

Supplementary Materials

Energy intake and nutritional status in older adults undergoing long-term rehabilitation for chronic diseases: A multicentre prospective study

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Supplementary Table 1. Baseline characteristics of patients included in the final analysis (n = 222) and those excluded due to missing discharge data (n = 114)[†]

	Included (Complete-case) group	Excluded (Missing discharge data) group	p-value
Sex (Male/Female), [n/%]	125 / 97 (56.3 / 43.7)	60 / 54 (52.6 / 47.4)	0.521
Disease category, [n/%]:			
Cardiovascular / Cerebrovascular / Respiratory / Musculoskeletal	37 / 48 / 88 / 49 (16.7 / 21.6 / 39.6 / 22.1)	11 / 19 / 56 / 28 (9.6 / 16.7 / 49.1 / 24.6)	0.151
Age (years) mean ± SD	78.9 ± 7.6	77.8 ± 6.9	0.212
MNA-SF, [n/%]:			
Score (Max 14)	10.0 (8.0–11.0)	10.0 (8.0–13.0)	0.444
Normal / At risk / Malnourished	54 / 124 / 44 (24.3 / 55.9 / 19.8)	39 / 52 / 23 (34.2 / 45.6 / 20.2)	0.124
Dietary type, [n/%]:			
Regular diets / Therapeutic diets / Others	97 / 104 / 21 (43.7 / 46.8 / 9.5)	51 / 55 / 8 (44.7 / 48.2 / 7.0)	0.752
Energy intake (kcal/kg/day)	24.5 ± 8.5	24.1 ± 8.8	0.693
Biochemical parameters:			
Hb (g/dL)	12.8 ± 1.9	12.7 ± 1.8	0.519
Alb (g/dL)	3.7 ± 0.6	3.6 ± 0.6	0.054
TLC (/μL)	1,327 ± 607	1,351 ± 663	0.742
CRP (mg/dL)	0.38 (0.11–2.24)	2.00 (0.14–7.85)	<0.001
Anthropometric measurements:			
BMI (kg/m ²)	22.0 ± 4.1	22.3 ± 4.6	0.179
AC (%)	99.3 ± 16.3	103.3 ± 14.7	0.033
TSF (%)	93.8 ± 54.3	101.2 ± 57.5	0.261
AMC (%)	100.3 ± 17.2	103.5 ± 13.5	0.100
CC (%)	98.0 ± 12.5	99.0 ± 11.4	0.532
BI: functional assessment of daily living	60 (30–100)	82.5 (38–100)	0.107

Hb, haemoglobin; Alb, albumin; TLC, total lymphocyte count; CRP, C-reactive protein; MNA-SF, Mini Nutritional Assessment Short-Form; BMI, body mass index; AC, arm circumference; TSF, triceps skinfold thickness; AMC, arm muscle circumference; CC, calf circumference; BI, Barthel Index.

[†]Seventy-four patients with missing baseline data at admission were excluded and not included in this comparison.

Statistical analysis: Student's t-test, chi-squared test (for sex and disease type), Fisher's exact test (for dietary type and MNA-SF classification), and Mann-Whitney U test (for CRP, MNA-SF score, and BI) were used for group comparisons.

Age, BMI, Hb, Alb, TLC, AC, TSF, AMC, and CC are presented as mean ± standard deviation (SD).

CRP, Barthel Index (BI), and MNA-SF scores were expressed as medians with interquartile ranges (IQR).

MNA-SF classification: 0–7 (malnutrition), 8–11 (at risk), 12–14 (good nutritional status).

Sex, disease category, dietary type, and MNA-SF nutritional status (normal, at risk, malnourished) are presented as numbers and percentages (n [%]).

Anthropometric values (AC, TSF, AMC, and CC) are presented as percentages of reference values (JARD 2001).

