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Preventive Effect of Protein-Energy Supplementation on the Functional Decline of Frail Older Adults With Low Socioeconomic Status: A Community-Based Randomized Controlled Study

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Background. Chronic undernutrition is a common condition in older people with low socioeconomic status and is clearly an important component of frailty. However, it is uncertain whether protein-energy supplementation can prevent functional decline in this group.

Methods. Eighty-seven frail older adults (usual gait speed, <0.6 m/second; Mini Nutritional Assessment, <24) were enrolled in this randomized controlled trial. Participants were randomly assigned to either an intervention group, which was provided two 200-mL cans of commercial liquid formula (additional 400 kcal of energy, 25 g of protein, 9.4 g of essential amino acids, 400 mL of water) per day for 12 weeks, or the controls group, which did not receive this supplement. The primary outcomes were the change of the Physical Functioning and Short Physical Performance Battery. Usual gait speed, timed up-and-go test, hand grip strength, and one-legged stance were also measured as secondary outcome variables.

Results. Physical Functioning increased by 5.9% (1 point) in the intervention group, although no change was observed in the control group (p =.052). Short Physical Performance Battery remained stable in the intervention group, although it decreased by 12.5% (1 point) in controls (p = .039). Usual gait speed decreased by 1.0% in the intervention group versus 11.3% (0.04 m/second) in controls (p = .039). Timed up-and-go improved by 7.2% (1.1 seconds) in the intervention group and worsened by 3.4% (0.9 seconds) in controls (p = .038). There were no differences between groups in hand grip strength or one-legged stance performance.

Conclusions. The results indicate that protein-energy supplementation administered to frail older adults with low socioeconomic status shows evidence of reducing the progression of functional decline.

Key Words: Frailty—Nutritional supplementation—Functional status—Clinical trial.

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CHRONIC undernutrition is a common condition in older people and is clearly an important component of frailty (1,2). However, the effect of nutritional intervention on the functional status of frail older people is controversial. Until now, it seemed obvious that protein and energy supplementation for frail elders would cause weight gain by significantly increasing total energy intake if care is taken not to replace their usual meal with supplements (3); however, the majority of investigators have reported that such improvements are insufficient for significantly improving muscle strength, performance status, or disability indicators (3–5). In a systematic review performed to assess the effectiveness of intervention studies in community-dwelling frail elders, no evidence was found to support the effect of nutritional interventions on disability measures (6). A meta-analysis of protein and energy supplementation in older adults also showed that the beneficial effects of supplementation were limited to in-hospital patients and possibly those in long-term care facilities (3).

However, information about the socioeconomic status (SES) of study participants is rarely reported in previous studies of nutritional intervention in community-dwelling frail elders (3,6,7). Low SES is associated with risks of malnutrition (8–10), frailty (11,12), and functional decline (13) among older adults. Understanding factors that determine the effectiveness of community-based nutritional interventions requires investigations that combine physiologic and psychosocial factors, and no such comprehensive studies have yet been published.

For this reason, the researchers recruited a study sample with low SES and evaluated the effects of a protein-energy

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supplementation on their disability scores and physical performance. The aim of this study was to evaluate whether protein-energy supplementation can prevent functional decline in frail older adults of low SES.

Methods

Study Design and Participants

This study was designed as a community-based, two-arm, randomized controlled trial. The study protocol was approved by the Institutional Review Board of Ewha Womans University, Seoul, Republic of Korea.

Study participants were recruited from the National Home Healthcare Services (NHHS) registration database in Gangbuk-gu, Seoul, South Korea. Registration for NHHS is limited by family income level, so only those below 120% of the national absolute poverty line qualify for the service (ie, $572/month for a one-person household, $974/month for a two-person household, and $1260/month for a three-person household).

The recruiting strategy consisted of three steps. First, from April 1 to June 12, 2011, newly registered older adults aged 65 years and older were recruited from the NHHS database. Second, participants who could not walk a 3-m course within 5 seconds at their usual pace were identified. During the NHHS registering process in Gangbuk-gu, all participants undergo a usual gait speed (UGS) test during routine home visits by nurses. Third, a trained physiotherapist reexamined the UGS test and a research dietitian performed a nutritional assessment for each eligible subject using a standardized procedure. Using this process, the researchers selected the study participants who met the frailty criteria.

