even when the biomarkers and BMI were considered together, with or without MNA score.

The limitations of this study include its cross-sectional design, the small number of residents that met the criteria for a spread or pulse diet potentially limiting the power to detect differences if present, and analyses by sex was not feasible given the smaller number of male participants in the sample. Moreover, serum samples were collected on approximately one-half of the cohort so power to detect differences was likely further reduced.

To our knowledge, this is the first study investigating the distribution of protein intake in Australian aged-care residents and the association between protein intake distribution and risk of malnutrition. The study demonstrated the necessity to ensure protein adequacy in aged-care, residents, which was more likely with a spread than pulse distribution. With the aging of the population and the costs associated with malnutrition and sarcopenia, reducing the risk in all aged-care residents by ensuring protein adequacy, would likely reduce the burden of these conditions on the aged-care and health sectors.

In conclusion, menu planning and food provision both fortified and nonfortified needs to provide sufficient opportunities for residents to choose foods that would enable them to meet their protein needs. Meeting protein requirements is needed before protein distribution may influence nutritional status in institutionalized elderly. Achieving adequate protein and energy intakes is more likely when protein is distributed evenly throughout the day. Provision of high protein foods especially at breakfast, and in the evening, may support protein adequacy and healthy aging in institutionalized elderly.

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