Abbreviations:

Supplementary Table 2. Energy intake sufficiency by disease category

Disease category	n	Energy intake at discharge (kcal/kg/day), median (IQR)	EER (kcal/kg/day), median (IQR)	Energy intake sufficiency (%), median (IQR)	Patients with adequate intake n (%)
Cardiovascular	37	24.8 (21.0–29.1)	28.9 (26.5–32.5)	83.0 (72.5–100.5)	12 (32.4)
Cerebrovascular	48	23.7 (19.2–26.7)	28.1 (26.4–30.2)	85.0 (63.8–97.8)	21 (43.8)
Respiratory	88	29.3 (24.9–36.2)	35.6 (32.4–38.8)	84.0 (73.0–96.8)	19 (21.6)
Musculoskeletal	49	26.2 (21.0–33.6)	31.6 (29.1–33.7)	84.0 (68.0–103.5)	17 (34.7)
Total	222	26.3 (22.6–32.2)	31.7 (28.7–35.6)	84.0 (71.0–98.4)	69 (31.1)

Energy intake sufficiency (%) was calculated as the ratio of actual energy intake at discharge to the estimated energy requirement, multiplied by 100.

Estimated energy requirements were calculated using sex-specific equations proposed by the National Institute of Health and Nutrition, Japan.

Values are presented as median (interquartile range, IQR) or number (percentage), as appropriate

Supplementary Table 3. Rehabilitation status by disease category

	All patients (n = 222)	Cardiovascular (n = 37)	Cerebrovascular (n = 48)	Respiratory (n = 88)	Musculoskeletal (n = 49)
Length of hospital stay (days)	26.2 ± 15.4	18.4 ± 8.2	22.5 ± 11.5	25.9 ± 16.8	36.2 ± 15.1
Proportion of patients who underwent rehabilitation (%)	83.3	91.9	89.6	69.3	95.9
Duration of rehabilitation (days)	13.0 (8.0–22.0)	11.0 (8.0–15.0)	11.5 (8.5–19.5)	10.0 (6.5–20.0)	25.0 (15.0–30.0)
Average daily rehabilitation time (minutes/day)	20 (14–30)	16 (14–30)	26 (20–39)	19 (11–24)	22 (15–30)

Length of hospital stay is presented as mean ± standard deviation (SD).

Duration of rehabilitation and daily rehabilitation time are presented as median (interquartile range, IQR).

Proportion of patients who underwent rehabilitation is presented as percentage (%).

Supplementary Table 4. Comparison of nutrient intake by dietary type at admission and discharge

		Regular diets	Therapeutic diets	Other	<i>p</i> -value
Intake at admission	(n)	87	85	50	
	Energy (kcal/kg/day)	28.6 ± 7.9 ‡§	23.4 ± 7.0 †§	19.4 ± 8.5 †‡	<0.001
	Protein (g/kg/day)	1.14 ± 0.33 ‡§	0.95 ± 0.29 †§	0.74 ± 0.35 †‡	<0.001
	Fat (g/kg/day)	0.59 ± 0.22	0.59 ± 0.26	0.59 ± 0.23	0.964
	Carbohydrate (g/kg/day)	3.70 ± 1.26	3.68 ± 1.64	3.79 ± 1.34	0.909
Intake at discharge	(n)	97	104	21	
	Energy (kcal/kg/day)	30.2 ± 7.9 ‡	24.8 ± 7.2 †	26.6 ± 7.6	<0.001
	Protein (g/kg/day)	1.21 ± 0.31 ‡	1.00 ± 0.33 †	1.10 ± 0.34	<0.001
	Fat (g/kg/day)	0.67 ± 0.23	0.66 ± 0.26	0.76 ± 0.24	0.232
	Carbohydrate (g/kg/day)	4.05 ± 1.40	4.34 ± 3.68	4.27 ± 0.78	0.748

Statistical analysis: One-way ANOVA followed by Tukey's post-hoc test.

Energy, protein, fat, and carbohydrate intake values are presented as mean ± standard deviation (SD).

Therapeutic diets include disease-specific dietary prescriptions with intentional modification or restriction of specific nutrients and/or total energy (e.g., sodium-restricted or fat-modified diets).