The researchers used the operational definition of frailty from the Interventions on Frailty Working Group (1). Two of the eight indicators—mobility and nutrition—that are strongly associated with the development or progression of disability were selected to define frailty. Participants were considered frail if their UGS was less than 0.6 m/second and if they scored less than 24 points on the Mini Nutritional Assessment (MNA). UGS is a reliable and valid predictor of adverse outcomes in community-dwelling older people (14). A gait-speed cutoff point was identified based on the Korean Geriatric Survey 2008, and a cutoff point matching the approximate value of the slowest 30% of 15,146 older Korean adults was used (15). The MNA score appears to be a good single marker of frailty and has been correlated with weight loss, poor appetite, and functional decline (16–18). An MNA score lower than 24 indicates a protein-calorie intake that is below recommended values (16). Study subjects who were participating in any kind of exercise program or clinical nutrition program were excluded. Participants who were ordered to restrict a high-protein diet by an internist (ie, for liver failure or severe renal failure) were also excluded. Participants who are unable to walk or are too functionally deteriorated to receive home health care services are automatically transferred to the National Long-Term Care Service; thus, all eligible subjects were able to walk inside a room, at a minimum.

Participants were randomly allocated to the intervention or control arms using a 1:1 allocation ratio. The randomization sequence was generated by a simple randomization procedure (using a random-number table) by a randomization unit (Health Science College, Ewha Womans University, Seoul, Korea) that was independent of the study. Intervention was centrally allocated by telephone. Outcome assessors and a physician (CK) who was responsible for clinical observation in this trial were masked to the allocation until the end of the study.

Of 258 persons in the NHHS database who were initially screened as UGS < 0.6 m/second, a total of 120 frail elderly participants were reexamined by research assessors. Thirty participants did not meet the frailty criteria, and three participants declined to participate in the study. After providing written informed consent, 87 participants were randomized to the intervention ($n = 43$) or control ($n = 44$) group (Figure 1).

Intervention

Each participant in the intervention group was provided with two 200-mL cans of commercial liquid formula per day (Greenbia HP, Dr. Jung's Food Co., Ltd., Korea) for 12 weeks. Using this nutritional supplement, the researchers were able to offer an additional 400 kcal of energy, 25 g of protein, 9.4 g of essential amino acids (60.2% leucine), 56 g of carbohydrate, 9 g of lipid, 400 mL of water, and micronutrients (vitamin A, 0.3 mg; thiamin, 0.42 mg; riboflavin B2, 0.6 mg; pyridoxine, B6 0.6 mg; vitamin B12, 0.96 µg; vitamin C, 40 mg; vitamin D3, 2 µg; vitamin E, 4 mg; vitamin K1, 30 µg; folate, 0.16 mg; niacin, 6.4 mg; biotin 12 µg; pantothenic acid, 2 mg; choline, 146 mg; L-carnitine, 40 mg; taurine, 40 mg; calcium, 280 mg; phosphorus, 280 mg; magnesium, 88 mg; zinc, 4 mg; iron, 4 mg; iodine, 60 µg; and copper, 0.32 mg) per day. Compliance was measured every 2 weeks during a home visit by the research dietitian (KL). At that time, the participants were clearly instructed not to replace their usual meal with the liquid supplement; rather, they were encouraged to use the supplement to increase overall food intake (19). Participants in the control group did not receive any treatment or counseling during the study period. To control for any effect of greater attention to one group, the same research dietitian (KL) visited the participants in the control group and gave a small gift every month. During the study period, home healthcare services provided by NHHS workers were suspended.

Assessments

Baseline and follow-up assessment were performed by three research healthcare providers who had no role in the