Others include modified texture diets and non-oral nutritional support, such as enteral nutrition (EN) and/or parenteral nutrition (PN).

†Significant difference compared to the Regular diet group (Tukey's test, $p < 0.05$).

‡Significant difference compared to the Therapeutic diet group (Tukey's test, $p < 0.05$).

§Significant difference compared to the Other group (Tukey's test, $p < 0.05$).

Supplementary Table 5. Comparison of nutrient intake by dietary type at admission and discharge

Variable	Model 1				Model 2			
	Binary		Continuous		Binary		Continuous	
	OR (95% CI)	p-value	B (SE)	p-value	OR (95% CI)	p-value	B (SE)	p-value
Age (per 10-year increase)	1.54 (0.96–2.47)	0.075	0.003 (0.002)	0.057	1.24 (0.80–1.90)	0.332	0.002 (0.002)	0.122
Sex (female vs male)	4.92 (2.46–9.82)	<0.001	0.168 (0.023)	<0.001	5.25 (2.75–10.04)	<0.001	0.172 (0.022)	<0.001
CRP at admission (log-transformed)	0.59 (0.49–0.71)	<0.001	-0.013 (0.002)	<0.001	0.65 (0.56–0.76)	<0.001	-0.012 (0.002)	<0.001
Energy intake at admission (per 5 kcal/kg/day increase)	2.16 (1.67–2.79)	<0.001	0.014 (0.001)	<0.001	1.96 (1.57–2.45)	<0.001	0.012 (0.001)	<0.001
CC at admission (per 10% increase)	0.89 (0.66–1.21)	0.464	-0.025 (0.100)	0.802				
TSF at admission (per 10% increase)					1.00 (0.94–1.06)	0.936	-0.022 (0.021)	0.303
MNA-SF score at admission					1.02 (0.90–1.17)	0.731	0.002 (0.004)	0.548
Disease category (overall effect)								
Cerebrovascular								
Respiratory								
Musculoskeletal								

Variable	Model 3			
	Binary		Continuous	
	OR (95% CI)	p-value	B (SE)	p-value
Age (per 10-year increase)	1.21 (0.76–1.94)	0.420	0.002 (0.001)	0.152
Sex (female vs male)	8.69 (3.90–19.39)	<0.001	0.177 (0.022)	<0.001
CRP at admission (log-transformed)	0.74 (0.61–0.88)	0.001	-0.012 (0.002)	<0.001
Energy intake at admission (per 5 kcal/kg/day increase)	2.95 (2.19–3.98)	<0.001	0.013 (0.001)	<0.001
CC at admission (per 10% increase)				
TSF at admission (per 10% increase)				
MNA-SF score at admission				
Disease category (overall effect)			—	0.297
Cerebrovascular	11.15 (3.13–39.66)	<0.001		
Respiratory	0.32 (0.09–1.15)	0.080		
Musculoskeletal	1.69 (0.51–5.65)	0.391		

OR, odds ratio; CI, confidence interval; SE, standard error; CRP, C-reactive protein; CC, calf circumference; TSF, triceps skinfold thickness; MNA-SF, Mini Nutritional Assessment–Short Form; IPW, inverse probability weighting.

Statistical analyses were performed to identify factors at admission associated with energy intake sufficiency at discharge.

For the binary outcome (energy intake sufficiency at discharge, defined as $\geq 100\%$ of estimated energy requirement), inverse probability weighting (IPW)–weighted multivariable logistic regression models were used, and results are presented as odds ratios (ORs) with 95% confidence intervals (CIs) and p-values.

For the continuous outcome (energy sufficiency ratio at discharge), multivariable linear regression models were used, and results are presented as unstandardized regression coefficients (B) with standard errors (SEs) and p-values.

Model 1 included age, sex, log-transformed CRP, energy intake (kcal/kg/day), and calf circumference (CC).

Model 2 included age, sex, log-transformed CRP, energy intake (kcal/kg/day), triceps skinfold thickness (TSF), and MNA-SF score.