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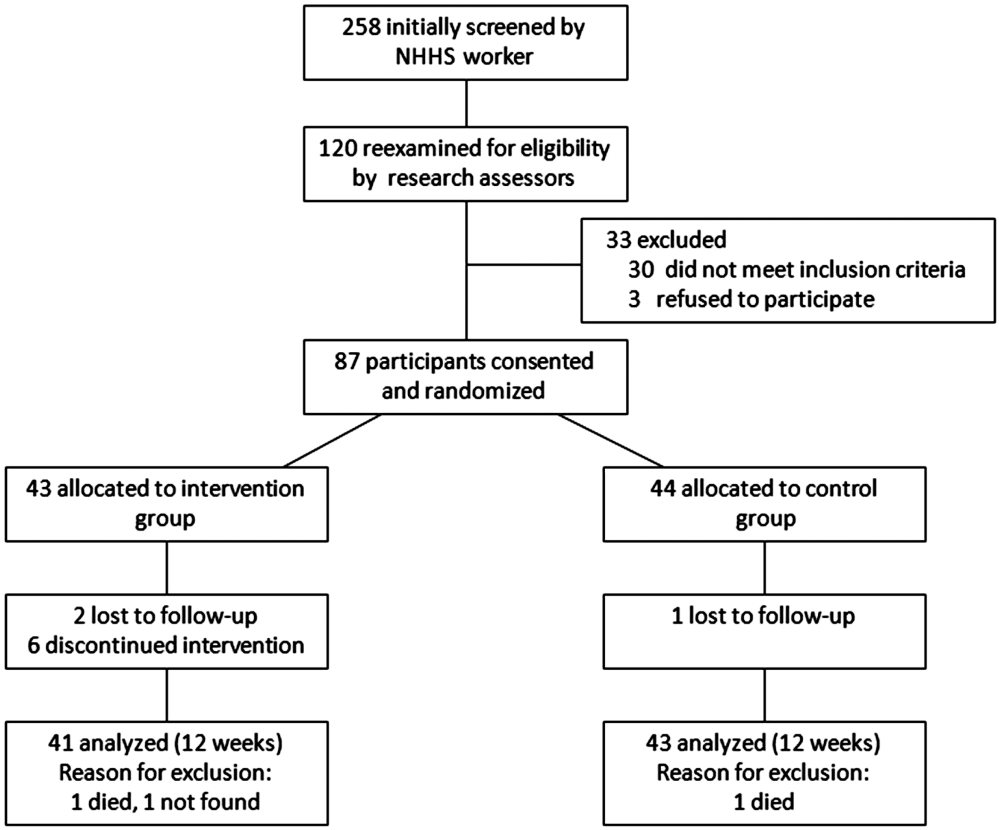

Figure 1. Screening, enrollment, randomization, and follow-up of the study participants. NHHS = National Home Healthcare Services in Gangbuk-gu, Seoul, Republic of Korea.

intervention and who were unaware of the study hypothesis or participant group assignment. Baseline characteristics and nutritional data were collected by a trained research dietitian. Primary and secondary outcome variables related to functional status were measured by a trained research physiotherapist. Blood sampling was performed by a research nurse.

Baseline characteristics.—Prior to randomization, baseline characteristics such as age, sex, education, living status, social support network, family income, beneficiaries of social security insurance, number of chronic diseases, use of herbal medicine, multivitamin, smoking, alcohol and food assistance program were assessed by a standardized interview form.

Primary outcome measures.—Baseline and follow-up assessments of functional status were conducted using Physical Functioning (PF) and Short Physical Performance Battery (SPPB) tests for primary outcomes.

Disability score.—PF is a valid and reliable disability score that was specially developed to measure geriatric function in the community-dwelling frail elderly adults of Korea (20). Self-reported information was collected for five physical performance activities (walking 400 m; climbing 10 steps of stairs; stooping, crouching, or kneeling; reaching up over one's head; lifting 8-kg weight) and five instrumental activities of daily living (bathing; dressing; transferring; shopping; using transportation). Summary scores for PF range from 0 to 30, and a higher score indicates better functional status. Test–retest reliability is good with an intraclass correlation coefficient of .59 (20).

Functional performance.—The SPPB is an objective measurement of functional performance developed at the Established Populations for Epidemiologic Studies of the Elderly (21). Objective data for walking speed, balance tests, and times for repeated chair stands were collected to create a global score, which ranges from 0 (worst performance) to 12 (best performance). The SPPB has shown very high test–retest reliability with intraclass correlation coefficients of .88 to .92 (22).