Model 3 included age, sex, log-transformed CRP, energy intake (kcal/kg/day), and disease category (cardiovascular [reference], cerebrovascular, respiratory, musculoskeletal).

Continuous variables were rescaled for interpretability: age per 10-year increase, energy intake per 5 kcal/kg/day increase, and CC and TSF per 10% increase (expressed as ratios relative to the JARD2001 reference, where 1.00 = 100%). CRP was log-transformed because of its right-skewed distribution.

For the binary outcome, disease categories are shown as category-specific ORs relative to the cardiovascular group. For the continuous outcome, the p-value for disease category represents the overall effect of the categorical variable in the model.

Supplementary Table 6. Factors at admission associated with energy sufficiency at discharge after multiple imputation

Variable	Model 1			Model 2			Model 3		
	OR	95% CI (lower – upper)	p-value	OR	95% CI (lower – upper)	p-value	OR	95% CI (lower – upper)	p-value
Age (per 10-year increase)	1.32	0.91 – 1.92	0.140	1.36	0.93 – 1.98	0.113	1.27	0.85 – 1.90	0.247
Sex (female vs male)	4.67	2.67 – 8.16	<0.001	4.74	2.70 – 8.30	<0.001	7.01	3.49 – 14.08	<0.001
CRP at admission (log-transformed)	0.70	0.61 – 0.81	<0.001	0.71	0.61 – 0.81	<0.001	0.81	0.68 – 0.95	0.009
Energy intake at admission (per 5 kcal/kg/day increase)	1.99	1.62 – 2.43	<0.001	2.02	1.65 – 2.48	<0.001	2.98	2.28 – 3.90	<0.001
CC at admission (per 10% increase)	0.95	0.09 – 10.23	0.965						
TSF at admission (per 10% increase)				1.03	0.60 – 1.76	0.921			
MNA-SF score at admission				1.03	0.92 – 1.16	0.580			
Disease category (ref: Cardiovascular)									
Cerebrovascular							6.48	2.34 – 17.94	<0.001
Respiratory							0.23	0.08 – 0.69	0.008
Musculoskeletal							1.11	0.42 – 2.98	0.831

CC, calf circumference; CRP, C-reactive protein; MNA-SF, Mini Nutritional Assessment–Short Form; TSF, triceps skinfold thickness; OR, odds ratio; CI, confidence interval.

Statistical analysis. Multivariable binary logistic regression was performed using pooled estimates obtained from multiple imputation to identify factors associated with sufficient energy intake at discharge ($\geq 100\%$ of estimated energy requirement).

All explanatory variables were assessed at admission unless otherwise specified.

Model 1 included age, sex, log-transformed CRP, energy intake (kcal/kg/day), and calf circumference (CC).

Model 2 included age, sex, log-transformed CRP, energy intake (kcal/kg/day), triceps skinfold thickness (TSF), and MNA-SF score.

Model 3 included age, sex, log-transformed CRP, energy intake (kcal/kg/day), and disease category (cardiovascular [reference], cerebrovascular, respiratory, musculoskeletal).

Continuous variables were rescaled for interpretability: age per 10-year increase, energy intake per 5 kcal/kg/day increase, and CC and TSF per 10% increase (expressed as ratios relative to the JARD2001 reference, where 1.00 = 100%). CRP was log-transformed because of its right-skewed distribution.

Reference categories: male for sex; cardiovascular for disease category.