Secondary outcome measures.—Two additional measures of physical performance (timed up-and-go test and one-legged stance) were obtained using standardized procedures (23,24). Maximal hand grip strength was also measured using a hand grip dynamometer (Tanita Co.,

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Ltd., Japan). To assess nutritional status, dietary intake was assessed by three nonconsecutive 24-hour recalls (one face-to-face, two by telephone, weekday and weekend ratio 2:1). Dietary data were coded by the same research dietitian and nutrient analysis was carried out using CAN-Pro 3.0 (Korean Nutrition Society, Seoul, Korea). Mean adequacy ratio was calculated from nutrient adequacy ratios for the intake of energy, protein, and 11 micronutrients (calcium, phosphorus, iron, zinc, vitamin A, thiamin, riboflavin, pyridoxine, niacin, vitamin C, and folate). Anthropometric data, such as body weight and mid-arm circumference, were also collected.

Compliance and adverse effects.—Compliance was calculated by dividing the number of cans the participants consumed by the number of total cans provided. An adverse effect was regarded as a sign or symptom that the participants complained about after initiation of the nutritional supplement. Compliance and adverse effects were monitored during the biweekly visits, which took place throughout the study. To investigate possible risk for deteriorating kidney function (25), blood sampling to measure serum level of blood urea nitrogen and to estimate creatinine clearance (using the Cockcroft-Gault formula) was also performed (26).

Statistical Analysis

The sample size calculations were based on data from a pilot study of the NHHS in Gangbuk-gu from the year 2010. In that trial, 72 participants experienced a 38% ± 74% increase in PF score and a 21% ± 50% increase in SPPB score with the same intervention protocol. It is hypothesized that there would be a 48% difference in PF score and a 31% difference in SPPB between the two groups of this study. At least 40 people per group were necessary to achieve 80% power with α equal to .05.

An analysis was performed according to the intention-to-treat principle. Baseline comparisons of the intervention group and the control group were made using the Chi-square test, Fisher's exact test, independent *t* test, or Wilcoxon rank-sum test according to the variable characteristics. Because relative changes in outcome variables did not follow normal distribution except for two variables (body weight and mid-arm circumference), differences in outcomes between the two groups were tested with nonparametric methods (Wilcoxon rank-sum test). In order to estimate whether the observed differences were clinically meaningful, data on the absolute differences between outcome variables were added. Additional analyses of Spearman's correlations were performed between changes in nutritional status and functional status. Significance for all results was set at a $p < .05$ level. No adjustments were made for multiplicity. This trial is registered at ClinicalTrial.gov (NCT01404299).

Results

Eighty-four participants (97%) completed the 12-week follow-up assessment. Three participants could not be evaluated by follow-up assessment. In the intervention group, one participant died, and one was lost after admission for gastric ulcer bleeding; one participant died in the control group. Among the participants in the intervention group, three (7%) complained of dyspepsia and three (7%) experienced acute illness, so they withdrew prematurely. The serum level of blood nitrogen urea in the intervention group was increased significantly by 2.0 ± 4.8 mg/dL (minimum, −10.8 mg/dL; maximum, 17.1 mg/dL; paired *t* test, $p = .011$). However, estimated creatinine clearance increased significantly by 2.5 ± 6.5 mL/min (minimum, −9.1 mL/min; maximum, 19.5 mL/min; paired *t* test, $p = 0.018$). Compliance with the supplement among the intervention group was 79.4%.

Baseline characteristics of the study participants were similar in the two groups, although there was a slightly greater prevalence of chronic disease in the intervention group ($p = .066$) (Table 1). The overall changes in the outcome variables of the 12-week intervention are presented in Table 2. Significant improvements in energy, protein, essential amino acid intake, and mean adequate ratio were observed in the intervention group relative to the control group ($p \leq .008$). For the primary outcome variables, PF increased by 5.9% in the intervention group, although no change was observed in the control group ($p = .052$). The median value of the absolute difference in PF was +1 point in the intervention group. SPPB remained stable in the intervention group, although it decreased by 12.5% in controls ($p = .039$). The median value of the absolute difference in SPPB in the control group was −1 point. For the secondary outcome variables, UGS decreased by 1.0% in the intervention group versus 11.3% in controls ($p = .039$). The median value of the absolute difference in UGS in the control group was −0.04 m/s. TUG improved by 7.2% in the intervention group and declined by 3.4% in controls ($p = .038$). The median value of the absolute difference in time needed to complete the TUG test was 1.1 seconds shorter in the intervention group and 3.4 seconds longer in the control group. There were no differences between groups in hand grip strength, one-legged stance, bodyweight, mid-arm circumference, or serologic markers of renal function.

To identify the factors that determine preventive effects among frail older adults with low SES, Spearman's correlations were performed to determine the changes in the nutritional status and functional status during the study period (Table 3). There was a modest correlation between the relative change of PF with the relative change in protein intake ($r_s = .23$; $p = .037$) and mean adequacy ratio ($r_s = 0.25$; $p = .023$). However, no correlations were found with change of energy or essential amino acid intake. There was no correlation between change of SPPB and change in

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Table 1. Baseline Characteristics of Older Adults Participating in a Study of Nutritional Intervention

Characteristics	Intervention Group (n = 43)	Control Group (n = 44)
Age in years, mean ± SD	78.9 ± 5.5	78.4 ± 6.0
Aged ≥85, n (%)	8 (18.6)	8 (18.2)
Women, n (%)	34 (79.1)	35 (79.6)
Educational level of		
≤6 years (elementary school), n (%)	30 (69.8)	35 (79.6)
Living alone, n (%)	20 (46.5)	25 (56.8)
Social support network type, n (%)		
Family dependent	4 (9.3)	5 (11.4)
Locally integrated or wider community focused	22 (51.2)	17 (38.6)
Local self-contained or private	17 (39.5)	22 (50.0)
Monthly family income in US$, median (interquartile range)	339 (80, 427)	339 (176, 357)
Monthly family income <$400, n (%)	30 (69.8)	37 (84.1)
Beneficiary of public assistance, n (%)	30 (69.8)	30 (68.2)
Use of herbal medicine or multivitamin, n (%)	20 (46.5)	20 (45.5)
Currently smoking, n (%)	3 (7.0)	7 (15.9)
Consuming alcohol, n (%)	1 (2.3)	5 (11.4)
Use of food assistance program, n (%)		
Free meal service (by community welfare center)	6 (14.0)	6 (13.6)
Meal delivery service (by community welfare center)	15 (34.9)	18 (40.9)
Number of chronic diseases*, median (interquartile range)	5 (3, 6)	3 (2, 5)
Usual gait speed in m/s, mean ± SD	0.35 ± 0.13	0.38 ± 0.13
Mini Nutritional Assessment score, mean ± SD	17.9 ± 3.0	17.9 ± 3.3

Notes: There were no significant differences in any of these characteristics between the intervention and control groups. Chi-square and Fisher's exact tests were used for categorical variables, and independent t test and Wilcoxon rank-sum test were used for continuous variables.

*Self-reported physician diagnosis of chronic disease including myocardial infarction, angina, congestive heart failure, claudication, arthritis, cancer, diabetes, hypertension, chronic obstructive pulmonary disease, stroke, hyperlipidemia, osteoporosis, chronic renal failure, chronic liver disease, anemia, depression, and dementia.

any dietary intake data. Change in mid-arm circumference was positively correlated with a change of SPPB (r_s = 0.31; p = .004).

Discussion

This study demonstrates that protein-energy supplementation applied to frail older adults with low SES increases dietary intake and shows evidence of reducing the progression of functional decline. The results showed a significant effect on an objective index of functional performance. According to the literature, a minimally meaningful change in UGS was estimated as 0.04–0.06 m/second, and a substantial change in SPPB was estimated as 0.99–1.34 points (27). In the results of this study, differences in the median values of absolute difference between the study arms were 0.04 m/s for UGS and one point for SPPB. Although only a marginal effect was reported on the subjective outcome variable (PF), positive correlations were observed between the change of protein intake, mean adequacy ratio, and the change of PF.

The results of this study differ from previous studies. Previous attempts to prevent the functional decline of community-dwelling frail older adults with a single nutritional intervention have been disappointing. For example, Payette et al. did not report significant effect on functional variables after 16 weeks of providing supplemental liquid products (19). A major reason for this positive finding may be the differing characteristics of the study participants. Very low energy (958 ± 318 kcal/day), protein (35.6 ± 15.3 g/day), and essential amino acid (9.7 ± 4.5 g/day) intakes were observed in our study population, possibly resulting in negative nitrogen-energy balance and rapid decline of functional status (28). According to recent research, only a large amount of high-quality protein (at least 20 g of protein contains 5–8 g of essential amino acids) can restore this downward cycle and activate nitrogen kinetics to enhance muscle synthesis in frail older adults (25,29,30). In our study, mean differences in protein and essential amino acids in the intervention group were 19.5 and 7.8 g.