Supplementary Table 7. Comparison of baseline characteristics between patients with adequate and inadequate energy intake at discharge

	Cardiovascular Disease (37)			Cerebrovascular Disease (48)		
	Adequate group (12)	Inadequate group (25)	<i>p</i> -value	Adequate group (21)	Inadequate group (27)	<i>p</i> -value
Age (years)	82.6 ± 9.3	79.2 ± 9.1	0.295	77.9 ± 6.0	76.9 ± 8.2	0.634
Sex (Male/Female), n	2 / 10	19 / 6	0.001	16 / 5	21 / 6	0.897
[Proportion, %]	16.7 / 87.3	76.0 / 24.0		76.2 / 23.8	77.8 / 22.2	
Length of hospital stay	22.7 ± 6.2	16.4 ± 8.4	0.027	20.7 ± 13.6	23.8 ± 9.7	0.362
MNA-SF score (Max 14)	9.5 (8.5–10.0)	11.0 (10.0–13.0)	0.018	10.0 (9.0–11.0)	10.0 (6.5–11.0)	0.424
Dietary type (n/%)						
Regular diets / Therapeutic diets / Others	0 / 10 / 2 (0 / 83.3 / 16.7)	3 / 20 / 2 (12.0 / 80.0 / 8.0)	0.365	1 / 11 / 9 (4.8 / 52.4 / 42.8)	7 / 10 / 10 (25.9 / 37.0 / 37.0)	0.141
Energy intake at admission (kcal/kg/day)	29.6 ± 4.2	22.8 ± 4.8	<0.001	26.6 ± 4.8	20.3 ± 6.3	<0.001
Biochemical parameters						
Hb (g/dL)	12.5 ± 1.9	12.9 ± 1.8	0.608	13.3 ± 1.8	13.4 ± 2.2	0.907
Alb (g/dL)	3.7 ± 0.2	4.0 ± 0.4	0.094	3.9 ± 0.5	3.8 ± 0.7	0.452
TLC (/μL)	1,186 ± 336	1,066 ± 727	0.591	1,491 ± 527	1,400 ± 850	0.672
CRP (mg/dL)	0.03 (0.03–0.62)	0.17 (0.07–0.30)	0.199	0.11 (0.06–0.29)	0.57 (0.17–1.79)	0.006
Anthropometric parameters						
BMI (kg/m ²)	22.8 ± 3.9	21.9 ± 4.5	0.983	23.8 ± 4.3	24.0 ± 3.3	0.855
AC (%)	103.0 ± 11.7	101.7 ± 10.7	0.731	103.3 ± 15.0	107.4 ± 14.0	0.333
TSF (%)	90.5 ± 44.6	108.7 ± 37.7	0.205	112.2 ± 57.8	125.8 ± 68.7	0.472
AMC (%)	102.7 ± 10.3	100.3 ± 11.0	0.516	102.2 ± 16.4	104.9 ± 13.5	0.528
CC (%)	99.8 ± 10.5	102.6 ± 10.0	0.435	100.0 ± 15.5	101.7 ± 11.3	0.669
BI	85 (45–100)	100 (65–100)	0.289	40 (30–70)	25 (22.5–40)	0.035

Hb, haemoglobin; Alb, albumin; TLC, total lymphocyte count; CRP, C-reactive protein; MNA-SF, Mini Nutritional Assessment Short-Form; BMI, body mass index; AC, arm circumference; TSF, triceps skinfold thickness; AMC, arm muscle circumference; CC, calf circumference; BI, Barthel Index.

Statistical analysis: Comparisons within each disease category were performed. Student's *t*-test was used for continuous variables, and the Mann–Whitney *U* test was applied for non-normally distributed variables (CRP, MNA-SF score, and BI). Categorical variables were compared using the chi-squared test or Fisher's exact test, as appropriate.

Data presentation: Continuous variables are presented as mean ± standard deviation (SD), and CRP, BI, and MNA-SF total score are presented as median (interquartile range, IQR). Categorical variables are presented as numbers (percentages).

MNA-SF classification: 0–7 (malnourished), 8–11 (at risk), and 12–14 (normal).

Anthropometric indices (AC, TSF, AMC, and CC) are presented as percentages of reference values (JARD, 2001).

Supplementary Table 7. Comparison of baseline characteristics between patients with adequate and inadequate energy intake at discharge (cont.)

	Respiratory Disease (88)			Musculoskeletal Disease (49)		
	Adequate group (19)	Inadequate group (69)	<i>p</i> -value	Adequate group (17)	Inadequate group (32)	<i>p</i> -value
Age (years)	78.6 ± 6.4	78.4 ± 6.8	0.903	82.5 ± 8.5	78.6 ± 7.8	0.115
Sex (Male/Female), n	6 / 13	50 / 19	0.001	1 / 16	10 / 22	0.043
[Proportion, %]	31.6 / 68.4	72.5 / 27.5		5.9 / 94.1	31.3 / 68.8	
Length of hospital stay	27.0 ± 14.1	25.6 ± 17.6	0.749	37.3 ± 16.2	35.6 ± 14.6	0.716
MNA-SF score (Max 14)	9.0 (6.5–10.5)	10.0 (7.0–11.0)	0.321	10.0 (9.0–10.0)	11.5 (9.5–13.5)	0.012
Dietary type (n/%)						
Regular diets / Therapeutic diets / Others	15 / 1 / 3 (78.9 / 5.3 / 15.8)	48 / 10 / 11 (69.6 / 14.5 / 15.9)	0.549	8 / 7 / 2 (47.1 / 41.2 / 11.8)	5 / 16 / 11 (15.6 / 50.0 / 34.4)	0.040
Energy intake at admission (kcal/kg/day)	40.0 ± 6.0	27.9 ± 6.7	<0.001	35.4 ± 6.0	23.4 ± 4.9	<0.001
Biochemical parameters						
Hb (g/dL)	13.1 ± 1.6	12.8 ± 1.8	0.535	11.9 ± 2.1	12.5 ± 1.8	0.241
Alb (g/dL)	3.6 ± 0.4	3.5 ± 0.6	0.327	3.9 ± 0.6	3.9 ± 0.5	0.869
TLC (/μL)	1,143 ± 631	1,203 ± 539	0.680	759 ± 751	1,320 ± 604	0.007
CRP (mg/dL)	0.44 (0.28–1.82)	2.50 (0.27–7.43)	0.033	0.78 (0.15–1.15)	0.27 (0.06–2.05)	0.578
Anthropometric parameters						
BMI (kg/m ²)	18.1 ± 3.7	20.8 ± 3.7	0.005	19.8 ± 2.7	23.5 ± 3.6	<0.001
89.0 ± 12.9	97.0 ± 19.2	0.093	92.0 ± 11.3	101.6 ± 12.6	0.012	0.333
60.5 ± 45.4	89.0 ± 52.6	0.034	61.1 ± 43.8	91.9 ± 46.6	0.029	0.472
95.7 ± 15.4	98.2 ± 22.7	0.652	99.4 ± 13.8	103.4 ± 12.5	0.306	0.528
89.1 ± 13.6	93.9 ± 11.0	0.113	97.5 ± 12.9	103.3 ± 11.9	0.121	0.669
BI	100 (45–100)	75 (45–100)	0.234	40 (30–50)	65 (30–100)	0.035

Hb, haemoglobin; Alb, albumin; TLC, total lymphocyte count; CRP, C-reactive protein; MNA-SF, Mini Nutritional Assessment Short-Form; BMI, body mass index; AC, arm circumference; TSF, triceps skinfold thickness; AMC, arm muscle circumference; CC, calf circumference; BI, Barthel Index.

Statistical analysis: Comparisons within each disease category were performed. Student's *t*-test was used for continuous variables, and the Mann–Whitney *U* test was applied for non-normally distributed variables (CRP, MNA-SF score, and BI). Categorical variables were compared using the chi-squared test or Fisher's exact test, as appropriate.

Data presentation: Continuous variables are presented as mean ± standard deviation (SD), and CRP, BI, and MNA-SF total score are presented as median (interquartile range, IQR). Categorical variables are presented as numbers (percentages).

MNA-SF classification: 0–7 (malnourished), 8–11 (at risk), and 12–14 (normal).

Anthropometric indices (AC, TSF, AMC, and CC) are presented as percentages of reference values (JARD, 2001).