The main outcomes of this study are consistent with the theory of a nonlinear relationship between physiologic capacity and physical performance. Buchner et al. reported that a nonlinear relationship represents a mechanism by which small changes in physiologic capacity may produce relatively large effects on performance in frail adults, although large changes on capacity have little or no effect on daily function in healthy adults (31). Based on this theory, the intervention in this study may provide the small increase in physiologic capacity, such as nitrogen kinetics, that will allow a relatively large effect on functional performance among severely frail older adults.

Despite the favorable results, this study has some methodological limitations, and the results should be interpreted with caution. First, attention should be paid to the potential problem of multiple testing. Statistical significance for all primary endpoints is needed to reach a confirmatory conclusion; however, one of the primary variables was not deemed to be significant (p = .052). However, the results of the other variables are sufficiently consistent to suggest benefits in the intervention group. Second, although the dietary intake was assessed using 24-hour recalls in the pre- and post-periods of the study, there remained some limitation on the estimate of how much protein or energy was actually consumed by participants during the study periods. There were inconsistent results between change of energy intake and change of body weight (Table 2). Repeated monitoring of 24-hour recall on a biweekly basis may yield more accurate results regarding dietary intake data; this approach was used in the previous study (17). Third, the external validity of this study is limited. It is unclear whether consistent results can be reached in persons with higher socioeconomic status and/or better physical performance. However, internal validity is a more important issue because the basic efficacy of single nutritional intervention in frail older adults was not fully established, especially with regard to functional status. In addition, frail older adults

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Table 2. Relative and Absolute Changes in Primary, Secondary, and Adverse Outcome Measurements Between Study Arms Over the Course of a 12-Week Nutritional Intervention for Frail Older Adults With Low Socioeconomic Status

	Intervention Group ($n = 41$)				Control Group ($n = 43$)				p Value*
	Baseline	12-Week	% Change	Absolute Difference	Baseline	12-Week	% Change	Absolute Difference	
Primary outcome									
Physical Functioning	17.0 ± 5.3	18.2 ± 4.9	5.9 (−4.5, 22.2)	1 (−1, 3)	18.4 ± 5.8	18.4 ± 6.1	0 (−12.5, 8)	0 (−2, 1)	.052
Short Physical Performance Battery	5.5 ± 1.5	5.8 ± 1.6	0 (−12.5, 25)	0 (−1, 1)	5.7 ± 1.8	5.4 ± 2.2	−12.5 (−20, 16.7)	−1 (−1, 1)	.039
Secondary outcome									
Usual gait speed, m/s	0.35 ± 0.13	0.35 ± 0.13	−1.0 (−15.6, 33.9)	0 (−0.06, 0.07)	0.38 ± 0.13	0.32 ± 0.14	−11.3 (−32.8, 11.1)	−0.04 (−0.13, 0.04)	.039
Timed up-and-go test, s	22.2 ± 12.4	21.4 ± 12.2	−7.2 (−24.7, 9.9)	−1.1 (−5.5, 1.9)	21.5 ± 12.7	26.4 ± 25.3	3.4 (−14.9, 28.9)	0.9 (−2.3, 4.5)	.038
Grip strength, kg	15.3 ± 4.6	15.1 ± 4.8	2.7 (−13.2, 13.9)	0.5 (−2, 2)	16.3 ± 5.0	16.4 ± 5.3	−5.1 (−12.5, 9.8)	−1 (−2, 2)	.561
One-legged stance, s	3.4 ± 2.8	2.6 ± 1.9	−21.7 (−41.7, 6.5)	−0.8 (−1.5, 0.3)	3.9 ± 3.5	3.5 ± 3.5	0 (−40.3, 44.7)	0 (−0.8, 0.6)	.334
Energy intake, kcal/day	965 ± 309	1124 ± 315	19.5 (−5.4, 36.7)	199 (−52, 351)	951 ± 331	896 ± 277	−5.0 (−29.0, 16.8)	−36 (−325, 187)	.008
Protein, g/day	35.4 ± 15.9	54.7 ± 21.2	69.5 (8.0, 106.7)	19 (2.9, 28.2)	35.9 ± 15.0	32.7 ± 10.3	−11.5 (−29.1, 20.6)	−4 (−12, 8)	<.001
Essential amino acid, g/day	9.1 ± 4.1	16.9 ± 6.0	68.2 (30.1, 176.5)	7.0 (.04, 10.7)	10.4 ± 4.9	9.0 ± 3.7	−8.2 (−32.1, 18.8)	−1(−3, 1.5)	<.001
Mean adequate ratio†, %	55.4 ± 20.2	87.4 ± 24.2	49.9 (14.1, 106.6)	31.9 (8.2, 42.9)	60.4 ± 23.6	56.2 ± 18.8	−1.6 (−30.7, 30.2)	−0.7 (−21.7, 12.4)	<.001
Body weight, kg	47.4 ± 9.3	49.0 ± 9.4	2.5 ± 5.7	1.2 ± 2.8	44.4 ± 7.7	45.8 ± 8.0	2.8 ± 5.3	1.2 ± 2.3	.822
Mid-arm circumference	24.7 ± 3.3	25.8 ± 2.7	4.1 ± 8.6	0.9 ± 2.0	23.2 ± 2.6	24.3 ± 2.7	4.7 ± 8.2	1.0 ± 1.9	.735
Adverse outcome									
Serum blood urea nitrogen, mg/dL	17.3 ± 8.4	19.3 ± 8.2	12.1 (−5.2, 28.3)	2.1 (−0.7, 4.4)	19.0 ± 12.1	19.9 ± 9.9	5.9 (−7.3, 40.4)	1.1 (−1.2, 5.4)	.558
Creatinine clearance‡, mL/min	36.2 ± 12.7	39.1 ± 15.5	5.6 (−5.4, 23.3)	1.7 (−1.9, 6.1)	34.9 ± 13.5	36.7 ± 13.8	5.0 (−4.2, 15.9)	0.7 (−0.1, 5.3)	.832

Notes: Data are presented as median (interquartile range) or mean ± standard deviation according to the variable characteristics.

*p Values are calculated between group values of percentage change from Wilcoxon rank-sum test, except for two of the outcome variables (body weight, mid-arm circumference), which are calculated from independent t test.

†Mean adequate ratio is calculated from nutrient adequacy ratio for the intake of energy, protein, and 11 micronutrients (calcium, phosphorus, iron, zinc, vitamin A, thiamin, riboflavin, pyridoxine, niacin, vitamin C, and folate).

‡Creatinine clearance is calculated by Cockcroft-Gaut formula: [(140 − age) × weight(kg)]/[72 × serum creatinine(mg/dL)] × 0.85(for women).

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Table 3. Spearman Correlation Coefficients Between 12-Week Change of Functional Status and 12-Week Change of Nutritional Status Among Frail Older Adults With Low Socioeconomic Status (n = 84)

	12-Week Change of Physical Functioning		12-Week Change of Short Physical Performance Battery	
	r_s	p Value	r_s	p Value
12-week change of dietary intake data				
Energy, %	.14	.198	−.01	.915
Protein, %	.23	.037	.13	.231
Essential amino acid, %	.16	.138	.12	.278
Mean adequate ratio*, %	.25	.023	.14	.216
12-week change of anthropometric data				
Body weight, %	.06	.569	.06	.616
Mid-arm circumference, %	−.02	.867	.31	.004

*Mean adequate ratio is calculated from nutrient adequacy ratio for the intake of energy, protein, and 11 micronutrients (calcium, phosphorus, iron, zinc, vitamin A, thiamin, riboflavin, pyridoxine, niacin, vitamin C, and folate).

with low SES are an important subgroup in the perspective of healthcare policy; they are most likely to be the recipients of state-level programs and policies to reduce functional limitation and reduce the need for institutional care.

In conclusion, the present results indicate that protein-energy supplementation applied to frail older adults with low SES shows evidence of reducing the progression of functional decline. Further studies are needed to ascertain the beneficial effects and to better identify factors predicting the effects of nutritional supplementation.

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Conflicts of Interest

No conflicts of interest to declare.

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